ISSN 1682-0800

European Competitiveness Report

2009

European Commission
Enterprise and Industry

European Competitiveness Report

2009

Commission staff working document

SEC(2009)1657 final

European
Commission

Cover photo: Crystall ball & World © Sebastian Duda #4877219

ENTERPRISE & INDUSTRY MAGAZINE

The Enterprise & Industry online magazine (http://ec.europa.eu/enterprise/e_i/index_en.htm) covers issues related to SMEs, innovation, entrepreneurship, the single market for goods, competitiveness and environmental protection, better regulation, industrial policies across a wide range of sectors, and more.

The printed edition of the magazine is published three times a year. You can subscribe online (http://ec.europa.eu/enterprise/e_i/subscription_en.htm) to receive it – in English, French or German – free of charge by post.

Europe Direct is a service to help you find answers to your questions about the European Union

Freephone number (*)**:**

00 800 6 7 8 9 10 11

(*) Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

This publication has been prepared by Unit B4, Economic Analysis and Evaluation,
DG Enterprise and Industry. For further information, contact
http://ec.europa.eu/enterprise/policies/industrial-competitiveness/competitiveness-analysis/index_en.htm

This publication is financed under the Competitiveness and Innovation Framework Programme (CIP) which aims to encourage the competitiveness of European enterprises.

More information on the European Union is available on the Internet (http://europa.eu).
Cataloguing data can be found at the end of this publication.
Luxembourg: Publications Office of the European Union, 2010

ISBN 978-92-79-12982-7
doi: 10.2769/21563

Printed in Luxembourg

Printed on white chlorine-free paper

EXECUTIVE SUMMARY

1. Introduction

The European Union and the world economy have witnessed a deep economic crisis. Global competition has become tougher as a result of the slump in demand and the built-up of over-capacities on the supply side. Over a longer-term perspective, the competitiveness of EU businesses on the quickly evolving world markets will remain the key determinant of EU prosperity.

That is why the European Economic Recovery Plan, while boosting demand through a coordinated fiscal stimulus, is accompanied by a commitment to accelerate structural reforms. Based on the Lisbon Partnership for Growth and Jobs, it in particular aims to boost future EU competitiveness by investing in a more innovative, highly skilled and low-carbon economy.

In order to underpin discussions about future priorities, this year's edition of the annual Competitiveness Report looks first at the possible short-term implications of the economic downturn for productivity developments — the key factor for competitiveness in the long run — and second at some of the main future determinants of the EU competitiveness position on the world markets: the evolving characteristics of the BRIC (Brazil, Russia, India and China) economies; the role of migration, in particular impact of its skill structure on EU productivity; the extent to and conditions under which training can boost productivity, with a particular emphasis on the role of Information and Communication Technologies (ICT) as a magnifier of training benefits; and the role of product and labour market regulations in influencing ICT investment and their joint relationship with productivity.

2. Overall competitiveness performance

The crisis thwarted the recovery from the 2001 slowdown

The bursting of the large real-estate and stock-market bubble in the US and in some European countries has put a halt to the robust growth seen since 2006. The wealth contraction associated with the bubble burst has negatively affected consumption and, by extension, almost all economic activity. The situation has been further exacerbated by the financial crisis and the contraction in international trade. The combination of these factors has yielded a downturn unprecedented in both magnitude and scope.

Output has been falling markedly in durables and equipment goods' sectors

The crisis has particularly affected demand for consumer durables as a result of reduced consumption saving by households. This lower demand is in turn, along with the uncertainty normally associated with turmoil, leading firms to freeze employment and investment projects. As a consequence, at sectoral level the classical pattern is observed where consumer non-durables, energy and services are contracting less than consumer durables and investment equipment goods. By mid-2009, manufacturing and services had contracted by about 20 and 10 per cent, respectively, on an annual basis. Within manufacturing, the contraction in electrical equipment and fabricated metal products exceeded 20 per cent and

for motor vehicles and basic metals even 30 per cent. In addition, the construction sector, directly affected by the real-estate bubble and usually one of the first sectors where employment drops, is set to undergo a major adjustment.

Employment has not yet hit the bottom

By mid-2009 the rise of unemployment was still moderate given the magnitude of the reduction in output and the adjustment in construction and services (in the order of two or three percentage points) probably due to the wide application of short term working schemes. Hence, one may expect a further contraction in employment in manufacturing and less markedly in services.

Key features of recent trends in the EU economy prior to the crisis

From a longer term perspective, two salient features stand out when examining sectoral trends.

First, the outsourcing of services from manufacturing has recently intensified and partly explains why productivity in manufacturing has grown faster than in services[1], maintaining a strong share of manufacturing in value added despite a contraction in employment. Outsourcing may also constitute an important part of the explanation for the increasing share of services in the economy, as value added previously recorded as manufacturing now appears as part of services. The quantitative importance of the inter-linkages between manufacturing and services in the EU is illustrated by the estimate that manufacturing "pulls" on average 17 per cent of its total production from services (uses services as input) and "pushes" an average 8 per cent of its total supply into the services sector.

Second, within manufacturing, the most recent EU enlargements have had a significant impact on EU industrial structure. Open international trade has increased access to export markets as well as the pressure on EU companies to remain internationally competitive. In high-tech products the EU is facing notable pressure from emerging countries but is maintaining a competitive position in this market segment: the EU has the highest international market share in high-tech exports; furthermore, it is improving its competitive position as reflected by increasing revealed comparative advantage indices, contrasting with the deteriorating position, both in absolute and relative terms, for the US and Japan.

Recessions may boost competitiveness

The impact of a large recession on productivity in the medium and long term may have both positive and negative aspects. Indeed, contrary to what one might expect, historical experience does not indicate any systematic negative impact of a recession on long-term growth.

Despite a negative impact in the short term…

In the very short term, a downturn has a "mechanical" negative impact on productivity due to changes in the intensity of use of factors, which are however difficult to measure.

For a number of reasons, firms are well-advised not to lay off their workers in the wake of a temporary slump in production. Thus, labour-hoarding or work-sharing schemes typically help to keep employment fairly stable in the early months of a recession. This is particularly true in manufacturing. The reasons are multiple. In a labour market with asymmetric information on both vacancies and job seekers, labour-hoarding preserves good matches that may be difficult to reproduce. Further, if there is an important learning-by-doing component in a worker's productivity, labour-hoarding may also preserve firm-specific human capital that will be costly to rebuild. Finally, if despite the above-mentioned reasons for firms not to lay off workers, firms decide to downsize their workforce, they may still be held back by labour market regulations and the resulting firing costs. As a consequence, the same number of employees produce less output and measured productivity thus drops. However, this does not reflect technical change and may explain why, once employment starts to fall, measured productivity recovers so quickly well before the recession is over.

... And some long-term risk factors…

Nevertheless, there are also real long-term effects on productivity. Understanding their mechanisms is important to design right policies during a recession.

Productivity will be negatively affected by firms having to freeze investment projects, particularly if they are liquidity- or credit-constrained. Postponed investment projects will decrease future productivity by extending the life of relatively obsolete equipment while missing the opportunity to improve productivity through better reorganisation of the production process and the improvement in quality embodied in new investment goods. The destruction of supply-chain and distribution networks — organisational capital — may negatively affect productivity directly but also divert resources from firms to rebuild these commercial relations. However, while these networks are not restored, the effect

1 Over the period 1995-2007, productivity in manufacturing grew at an average 3.2 per cent, i.e. much faster than in other sectors.

will be to depress total factor productivity and labour productivity.

In the labour market, when employment starts to contract, lay-offs will cause firm-specific human capital to be lost while unemployment, particularly long-term unemployment, is associated with a strong depreciation in human capital.

Finally, in bad times, many firms turn to aggressive cost-saving strategies and a usual target is innovation and, in particular, R&D expenditure.

… Other mechanisms may boost productivity and competitiveness

Other firms, particularly those whose business models rely on innovation, will intensify innovative activities as a way forward in an increasingly competitive environment.

A recession can also help in adopting the most productive technologies and business practices. The selection mechanism is closely related to the impact of the restructuring that often comes together with a crisis. There are gains from selecting more productive firms and reallocating resources to best performers. In close connection with this mechanism and the notion of creative destruction, a recession may induce firms to develop or adopt better technologies in order to be better fit to survive the downturn. Those who fail to adapt will face a higher probability of disappearing.

Less intensive use of physical capital may significantly decrease the rate of depreciation of the stock of machines. At the same time, on the human capital side, a recession may also be an opportunity to intensify the accumulation of human capital, both in the formal education sector and on-the-job: younger people may decide to postpone entry into the job market by extending their period of education while firms facing low levels of activity may encourage workers to engage in on-the-job training.

Momentum for reforms

All in all, it is not evident that a recession will necessarily have a negative impact on long-term productivity and therefore GDP growth. Policies that help enterprises invest in innovation and reap emerging market opportunities, and which boost investment in human capital, are key to turning challenges into opportunities. But perhaps the strongest positive impact on productivity comes from the momentum that a crisis may provide for structural reforms.

That is why the European Economic Recovery Plan (EERP) is embedded within the Lisbon Partnership for Growth and Jobs and reconciles short-term action with long-term priorities. On the one hand, the task is to preserve the Single Market and integrate the EU further in international markets. It is indeed a temptation in bad times to turn to protectionism in order to shield those most affected by the recession through exposure to trade, but such measures also hamper recovery and, if perpetuated, can hinder future growth. On the other hand, public intervention has been devised in order to comply broadly with the strategic aims of the Lisbon Strategy: investing in the right skills; energy efficiency; clean technologies to speed up the transition to a low-carbon economy; support for small and medium-sized enterprises; better regulation and investing in infrastructure and interconnection in network grids in order to promote efficiency and innovation.

Many of these interventions reinforce mechanisms that have a positive impact on productivity, as mentioned above. For instance, measures to speed up the transition to a low-carbon economy create incentives to innovate. Many Member States have facilitated the adoption of work-sharing programmes in order to avoid unemployment but also to preserve the human and organisational capital of firms.

3. External dimension of EU competitiveness: challenges and opportunities presented by BRICs

Competition in world markets is both a test of the competitiveness of an economy and a chance to further enhance economic performance. Understanding the trends on fast changing international markets is therefore crucial. In this context, the quickly evolving competitiveness position of the so-called BRIC (Brazil, Russia, India and China) countries stands out.

While the immediate impact of the global crisis was a deep contraction in BRICs' foreign trade and, more worryingly, growing protectionist tendencies to support domestic industry, such as the "buy Chinese" initiative, the catching-up process in the BRICs is expected to continue, creating new opportunities as well as numerous challenges for the rest of the world and for the EU in particular.

Despite a common label, the engines of economic development in the BRICs are very different

All the BRICs have large populations and display fast economic growth, resulting in expanding markets. However, despite these common features, each indi-

vidual BRIC country has a different economic development model: Brazil is a domestically oriented service economy; the Russian economy is heavily dependent on energy exports; the Indian economy is essentially service-led, supported by exports; and China's economic development is driven by manufacturing exports and investment. Regarding energy, rising and potentially competing demand is coming from China and India, especially for oil and to a much lesser extent for gas. Russia and Brazil, on the other hand, are suppliers of energy.

China has shown clear signs of technological upgrading

Since 2000, the Triad (EU, US and Japan) has lost market shares in global markets to the BRICs and in particular China, which has become the second largest exporter of goods. Despite the EU's relative success in keeping high market shares, it has trade deficits with all BRICs except India.

Technology-driven industries increasingly dominate EU imports from China. In 2007, the share of these industries in EU imports from China was already higher than in intra-EU imports while high-skill industries recorded rapidly rising shares between 2000 and 2007, providing evidence for China's technological upgrading. Moreover, China (as well as India and even Russia) has been successful in price competition in high-skill industries and gained market shares in the EU. In a longer-term perspective, this striving for "industrial upgrading" poses the most serious challenge to the EU in maintaining its competitive advantages in high value-added products and services.

Several factors contribute to China's strong export performance. One is that trade and investment of the Triad countries have provided China with the necessary capital goods, technology and know-how to diversify and upgrade domestic industrial and export capacities. A distinctive feature of Chinese trade is its increasing involvement in the global supply chain. In addition, foreign investment firms account for more than half of Chinese exports. Indeed, much evidence suggests that China's bilateral trade balances and comparative advantages reflect to a large extent the competitiveness of foreign firms exporting out of China.

The EU emerges as the largest provider of FDI for BRICs, guided by market-seeking opportunities

In this context, it is significant that although the share of EU FDI going to the BRICs still remains small – and has increased only moderately since 2002 – the EU is the largest provider of FDI in each of these countries. As in the case of global outward FDI, EU FDI stocks owned in the BRICs are skewed to the services sector confirming the importance of direct investment in the internationalisation of services. Indeed, as services are much less tradable than goods, settling in BRICs (through FDIs) is the main alternative for EU companies to get access to those fast-growing markets.

Based on investors reported motivations, investment decisions appear to be largely guided by the growth of the host market, more than by production costs. This suggests a longer term perspective for investment in these markets, as likely wage increases and associated rising costs will not deter investors, but may rather attract them further due to growing demand.

However, fully reaping these opportunities hinges upon the willingness of the BRICs to address the many impediments for doing business that still exist, in particular in sectors that are considered to be less advanced, where there is a state monopoly or which are declared as "strategically important".

Challenges for the EU to enhance its economic relations with the BRICs and to reap opportunities

Further advancing trade relations with the BRIC countries presents tremendous opportunities for the EU in terms of access to large and fast-growing markets and in terms of savings from a better global division of labour.

However, in line with the above-mentioned specificities of each of the BRICs, the challenges and opportunities differ for each of them. In a nutshell, the biggest challenges for EU policies will concern manufacturing with regard to China, services with regard to India, agriculture (including biofuels) with regard to Brazil, and energy (especially gas) in relations with Russia. However, manufacturing is going to play an increasing role in relations with India, Brazil and probably Russia as well, and the outsourcing of services will gain importance with China.

Main challenges for building mutually beneficial economic relations with the BRICs arise from the still weak regulatory framework and various institutional impediments linked, for example, to uneven enforcement of laws, continuing non-tariff barriers to trade (including certification procedures and standards) and the low standards built into environmental regulations and labour laws, which moreover often discriminate against foreign companies. Prominent examples are intellectual property rights protection and its enforcement in China, labour legislation in India and Russia, and environmental regulations in both Russia and China.

In addition, the strong state interference in the BRIC economies – taking the form of various subsidies, privileged access to bank loans or raw materials, or tax

preferences, especially for the state-owned enterprises – makes BRICs' exports to the EU cheaper, impairing the competitiveness of EU companies on both home and third markets. State interference is particularly high in Russia and China, which poses great challenges for the EU in particular in view of the export-driven character of the Chinese economy.

Finally, in the light of new development plans and current industrial policies in the BRICs – with a focus on improving infrastructure and diversification of the economy – policy areas such as public procurement and public-private partnerships (particularly in Russia) will gain importance. Moreover, the restructuring and technological upgrading of the BRICs will increase demand for investment goods, where the EU has, and is expected to keep, a comparative advantage with respect to the BRICs. As in the case of consumer goods, special support for SMEs with regard to market research and direct investment would encourage more European enterprises to tap new distant markets.

In the EU's energy relations with China and India, supporting energy efficiency and the use of renewable energy sources will be important. In the case of Russia, energy security in connection with the EU's internal energy market regulations and energy transit represent the major challenges. With respect to Brazil, important issues are the standardisation of biofuels (which should facilitate trade), subsidisation, and tariff barriers.

4. Migration, skills and productivity

As global competitors move up the value chain, and as immigration and emigration barriers decrease, the capacity to build human capital and to attract and retain the most qualified workers is increasingly becoming the key factor for economic success.

In this context, two challenges are of a pressing character: attracting qualified migrants and fostering skill upgrading in the EU. Evidence that EU countries have a lower share of highly qualified migrants than high-migration non-EU OECD economies and that the provision and quality of training varies widely in the EU signals the need for both the EU as a whole and for individual EU countries to do more.

Making use of the rich skill potential of migrants

In comparison with other receiving countries the EU economies attract – on average – a relatively lower share of the highly skilled migrants from source countries. Most EU-27 countries have undertaken steps in recent years to change immigration rules in order to better target highly skilled migrants, which has resulted in a growing share of high-skilled migrants settling in the EU.

At the same time, there is rising labour market demand for low-skilled workers, who often enter the EU labour market as temporary or seasonal workers or even illegal migrants. While international competition for migrants is focusing primarily on the high-skilled, comprehensive migration policies therefore need to address future labour market needs across the full skill spectrum.

With respect to high-skilled migrants, evidence shows that increasing the selectivity of migration regimes alone will not suffice to attract more highly skilled foreign labour. This is because high-skilled migrants are sensitive to impediments, such as the still fragmented nature of EU labour markets, which hinder both the mutual recognition of qualifications and the transparent portability of entitlements to social security systems.

Initiatives that enable migrants to work within the entire EU and which focus on the highly skilled, such as the "blue card"[2], but also the creation of European networks with the aim of cross-linking national agencies and providing job exchange platforms are good examples of measures that could provide substantial returns in this respect.

The EU is also weak in using the potential of high-skilled migrants. In contrast to less-skilled workers, highly skilled migrants have lower labour market participation rates, higher unemployment rates and lower employment rates than natives with comparable qualifications, and face a substantially higher risk of being employed in jobs that do not fit their skill profiles. In almost all fields (except the health sector) and all countries, migrants also tend to receive less training than non-migrants.

Therefore, there is a need for increased efforts to integrate highly skilled foreign-born workers into the labour market in particular as regards highly skilled women. Aside from measures to improve the language skills of migrants, the mutual acceptance of professional qualifications, and training and action to fight discriminatory practices in the workplace, a number of EU-27 countries acknowledge that improved integration requires a more broad-based approach backed by measures to improve the social, cultural, regional and political integration of foreign-born workers.

Finally, it should be noted that, quite apart from highly skilled migrants from third countries, migrants within the EU are also often faced with a sizeable "transferability discount" on their human capital, which is reflected in higher rates of over-qualification and lower employ-

2 Cf. Council Directive 2009/50/EC of 25 May 2009.

ment rates. This applies to migrants moving from one EU-15 country to another, but even more so to migrants from the new Member States to the old Member States, who (even after correcting for differences in age and gender structure) face an over-qualification risk 29.6 percentage points higher than for natives, while medium skilled migrants from the new Member States have an over-qualification risk 19.6 percentage points higher than that of natives.

Policy instruments to reduce over-qualification among EU migrants clearly should follow similar lines as initiatives targeting third-country migrants (i.e. giving high priority to formal and informal transferability of qualifications, language proficiency and training). With respect to these intra-EU migrants, the role of the European Union in devising policy instruments, programmes and supervising their effective implementation could be particularly important.

Ensure higher training uptake and a higher impact of training on productivity

According to survey evidence from 2006, the proportion of workers trained was much higher in the old Member States than in the new EU Member States. However, there seems to be a trade-off between the length of training and the proportion of people benefiting from training. While more workers are trained in the EU-15, trainings in the new Member States tends to be longer.

In almost every EU country, lower-skilled and older workers are less likely than other workers to receive training. This is due to the individuals themselves, but also to the reluctance of employers to invest in such workers. For instance, older people are less likely to enrol in training because they are closer to retirement, and their employers or they themselves expect a lower return on training. More generally, barriers to training are generated by three main types of factors: a person's situation in life at a given time, institutional factors (high fees, entrance requirements, etc.) or psychological factors. Research on the topic suggests that policies can be put in place to counter those barriers. Since older people have a lower training uptake, they can be encouraged to engage more in training by stressing the tangible benefits they can expect, by making the purpose of training clearer or by closely linking training to specific employment opportunities.

In addition, available analysis on training take-up suggests that the longer an employee has been in a job the higher the probability of undertaking on-the-job training. This implies that labour market systems that promote long-term relationships between firms and workers might have positive impacts on human capital accumulation.

Finally, the available analyses find that, for training to result in a sustained increase in labour productivity, the combination of training and ICT investment is essential, in particular in countries with a more "academic" general education system. Considering the pervasiveness of ICT, general training provision backed by ICT capital has in many cases more impact than training alone. Conversely, training appears to have a direct impact on the adoption and efficient use of ICT, although this impact is gender-, age- and skill-specific. This is consistent with recent research emphasising the role of organisational changes and retraining of the workforce to underpin the diffusion of new technology.

5. Regulation, ICT and productivity

Empirical evidence indicates that it is the flexibility of the US economy in adapting to major changes – such as the IT revolution – that has given it a temporary productivity advantage, while predicting at the same time that the EU will start realising enhanced IT-driven productivity growth over the next few years.

As excessive or inadequate regulations are believed to be a constraint on European competitiveness, the question should be asked whether excessive regulation may have negatively affected the adoption of ICT and hindered the effective translation of investment into productivity gains.

Regulation is found to constrain ICT investment and productivity

The available analyses shows that at the aggregate economy level, restrictive regulatory regimes[3] for product markets both hinder ICT investment as such and lower the impact of ICT capital input on productivity and that this impact is bigger for ICT investment than for non-ICT investment. From a sectoral perspective, product market regulation has a negative and significant effect upon investment in IT, software and other machinery and equipment.

With regard to labour market regulation[4], there is some evidence that employment protection legislation may impede ICT capital accumulation and productivity since it may hinder enterprises to make the shift towards high-skilled workers. It might however also be an indication

3 Product market regulation indicators (from OECD) relate to state control, barriers to entrepreneurship and barriers to trade and investment.

4 Labour market regulation indicators cover a number of factors including unionisation, social security systems, employment protection, labour compensation and taxation.

that enterprises do not or cannot provide for sufficient or adequate training to their employees.

Finally, account should be taken of the potential complementarities between product and labour market regulations. Some evidence is found that benefits from deregulating product markets in terms of ICT investment may be larger if labour markets have a certain degree of flexibility that allows firms to reorganise their factors of production in a more efficient way.

Further regulatory reforms are an opportunity to improve Europe's competitiveness

The importance of reducing administrative burdens, introducing flexibility in the labour markets and liberalising key sectors in the economy to reap the full potential of ICT technologies is thus clear. While significant product market reforms have been introduced over the last few years, their potential benefits are likely to be reduced if labour markets remain too rigid.

6. Implications

The analysis of the European Competitiveness Report 2009 confirms that if the crisis is used to trigger momentum for structural reforms it can become an opportunity to increase productivity growth and boost EU competitiveness.

Enhancing trade and investment relations with the BRICs and reaping the emerging opportunities will play a key role. In this context, besides the need to constantly reassert the EU's own competitive advantages, it will be crucial to push for improvements to the weak regulatory frameworks and the enforcement of laws in these countries, as well as addressing the strong state interference, including the build-up of non-tariff barriers to trade.

The EU labour market, in particular employment, merits special attention in getting out of the crisis and its aftermath. The priority areas, as mentioned by the June European Council, include promoting mobility, upgrading skills and matching labour market needs. In this context, re-thinking its migration policies could also strengthen the productivity performance of the European Union, as it seems to attract relatively few highly qualified migrants. In parallel, the labour market integration of high-skilled third country migrants needs to be improved.

Moreover, adequate training is a concrete solution for mobility, skill upgrading and labour mismatch. A highly skilled workforce is a source of long-term European comparative advantage. But not all training has the same impact and not all individuals that could benefit from training actually enrol. Maximising the impact of training therefore calls for the right policies to be put in place to target the right persons and offer training (including the use of ICT) that best matches the needs of the economy.

Besides the growing need for ICT training, the EU can do better in reaping the potential of ICT investments. In this context, improving the quality of regulatory regimes, including market liberalisation, is likely to generate incentives for further investment and provide solid ground for future growth.

Table of Contents

Introduction

This is the twelfth edition of the Commission's European Competitiveness Report since the 1994 Industry Council Resolution called on the Commission to produce such a report every year. Competitiveness is understood to mean a sustained rise in the standards of living of a nation or region and as low a level of involuntary unemployment as possible. For an industrial sector, the main competitiveness criterion is maintaining and improving its position in the global market.

As in previous years, the Report approaches the issues using insights from economic theory and empirical research and its ambition is to contribute to policy-making by bringing to attention relevant trends and developments and by discussing policy options. Its main subjects continue to be topics related to productivity, as the most reliable indicator for competitiveness over the longer term, and other microeconomic issues in the context of the Lisbon Partnership for Growth and Jobs.

The 2009 edition of European Competitiveness Report reviews the EU's overall competitiveness performance as well as the external and internal aspects of competitiveness. It looks at the external dimension of competitiveness by analysing the consequences of the recent developments among the BRIC countries (Brazil, Russia, India and China) in the global arena. This year's edition also investigates some other determinants of competitiveness of a more domestic character: the role of migration and in particular the impact of the skill structure of migration on productivity; the extent to and conditions under which training can boost productivity, with a particular emphasis on the role of Information and Communication Technologies (ICT) as a magnifier of training benefits; and the role of product and labour market regulations in influencing ICT investment and their joint relationship with productivity[5].

Chapter 1 provides a snapshot of recent developments, puts them into perspective compared with earlier recessions and analyses the likely impact on European competitiveness. The economic contraction may not necessarily have a negative impact on long-term productivity growth, and therefore growth of GDP, as there are powerful mechanisms boosting productivity as well. Indeed, the crisis can also have a positive impact on productivity to the extent that it provides the momentum for structural reforms. In fact, the challenge is to reconcile short-term action with long-term competitiveness, which means that the exceptional measures taken to tackle the crisis should be consistent with the EU's medium-term structural reforms.

The external dimension of EU competitiveness is confronted with the new challenges and opportunities presented by the BRIC countries. These countries have recently increased their role in world trade and bilateral trade with the EU. Though all have large populations and have in recent years displayed fast economic growth, resulting in quickly expanding markets, each individual BRIC country has followed a different economic development model. Thus, they also pose quite different challenges and opportunities for the EU, which are discussed in Chapter 2.

Chapter 3 addresses the issue of migration, skills and productivity, based on the notion that people are the cornerstone of a competitive EU. Considering that competition for talent is more and more a global phenomenon, and that immigration and emigration barriers have fallen, the EU needs to retain and attract the most qualified people. At the same time, improving the labour market integration of high-skilled migrants is essential, as they face higher unemployment rates and a higher risk of being over-qualified. This holds not only for third country migrants, but also for migrants from the new Member States to the EU-15.

This second aspect is further analysed in more details in Chapter 4 on education, training and productivity. This

5 The analysis of external and internal aspects of competitiveness is based on a number of background studies prepared for this year's Competitiveness Report (see Annex "List of background studies to the European Competitiveness Report 2009").

part starts out from the notion that ensuring the right qualifications for all participants in the labour market and matching these qualifications with the needs of the economy is of crucial importance. Training is one way of improving this match between skills and economic needs. Adequate training can generate higher productivity, and a skilled workforce is a source of long-term comparative advantage for the EU. And ICT, among other factors, may play an important role in such training.

Chapter 5, on regulation, ICT and productivity, analyses the importance of ICT for broader productivity gains in the economy. It explores the extent to which regulation in both the product and labour markets has affected investment in ICT versus non-ICT capital, but also investigates whether excessive regulation not only may have negatively affected the adoption of ICT, but also may have hindered the effective translation of investment into productivity gains.

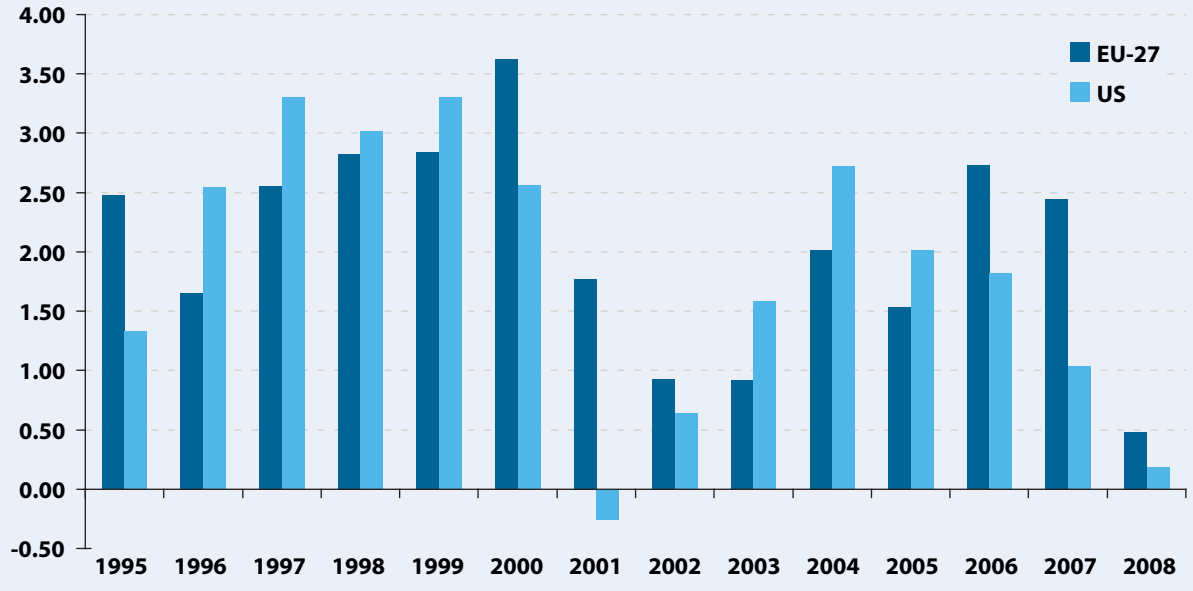
CHAPTER 1
Competitiveness and the crisis

1.1. Introduction

The crisis has brought about an unprecedented contraction in economic activity in both magnitude and scope. The bursting of a large real estate and stock market bubble in the US and some European countries has marked a dramatic downturn, further exacerbated and spread by the subsequent financial crisis and the contraction in international trade. The rate of growth in EU GDP per capita fell from 2.7 per cent in 2006 to 0.5 per cent in 2008. Forecasts for 2009 are negative and large in absolute terms: down to –4 per cent in 2009[6].

In this chapter we review the impact of the crisis on competitiveness[7], looking at short-term developments but also taking a broader longer-term perspective. While these developments are expected to have a negative impact on competitiveness in the short-term, there are also reasons to expect a rapid recovery in productivity. Not least because the crisis provides momentum for structural reforms that can boost future competitiveness.

Figure 1.1: Growth of GDP per capita



Source: AMECO database, Commission services.

6 Autumn Forecast, November 2009, DG Economic and Financial Affairs, European Commission.

7 Competitiveness relates to the ability of an economy to provide its citizens with sustained growth in living standards and broad access to jobs for those willing to work (see Box 1.1).

Box 1.1 Competitiveness

Competitiveness refers to the overall economic performance of a nation measured in terms of its ability to provide its citizens with growing living standards on a sustainable basis and broad access for jobs to those willing to work. At the roots of competitiveness we find the institutional and microeconomic policy arrangements that create conditions under which businesses can merge and thrive and individual creativity and effort are rewarded. Of equal importance are macroeconomic policies to promote a safe stable framework for business activity and the development of a strategic vision for a low-carbon economy to ensure environmental sustainability. To the extent that the notion of living standards encompasses many social aspects, this broad definition of competitiveness[8] comprises elements of all the three pillars of the Lisbon Strategy: prosperity as well as social and environmental issues.

This paper focuses on productivity and employment to provide a picture of the state of the European industry, both recent developments and from a longer-term perspective. Hence, attention is mostly restricted to three key indicators:

- Productivity, that is, value added per hour worked;
- The employment rate, the percentage of the working-age population that is in employment;
- The unemployment rate, the percentage of active population, people willing to work, that is out of employment.

Average labour productivity reflects the state of technology in a broad sense; the ability to produce goods and services per hour worked. At the aggregate, productivity growth is the only source of sustained growth of income per capita, the backbone of growing living standards[9]. The employment and unemployment rates reflect, in turn, the ability of an economy to provide everyone with the opportunity to share the fruits of increasing productivity.[10] At a sectoral level, both productivity and employment indices provide useful information to display and interpret the evolution of the different branches of the European industry.

It should be noted that in other contexts the same word "competitiveness" might mean something very different; see Box 1.2 below on external competitiveness.

1.2. Macroeconomic environment

The years 2008 and 2009 have been marked by the emergence of an unprecedented recession. Decreasing rates of economic activity have coincided with a large contraction in employment. The drop in revenues together with rising expenditure due to automatic stabilisers and stimulus packages are putting public finances under considerable strain.

1.2.1. Key indicators in an interrupted strong recovery

After a disappointing first half of the current decade, the year 2006 seemed to represent the end of the slowdown triggered by the 2001 recession in the US and the subsequent relatively slow recovery[11]. Indeed, real GDP per capita in the EU had been following a fast growth path, even surpassing the rapid pace of recovery in the US (see Table 1.1). On average, European economies grew in 2006 at more than double the average growth rate in 2001-05, with Germany as the largest economy outperforming the first half of the decade by a factor of more than five. Among the smaller economies, the New Member States (NMS) saw an impressive take-off suggesting a fast catch-up with the rest of the European Union, a process reinforced by their accession to the EU in 2004. The only exception among the EU economies was Ireland, but only because its previous performance was already above the average, while in 2006 it returned to normal growth rates. The same pattern can be seen in the evolution of the labour market. Table 1.2 shows that the employment rate rose slightly due to increases in the labour participation rate, but also because of the reduced unemployment rate. In the EU-27 the unemployment rate decreased on average from 9 per cent at the beginning of the decade to 7 per cent in 2007. Total employment as a share of the working-age population

8 Common notions of competitiveness are usually narrower. For instance, the Global Competitiveness Report 2008-2009 (Sala-i-Martin et al. (2008)) of the World Economic Forum only mentions "raising prosperity" with no reference to jobs or sustainability .

9 Even if we accept income per capita as a crucial component of living standards, the latter ought to include many other dimensions influencing welfare; see COM(2009) 433 "GDP and beyond. Measuring progress in a changing world" or the so-called Stiglitz report (2009).

10 More details on the labour markets or the social dimension of employment can be found in the Employment in Europe Report published regularly by the DG Employment, Social Affairs and Equal Opportunities.

11 In particular, employment in the US took longer than usual to recover. The data are analyzed in Potter et al. (2004) while Schweitzer (2004) suggests "business restructuring" as a main reason for the slow recovery.

Table 1.1: Annual growth rates of real GDP per capita

	1996-2000*	2001-05*	2006	2007	2008
BE	2.49	1.17	2.31	1.99	1.17
BG	-0.21	6.44	6.59	6.17	6.01
CZ	1.60	3.82	6.45	5.38	2.50
DK	2.44	0.95	3.00	1.22	-1.72
DE	1.88	0.53	3.08	2.59	1.46
EE	7.19	8.25	10.61	6.52	-3.53
IE	8.59	3.72	3.11	3.50	-4.09
EL	2.91	3.85	4.08	3.62	2.52
ES	3.65	1.73	2.31	1.80	-0.44
FR	2.35	0.98	1.56	1.56	0.22
IT	1.87	0.31	1.46	0.82	-1.89
CY	2.49	1.42	2.15	2.93	2.65
LV	6.36	8.84	12.85	10.55	-4.16
LT	5.47	8.32	8.49	9.52	3.55
LU	4.70	2.35	4.78	3.58	-2.64
HU	4.25	4.51	4.28	1.23	0.65
MT	3.88	0.44	2.60	2.70	1.00
NL	3.43	0.82	3.22	3.23	1.73
AT	2.82	1.12	2.77	2.65	1.41
PL	5.42	3.13	6.31	6.69	4.79
PT	3.68	0.25	1.03	1.67	-0.19
RO	-1.05	6.50	8.11	6.45	7.29
SI	4.35	3.54	5.53	6.19	2.44
SK	3.25	4.97	8.42	10.31	6.13
FI	4.54	2.24	4.50	3.76	0.46
SE	3.23	2.19	3.66	1.81	-1.00
UK	3.13	1.98	2.21	2.69	0.25
EU-15	2.57	1.12	2.38	2.11	0.14
EU-27	2.70	1.43	2.73	2.45	0.48
US	2.94	1.33	1.82	1.04	0.19

* Geometric average.

Source: AMECO database, Commission services.

rose from 64 to 67 per cent moving closer to the Lisbon target of 70 per cent.

However, by the beginning of 2007, early signs of the current crisis could already be observed in the US[12]. An increase in subprime mortgages defaults triggered a spiral of events that left the economy in a state of considerable uncertainty by the end of the year. These events were not restricted to the financial sector; they had already an impact on real economic activity and were reflected in the annual accounts for 2007. The EU-27 as a whole did not show a marked change in trend, with growth barely dropping from 2.7 to 2.4 per cent, partly because of an increase in employment. Individual countries, however, showed signs of a slowdown, with Ireland's GDP per capita growth rate dropping from 4.3 to 3.5 per cent or Estonia's declining from 10.6 to 6.5 per cent. In the US real GDP growth fell from a modest 1.8 to a worrying 1.0 per cent.

The overall positive developments apparent in 2006 definitively came to an abrupt halt in 2008 when major economic indicators peaked in most European countries. This was followed by an unprecedented contraction both in size and in scope, subsequently turning into the worst global crisis in many decades.

12 For a chronology of events see the Bank for International Settlements (BIS) annual reports for June 2008 and June 2009. For a chronology of events in the financial markets, see Brunnermeier (2009).

Table 1.2: Annual growth rate of employment [1)]

	1996-2000 [2)]	2001-05 [2)]	2006	2007	2008
BE	1.14	0.67	1.40	1.82	1.63
BG	-0.26	1.53	3.34	2.82	3.27
CZ	-0.84	0.35	1.56	2.20	1.16
DK	0.85	-0.07	1.24	2.01	1.23
DE	0.78	-0.14	0.69	1.72	1.43
EE	-2.00	1.17	6.22	1.40	0.29
IE	5.72	2.91	4.30	3.56	-0.88
EL	0.59	1.33	2.10	1.29	1.21
ES	3.86	3.26	3.90	2.97	-0.47
FR	1.40	0.64	0.96	1.66	0.89
IT	0.98	1.54	1.64	1.18	0.31
CY	1.24	3.08	1.76	3.25	2.63
LV	-0.54	1.66	4.70	3.58	0.74
LT	-1.12	0.86	1.83	2.78	-0.48
LU	1.91	1.52	1.91	2.26	2.70
HU	1.26	0.23	0.73	-0.10	-1.19
MT	0.75	0.81	1.29	2.97	1.12
NL	2.52	0.30	1.85	2.50	1.52
AT	0.92	0.68	1.40	1.80	1.76
PL	-0.36	-0.57	3.27	4.10	4.01
PT	2.11	0.28	0.51	0.05	0.44
RO	-1.89	-1.35	0.69	0.44	0.26
SI	-0.29	0.36	1.50	2.98	2.87
SK	-0.42	1.07	3.85	2.42	3.42
FI	2.29	0.85	1.77	2.06	1.35
SE	0.82	0.22	1.69	2.16	0.94
UK	1.26	0.93	0.87	0.68	-0.67
EU-15	1.46	0.90	1.46	1.63	0.58
EU-27	1.00	0.69	1.62	1.78	0.86
US	1.78	0.68	1.87	1.10	-0.47

1) Employment in persons; total economy (National Accounts).
2) Geometric average.
Source: AMECO database, Commission services.

1.2.2. The downturn

The year 2008 was marked by the largest contraction in economic activity in the post-WWII period, not only in the EU but worldwide. Seven Member States — see again Table 1.1 — experienced negative growth rates of GDP per capita while those economies that were still growing did so roughly at half the 2006-2007 pace.

The current recession was preceded by a large real estate and stock market bubble in the US but also in the EU, notably in Ireland, UK and Spain[13]. As in previous similar bubble bursts, the drop in housing prices induced a contraction in household wealth, in turn causing a considerable downturn in consumption and, by extension, in all economic activity. Solow (2009) mentions data from the Fed estimating the loss of household wealth in the US at 20 per cent between mid-2007 and the end of 2008. Using a rule of thumb, and abstracting from other factors such as increasing uncertainty or the role of the financial system, Solow estimates that this contraction in wealth led to a 5 per cent drop in consumption over little more than a year[14].

The recession was exacerbated and spread by a financial sector overexposed to mortgage-related risk. Brunnermeier (2009) describes recent changes in the sector that explain the current financial crisis. First, new developments in credit derivatives (and their ratings) and credit default swaps allowed banks to write off

13 On both sides of the Atlantic, the bubble has its origin in a classical combination of a period of sustained income growth, fiscal incentives that fostered speculative housing purchases and, since 2001, a lax monetary policy that maintained the interest rate so low, given housing inflation, as to render the real interest rate virtually close to zero; see, for instance, Gjerstad and Smith (2009) or, for an early warning, chapter II in the IMF World Economic Outlook 2004.

14 See also Reinhart and Rogoff (2008, 2009). This crisis is unprecedented not because there were no similar contractions in the past but because of the combination of its magnitude and global scope.

Table 1.3: Annual growth rate of real labour productivity [1)]

	1996-2000 [2)]	2001-05 [2)]	2006	2007	2008
BE	1.90	0.80	1.18	1.27	-0.06
BG	1.68	3.47	3.17	2.78	2.69
CZ	1.94	4.47	5.22	3.86	2.45
DK	1.08	1.18	0.94	-1.95	-2.46
DE	2.01	1.29	2.48	0.61	-0.01
EE	N/A	6.43	5.22	5.66	-2.32
IE	5.35	3.09	1.67	2.73	-1.43
EL	2.86	3.23	-0.97	1.63	2.41
ES	0.25	0.75	0.86	1.77	2.13
FR	2.12	1.44	2.39	0.48	-0.17
IT	0.89	0.11	0.29	0.22	-0.52
CY	2.08	0.96	1.46	1.47	0.92
LV	N/A	7.06	7.19	7.95	-4.80
LT	4.56	6.59	6.89	4.70	1.86
LU	2.61	1.67	3.06	0.29	-5.13
HU	2.53	3.22	3.96	1.44	1.71
MT	N/A	-1.24	2.59	0.52	0.32
NL	1.75	1.58	1.52	0.84	0.42
AT	1.79	1.14	2.87	2.15	0.08
PL	6.17	3.61	3.21	2.58	0.82
PT	3.41	0.75	0.51	3.74	-0.37
RO	N/A	N/A	6.20	N/A	N/A
SI	N/A	3.38	5.32	3.68	0.70
SK	4.93	4.87	5.75	7.91	3.93
FI	2.80	2.01	3.36	2.16	-1.53
SE	2.48	2.80	2.88	-0.59	-1.76
UK	2.53	1.93	2.39	2.27	0.55
EU-15	1.76	1.22	1.66	1.11	0.20
EU-27	N/A	N/A	1.68	N/A	N/A
US	2.18	2.38	0.95	1.32	N/A

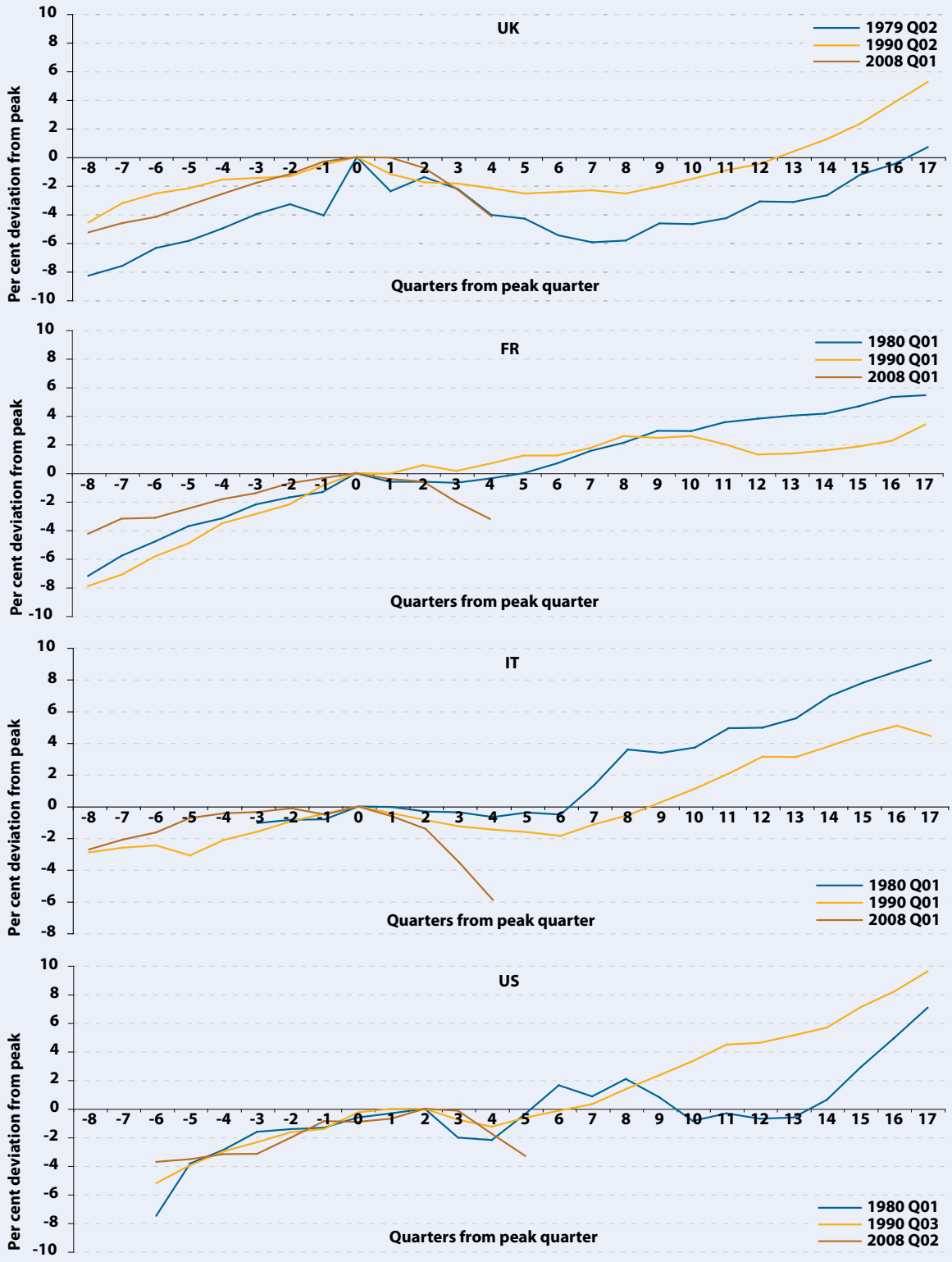
1) GDP at 2000 prices over total hours worked.
2) Geometric average.
Source: AMECO database, Commission services.

risky assets from their balance sheets, eluding classical capital holding requirements. Second, in recent years banks switched to shorter maturity instruments to finance their asset holdings. As a consequence, the entire financial system became exposed to macroeconomic risk, while banks, in particular, had become especially vulnerable to a liquidity drought. Once foreclosures started to surge, uncertainty about who was liable with respect to whom and liquidity hoarding plunged the financial system into an otherwise classical banking crisis.

The crisis was further spread by the corresponding contraction in international trade. In an increasingly globalised world, economies are more and more interconnected and thus vulnerable to the economic conditions of trade partners even if a particular economy does not suffer from any fundamental imbalance. Total EU imports or exports (extra- and intra-EU trade) in the first months of 2009 were roughly 20 per cent below the level a year before[15]. The implications of this drop in trade are clearer if one keeps in mind that economies have become more integrated than ever in recent history: between 2005 and 2008 world trade increased by 80 per cent[16]. The downturn in international trade has been of the same order of magnitude elsewhere. For instance, in the US total imports dropped by more than 45 per cent and total exports by 33 per cent in a few months from mid-2008 to the beginning of 2009.

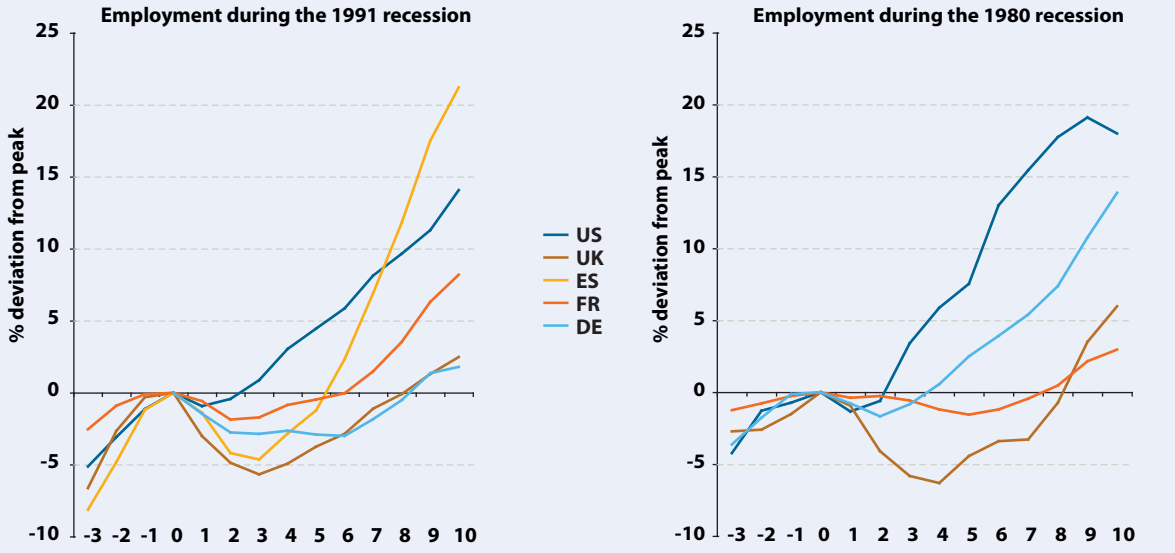
15 Eurostat short-term external trade indicators.
16 However, these increasing flows of commodities reflected not only trade for final consumption but also an increasingly globalised supply chain. As an illustration, 65 per cent of extra-EU imports, excluding energy and raw materials, are intermediate goods that enter the EU's own production processes. See the report *EU performance in the global economy*, European Commission 2008.

Figure 1.2: Comparison with previous recessions: level of GDP per capita



The graphs use quarterly series of real GDP levels and represent the percentage deviation from the peak level reached before each downturn. The horizontal axis represents the number of quarters before (negative values) and after (positive) the peak.
Source: Eurostat data.

Figure 1.3: Employment recovery from a recession



The graphs use annual series of employment in persons (all domestic industries) and represent the percentage deviation from the peak level reached before each downturn. The horizontal axis represents the number of years before (negative values) and after (positive) the peak
Source: AMECO database, Commission services.

The depth of the recession can be assessed by comparing the evolution of the levels of income per capita and employment with previous downturns. As an illustration, Figure 1.2 compares the last three large recessions for the UK, US, Italy and France, countries for which detailed quarterly data are available. The figure plots percentage deviations in real GDP per head from the peak level preceding the downturn. The magnitude of the contraction for the US is unprecedented: in 1980, GDP per head dropped by a maximum of 2 per cent, but in the current downturn, since the second quarter of 2008, it has dropped by 3.3 per cent. In Europe some countries seem particularly affected. For instance, Italy, a country that has never lost more than 2 per cent of GDP in recent recessions, lost 6 per cent of real GDP by the first quarter of 2009 with respect to the peak value a year before. A similar situation was seen in France. Although not included in the figure, particularly abrupt was the halt to the ongoing catch-up process in the NMS. In hardly one year Lithuania, Latvia or Slovakia lost 10 percentage points of real GPD relative to peak levels.

Other European countries, however, have experienced similar contractions in recent decades. Notably the UK for which the current recession so far does not seem to be worse than that of 1980, although this is hardly comforting if one keeps in mind that the UK economy then took four years to regain the peak level of GDP per capita and eight years to regain the level of employment. A similar pattern was observed in the 1990 recession. This longer time required to regain the level of employment can be seen in Figure 1.3 and is a common feature of large recessions as noted by Reinhart and Rogoff (2009).

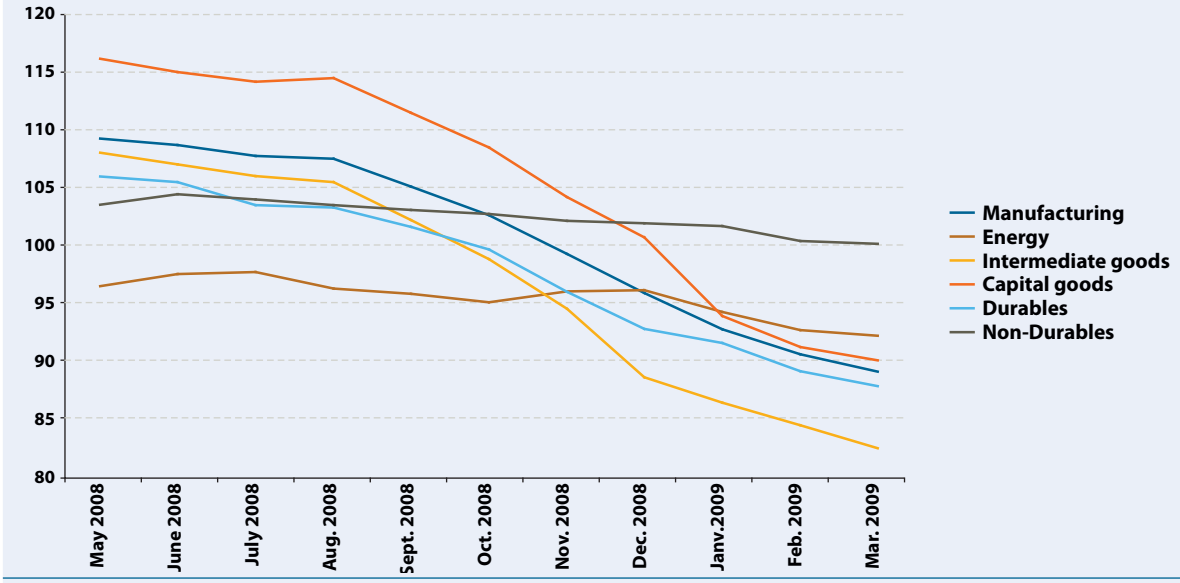
The sharp contraction in economic activity has increased the unemployment rate, in some cases dramatically. This is particularly true for countries affected by real estate bubble and the subsequent drop in activity in the construction sector. A case in point is Spain, which saw unemployment reach 18 per cent by mid-2009. The NMS are the other group with high levels of unemployment, for instance Lithuania with 16 per cent.

The Autumn Forecast 2009, issued by DG Economic and Financial Affairs, depicts a dismal scenario with EU GDP contracting 4.1 per cent in 2009, private consumption dropping by 1.7, investment by 11.4, and the unemployment rate close to 10 per cent and exceeding this percentage in the next two years. Recovery packages (see section 1.5 below) are likely to produce a positive growth rate in public consumption, of around 2 per cent per annum, but government debt is expected to climb to 80 per cent of EU GDP by 2011.

1.2.3. Impact of the crisis in the medium-term

Historical experience shows that employment reacts with a lag and takes longer to recover. It is difficult to foresee the future evolution of the crisis although the relative depth of the current downturn may help predict roughly the length of the recovery. In downturns of this nature, GDP per capita takes from two to four years to regain its

Figure 1.4: Evolution of real industrial production in the EU-27; Index, 2005=100.



Source: Eurostat data, Short-term business statistics.

former peak level. Employment, in turn, reacts with a lag and takes roughly twice as long to recover[17].

Breaking down output by broad categories does not reveal major surprises. By May 2009 manufacturing and services contracted 20.2 and 10.5 per cent respectively on an annual basis[18]. Capital goods, intermediate goods and consumer durables have been the most strongly hit branches of economic activity[19]. This is not the case for consumer non-durables, which entered a trough only during the 1992-93 downturn[20]. Electrical equipment and fabricated metal products contracted by more than 20 per cent and motor vehicles and basic metals by more than 30 per cent. This can also be seen in Figure 1.4 which shows that durables are contracting while non-durables are remaining fairly constant. In times of uncertainty, household investment in durables is typically delayed in very much the same way that investment by firms freezes. Non-durables and energy are more stable, since their consumption cannot easily be postponed or substituted. The reaction of employment is still moderate but is expected to be similar to that of output as regards the sectoral pattern of the contraction[21].

17 This can be seen by comparing the charts in Figure 1.2 and Figure 1.3 and has been noted in European Commission (2009a) and elsewhere in the literature.

18 All these figures are from the note "Impact of the economic crisis on key industrial sectors of the EU – the case of the manufacturing and construction industries. May 2009 update," European Commission, DG Enterprise and Industry, 19 May 2009.

19 See "EU Industrial Structure 2009" report by DG Enterprise and Industry.

20 Idem.

21 One can expect the pattern to be similar to previous downturns and to that of the US. Hall (2005, Table 2.4) shows how the average contraction in employment across sectors in recessions over the period 1948-2001 has always followed a similar pattern with employment in durables falling 11.4 per cent compared to 4.2 per cent in non-durables, or construction falling 5.85 per cent compared to 1 per cent in retail.

1.2.4. Impact of the crisis in the long-run

In periods of turmoil, short-term measured productivity conveys little information on the abstract long-term notion of productivity as the capacity to produce value in an hour of work with a given state of technology. This is because employment lags GDP throughout the recession and the subsequent recovery. Initially, the fall in GDP dominates and measured productivity drops. This explains the negative growth rates in Table 1.3. Then GDP per capita recovers faster and the drop in employment (and therefore in hours worked) starts to dominate leading measured productivity to recover relatively fast[22]. Hence, short-term data tells us little about future developments in productivity. Section 1.4 below contains a speculative, rather than quantitative, discussion on the potential real impact of a recession on productivity in the longer term.

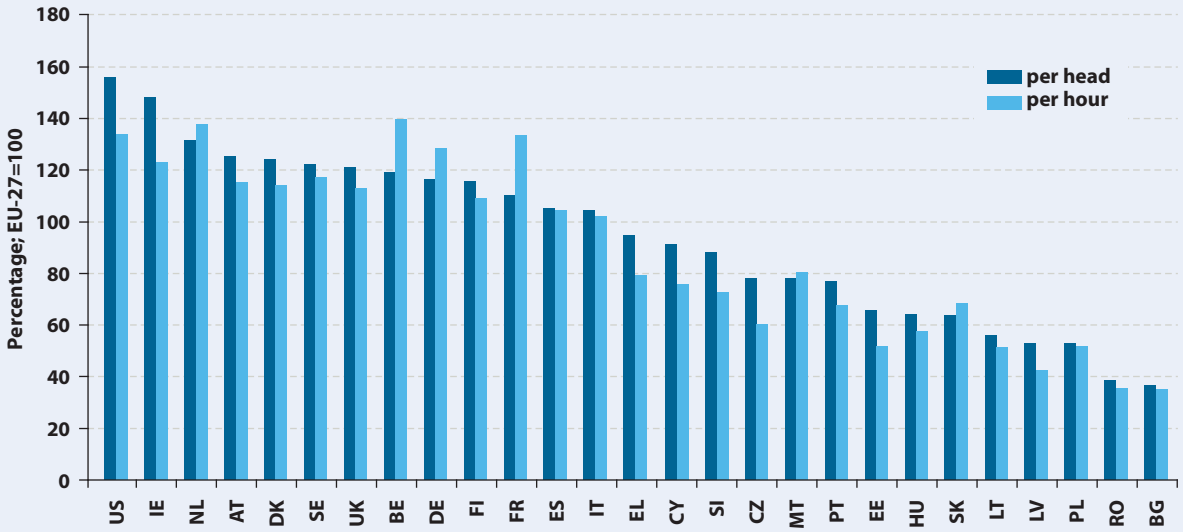
1.2.5. A comparison with the United States

The US economy is a good benchmark for evaluating comparative performance as it is the world's largest single economy and the one most similar to the EU.

Nevertheless, there are marked differences, in both the short- and long-term performance of these two economic areas. In the short-run, the US economy seems to be characterised by a higher degree of flexibility, a

22 This phenomenon is more likely to be associated with economies with a relatively sluggish labour market. Compare the recovery of employment in the US versus the UK, Spain or France in Figure 1.3. See also Cole and Ohanian (1999) and Conesa et al. (2007).

Figure 1.5: GDP in PPS per head and per hour worked



GDP per head and per hour worked in 2006 in PPS, EU-27 = 100. Last year available for both variables. Luxembourg has been excluded from the graph for the sake of a clear scale; the country has 267 and 189 per cent of GDP per head and per hour worked in PPS respectively.
Source: AMECO database, Commission services.

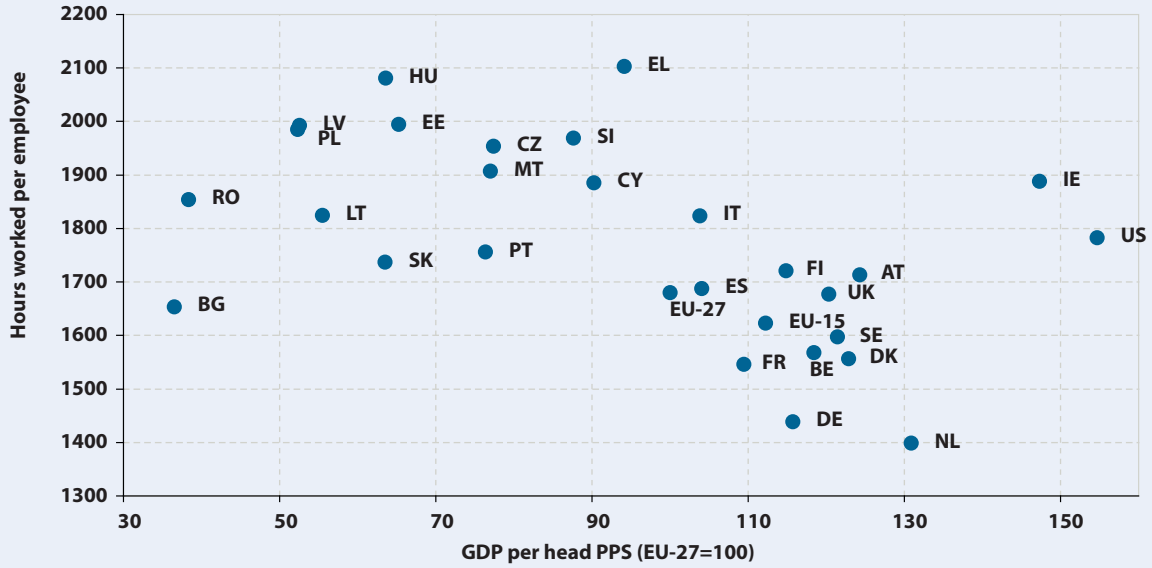
key factor in the midst of a recession: US employment and output tend to fall less dramatically and recover after recessions much faster than in the European economies (see again Figure 1.2 and Figure 1.3). But it is in the labour market where the greatest differences lie: in the UK employment fell by 6 per cent and took up to 32 quarters to recover to the peak level that preceded the 1980 and 1990 recessions; in the US, the drop was around 1 per cent and the time taken to recover from the 1980, 1990 and 2001 recessions was less than 10 quarters. These differences in short-term reactions are connected with a short-term dimension of competitiveness, which is influenced by many factors; some relatively easy to target by structural reforms, like the relatively more generous European unemployment insurance schemes (see Blanchard (2004)), others more difficult to change: Gáková and Dijkstra (2009) argue, for instance, that the differences in per capita income convergence across states in the US versus regions in the EU are directly related to a greater mobility of labour in the US. This greater mobility may also explain why the US labour market recovers so quickly from recessions compared to the EU. And yet, these differences in geographical mobility are related to language and cultural differences that are to a large extent beyond the influence of economic policies.

Nevertheless the European economies not only differ from the US in short-term flexibility, but also exhibit differences in long-term behaviour; the US consistently achieves higher income per capita than Europe, a phenomenon always worth exploring because it may signal structural inefficiencies in European economies. Figure 1.5 compares levels of income per head and per hour worked as measured by GDP in purchasing power standards (PPS) so as to permit international-level comparisons. The gap in income per head between the US and the EU is still sizeable: the average US income represents almost 160 per cent of the average of the EU-27 with virtually no Member State reaching this level with the exception of Luxembourg. However, differences in per capita income can be due to differences in production per worker or differences in labour force participation. The picture is thus slightly different when we focus on output per hour worked: the US economy then stands at 132 per cent of the EU-27 average, with some Member States like Belgium, France and the Netherlands above the US level. The explanation lies in the difference in hours worked per person in employment and, to a lesser extent, in different employment and unemployment rates.

Indeed, while in 2006 the average American employee worked 1775 hours per year, the corresponding figure for Belgium was 1571, for France 1540 and for Germany 1431. Compared with these European countries, US workers work between 12 and 24 per cent more than their European counterparts[23]. When extracting policy implications from these figures, one has to keep in mind

23 Other European countries, particularly those with lower GDP per capita, work more hours. In 2006, the only countries where average hours worked exceeded American hours are the New Member States, with the exception of Slovakia, plus Ireland, Greece and Italy (Eurostat data).

Figure 1.6: GDP per head and hours worked per employee



Income is GDP per head for 2006 in PPS, EU-27 = 100. Hours worked is the 2002-2006 average of average hours worked per person in employment. Luxembourg has been excluded from the graph for the sake of a clear scale; for this country income stands at 266 and average hours 1577.
Source: AMECO database, Commission services.

that public intervention is justified only if these low European hours reflect an impediment for European workers to work more hours rather than different preferences. There is an ongoing debate on the reasons for these differences but in a preliminary look at income per capita compared to hours worked the US stands out as an outlier. Although European economies have quite heterogeneous labour market institutions, Figure 1.6 shows that they have a clear negative relationship between income and hours worked reflecting a negative income-elasticity of labour supply. The US, together with Ireland, stands out as working much more than its expected level given its income. Although some reasonable theories have been put forward, so far the debate is still open[24].

In any case, even in terms of output per hour worked, the EU is still significantly below the US level and many individual Member States lag well behind the European average. Even if the sample is restricted to the EU-15, income per capita in PPS represents 85 per cent of US income per capita.

One of the explanations refers to the differences in higher education and in R&D expenditures. In the US 2.9 per cent of GDP is invested in higher education contrasting with a 1.2 per cent in Europe[25]. In terms of R&D, European universities and government spend roughly as much as their American counterparts[26]. The difference between the EU and the US is to be found in the business enterprise sector R&D: in 2006 (OECD data) the figure for the EU is 1.17 percent whereas for the US it is 1.87 percent[27]. Indeed, if we focus on the percentage of R&D expenditures financed by the business enterprise sector, only Germany, Sweden, Finland and Luxembourg score above the US average. Additionally, the high-tech industry is also about 20 per cent more research-intensive in the US than in the EU, amounting to 0.47 percent of GDP in the EU and 0.75 percent in the US[28]. These differences in R&D in the business enterprise sector and in the high tech sector are very likely reflecting a more dynamic business environment in the US relative to the EU, an environment in which it is easier to profit from business opportunities. Incidentally, this dynamism may also constitute a factor determining the greater ability of the US economy to recover from a recession.

24 Extending this graph to all OECD countries yields a similar pattern so this negative relation does not seem to be specifically European. The seemingly outlier character of the US in Figure 1.6 has been extensively discussed. See again Blanchard (2004). Prescott (2004) has suggested the impact of transfers to households within the European welfare state as an explanation, while Michelacci and Pijoan-Mas (2007) suggest that career prospects may determine a large part of the US-EU differences, exploring in this context the role of (higher) earnings inequality (in the US relative to the EU) and the degree of tightness of the labour market.

25 Data from the New Cronos Eurostat database. For details, see "An agenda for a growing Europe – Making the EU Economic System Deliver", a report by A. Sapir to the European Commission, 2003.

26 According to OECD data, EU-25 universities spend 0.39 percent of GDP against 0.36 percent in the US, but American statistics do not include capital expenditures or research in humanities; once the figures are corrected to be comparable, the percentage is roughly equal. R&D intensity in the government sector is equivalent in the EU and the US: 0.65 percent and 0.66 percent of GDP respectively.

27 See the "Science, Technology and Competitiveness report 2008/2009" of the European Commission.

28 See Wilén (2008).

Box 1.2 External competitiveness

In the literature the word "competitiveness" conveys a different meaning when applied to an individual firm or an individual sector or economic activity within a country or region. An industry's competitiveness refers to the competitive position of this industry in the world market relative to the same industry in other countries. Industry-specific external competitiveness is captured by indices like:

- Revealed comparative advantage (RCA), which measures the share of a given industry's exports relative to the average exports in the rest of the world;
- Relative trade balance (RTB), compares the trade balance of a particular commodity to the total volume of trade, exports plus imports;
- Relative unit labour costs (RULC), which measures the cost of labour in a given industry relative to its productivity (unit labour costs) and relative to the corresponding index in another country (see Box 1.3).

While RCA and RTB reflect the position of individual industries in the world market, RULC reflects the ability to remain competitive. Changes in these indices will show in which industries Europe is developing a comparative advantage or disadvantage. However, they have to be interpreted with care: from the aggregate point of view, the loss of competitiveness in an individual industry may well reflect the outstanding export performance of other domestic industries. For example, appreciation of the Euro may worsen the competitive position of a given industry, but may just reflect strong productivity growth in other industries, and hence strong exports and an increasing demand for the euro. Another issue is that of the domestic content of exports. For example, any country involved in electronics' assembly will record a high share of electronics' exports that will not reflect the actual production structure of the country, artificially inflating the RCA index; see again Box 1.3 for details.

At this point it may be also worth noting that our notion of the competitiveness of a country as described in Box 1.1 is not related to the notion of competition. Firms compete in the market just as industries in different countries compete in the world market, but, given the nature of international exchanges, the notion of competing countries does not make sense (see Krugman (1994)).

1.3. Sectoral performance, productivity and unit labour costs

An assessment of external competitiveness (see Box 1.2) requires sectors to be examined individually.

Three stylised facts shape the evolution of economic activity in Europe. First, there is a sustained difference in productivity growth between manufacturing and services; where the faster growth in manufacturing goes together with a secular decline in the share of manufacturing in employment, very much in line with what is observed in all major industrialised countries; Table 1.4 shows how manufacturing outperforms services in terms of productivity, while all subsectors record negative employment rates. Second, the share of services in value added is increasing at the expense of manufacturing. Finally, the EU is consolidating its position vis-à-vis the US and Japan in high-tech manufactures in the international markets. The picture is mixed across sectors and Member States but in an increasingly globalized world high-tech production in the EU is overall holding up relatively well compared to the US and Japan: the EU has the highest market share with 17.2 per cent of world exports of high-tech commodities and the last years have seen a substantive improvement in revealed comparative advantage[29] (RCA, see box 1.3) for this class of commodities.

1.3.1. Labour productivity

Labour productivity can be measured as value added per hour worked. Hence, it is a measure of the average amount of value that an hour worked can produce given factors such as capital, labour skills, organisational capital or the state of technology.

Faster productivity growth in manufacturing is explained by its higher capital-intensity. Thus, labour in manufacturing profits from the increasing quality of equipment goods[30]. But there are other important factors explaining this acceleration of productivity in manufacturing, notably the outsourcing of services by manufacturing firms (see ten Raa and Wolff (2001)). First, value added previously recorded as manufacturing now appears as part

29 See European Commission (2008) as well as table 5 in European Commission (2009e). The EU loses some international market share in high-tech goods but less than the average for all other commodities, and hence the RCA index improves while for the US and Japan it deteriorates.

30 What the literature has come to call embodied technical change (ETC). For the long-term impact of ETC see Gordon (1990, 2005) and Greenwood et al. (1997).

Table 1.4: EU real labour productivity (annualized) growth in 1995-2007

NACE – 31 sector classification	Sector	Labor productivity growth (1995-2007) in %	Value added growth (1995-2007) in %	Employment growth (1995-2007) in %
A	Agriculture, hunting and forestry	2,8	0,7	-2,0
B	Fishing	-0,3	-1,7	-1,4
C	Mining and quarrying	-0,1	-3,9	-3,9
D	Manufacturing	3,2	2,7	-0,5
DA	Food products; beverages and tobacco	1,3	1,1	-0,2
DB	Textiles and textile products	1,5	-1,2	-2,7
DC	Leather and leather products	0,0	-3,4	-3,4
DD	Wood and wood products	2,2	1,4	-0,8
DE	Pulp, paper and paper products; publishing and printing	2,5	1,5	-0,9
DF	Coke, refined petroleum products and nuclear fuel	2,5	0,4	-2,0
DG	Chemicals, chemical products and man-made fibres	5,2	4,2	-1,0
DH	Rubber and plastic products	2,3	2,9	0,6
DI	Other non-metallic mineral products	2,9	1,9	-1,0
DJ	Basic metals and fabricated metal products	2,5	2,7	0,2
DK	Machinery and equipment n.e.c.	2,9	2,5	-0,4
DL	Electrical and optical equipment	6,8	6,5	-0,3
DM	Transport equipment	2,4	3,0	0,6
DN	Manufacturing n.e.c.	1,9	1,7	-0,2
E	Electricity, gas and water supply	2,0	0,5	-1,5
F	Construction	-0,1	1,3	1,5
G	Wholesale and retail trade; repair of motor vehicles	1,3	2,6	1,3
H	Hotels and restaurants	-0,2	2,3	2,5
I	Transport, storage and communication	3,3	4,0	0,7
J	Financial intermediation	2,7	3,5	0,8
K	Real estate, renting and business activities	-1,0	3,4	4,5
L	Public administration and defence	0,3	0,9	0,6
M	Education	-0,2	0,9	1,2
N	Health and social work	0,3	2,1	1,8
O	Other community, social, personal service activities	0,1	2,3	2,2
TOTAL		1,4	2,5	1,0

Source: EU Industrial Structure 2009.

of services, thus contributing to the increasing share of services in value added. Second, when a firm outsources part of its activity, it is more likely to sub-contract those tasks that do not fall within its core business, so there is an efficiency effect from focusing on its proper line of activity following the outsourcing of these activities. The quantitative importance of this phenomenon is illustrated by Grilo and Irigoyen (2009) who estimate that manufacturing "pulls" on average 17 per cent of its total production from services and "pushes" an average 8 per cent of its total supply into the services sector. Offshore outsourcing is another factor explaining the acceleration of manufacturing productivity, in that it typically covers the least productive steps in the manufacturing process (e.g. assembly in electronics).

Table 1.4 displays the evolution of labour productivity by NACE 1-digit sectors, while manufacturing is in turn broken down into 2-digit categories. The gap between manufacturing and services in productivity growth is readily seen in the first column: with the exception of Transport, Storage and Communication, no other sector of activity achieved the 3.2 per cent productivity growth in manufacturing over the period 1995-2007.

Within non-tradables, the performance of the Financial Intermediation sector is especially remarkable. Its productivity growth relied basically on an average increase of 2.7 per cent in value added, while employment increased at a significantly lower pace of 0.8 per cent. This gain in productivity is likely to be linked to the ongoing liberalisation process, the importance of ICT diffusion in this sector and the simultaneous deepening of the integration of the European market for financial services. The construction sector, at the other extreme, saw a negative productivity growth due to a significantly high growth in employment, supported by considerable low-skilled immigrant inflows.

Box 1.3 Labour costs and comparative advantage

Unit labor costs (ULC) is a closely followed index as it may signal inflationary tensions or exchange rate movements. Indeed, dividing both labour compensation and value added by total hours worked, ULC can be seen as the ratio of the hourly wage to productivity. An increase in ULC over its average value would signal excessive remuneration of labour relative to productivity, creating pressure on producer prices (Sbodorne (2002)) and by extension on exchange rates (Dullien and Fritsche 2007).

Hence, at the aggregate level ULC is related to: (a) domestic competitiveness, to the extent that it may signal a relative underperformance in terms of productivity growth, and (b) external competitiveness, since it may reflect a loss of cost-competitiveness for exporting firms leading to a trade deficit that may be difficult to correct within a monetary union.

In the long-term, however, aggregate ULC does not tell us much about external competitiveness as described in Box 1.2 because it is not the aggregate level of ULC but rather comparative advantage and economies of scale that drive international trade. For external competitiveness, sectoral ULC indices are needed as they can reveal interesting patterns associated with specialisation due to international trade. Since all sectors within an economy compete for workers in the same labour market, wages in each sector will reflect the average level of productivity in the economy. If there is a sector where we have a comparative advantage, we should expect wages to grow more slowly than productivity, hence lowering ULC. As a consequence, sectoral ULC may point to comparative advantages and disadvantages vis-à-vis our trade partners without looking at trade flows.

Comparative advantage can be explored using trade flows by means of the index of revealed comparative advantage (RCA), which measures the extent to which the EU is specialised in a given sector. For each sector, the share of exports in total exports is computed and then compared to the "world" share. For a given sector, a RCA index greater than one signals that this is a sector where Europe exports relatively more than the world average, and is interpreted as Europe having a comparative advantage in this sector. In the EU Industrial Structure 2009 report, Europe is EU-25 and the "world" is the EU-25 plus 38 other countries; the source is the UN COMTRADE database.

As noted in box 1.2, like any measure of external competitiveness, it has to be interpreted with care. The RCA for China and high-tech manufacturing may reflect the integration of China in the global supply chain; for example, in the assembly of electronic components. Koopman et al. (2008) estimate the domestic content of Chinese exports at less than 50 per cent, a very low share compared to other countries, and even lower for high-tech manufacturing, where the domestic content of Chinese exports is around 20 per cent. Another factor to keep in mind is the location of China on the quality ladder: Schott (2007) notes that the increase in Chinese electronics exports involves in fact low-quality exports, a dimension of trade flows that is difficult to uncover just looking at raw trade data.

To interpret the categories within tradables, one has to keep in mind the trade patterns of the EU. For instance, positive productivity growth in Textiles and Textile Products has not prevented this sector from shrinking in terms of both value added and employment[31]. This reflects a comparative disadvantage in inexpensive textiles with regard to China, Morocco, Bangladesh or Turkey.

In section 1.3.3 labour productivity is compared to nominal labour costs and to the US situation. This will shed some more light on the performance of European sectors of activity.

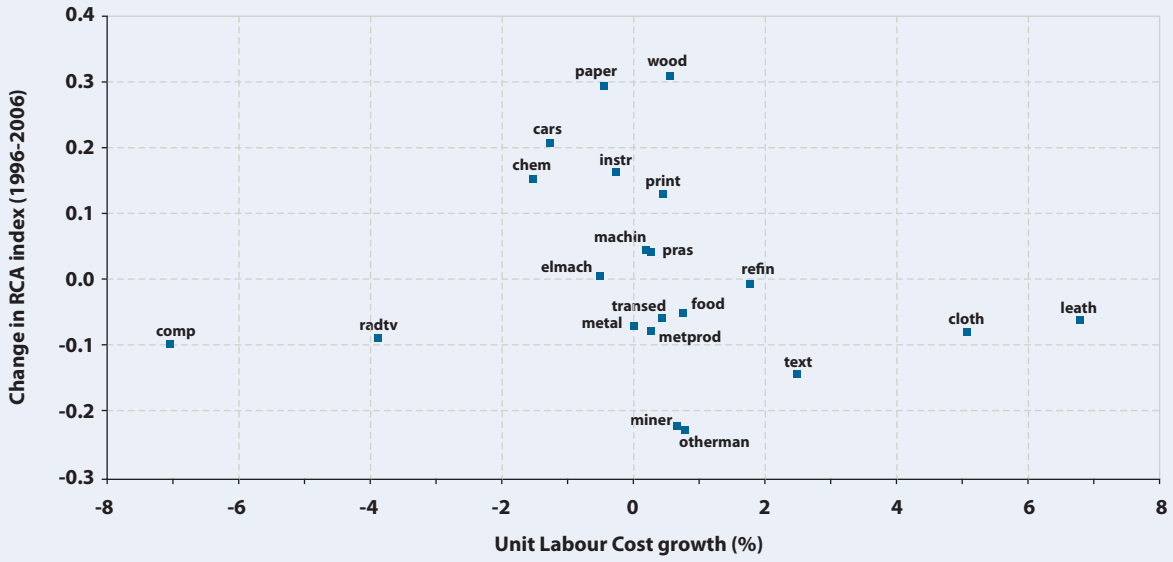
31 Table 1.2 shows that for the 1995-2007 period, with almost no exception, total employment increased. Hence, a negative growth rate for a given sector in Table 1.4 automatically implies a fall in the share of the corresponding sector in total employment.

1.3.2. Unit labour costs

Productivity is only half of the story when it comes to assessing the external competitiveness of European industry. For internal competitiveness, one ought to compare productivity with labour compensation, while for external competitiveness a further comparison with the situation of the EU's trade partners is required.

Unit labour costs (ULC) are measured as the average cost of labour input per unit of value added (a detailed introduction can be found in Box 1.3). In the short-run, ULC constitutes a useful index that may signal pricing tensions or exchange rate movements. In turn, in order to be able to say something about external competitiveness the information needs to be broken down to sector level. Indeed, sectoral ULC may help to identify sectors where the EU has a comparative advantage or disadvantage.

Figure 1.7: ULC growth rate in 1996-2008 and RCA changes in the EU 1996-2006



Rate of growth of unit labour costs (ULC) in the period 1996-2008 compared to percentage change in revealed comparative advantage (RCA) in 1996-2006.
Source: Figure VI.6 in EU Industrial Structure 2009.

1.3.3. Unit labour costs and revealed comparative advantage

Consider a European industry whose productivity growth is ahead of the European average. One should expect two things to happen: first, since wages reflect average productivity, labour compensation in this sector is going to grow more slowly than value added, thus lowering ULC relative to other sectors; second, as the gap with other sectors of the European economy grows, a comparative advantage is more likely to emerge in this particular sector, which will be the case if this gap is higher than in the economies of our trading partners.

This mechanism seems to be at work when one compares ULC with RCA as is done in the European Union Industrial Structure 2009 report. Figure 1.7 shows a roughly negative relationship between the rates of change for the two indicators.

1.3.4. Relative unit labour costs

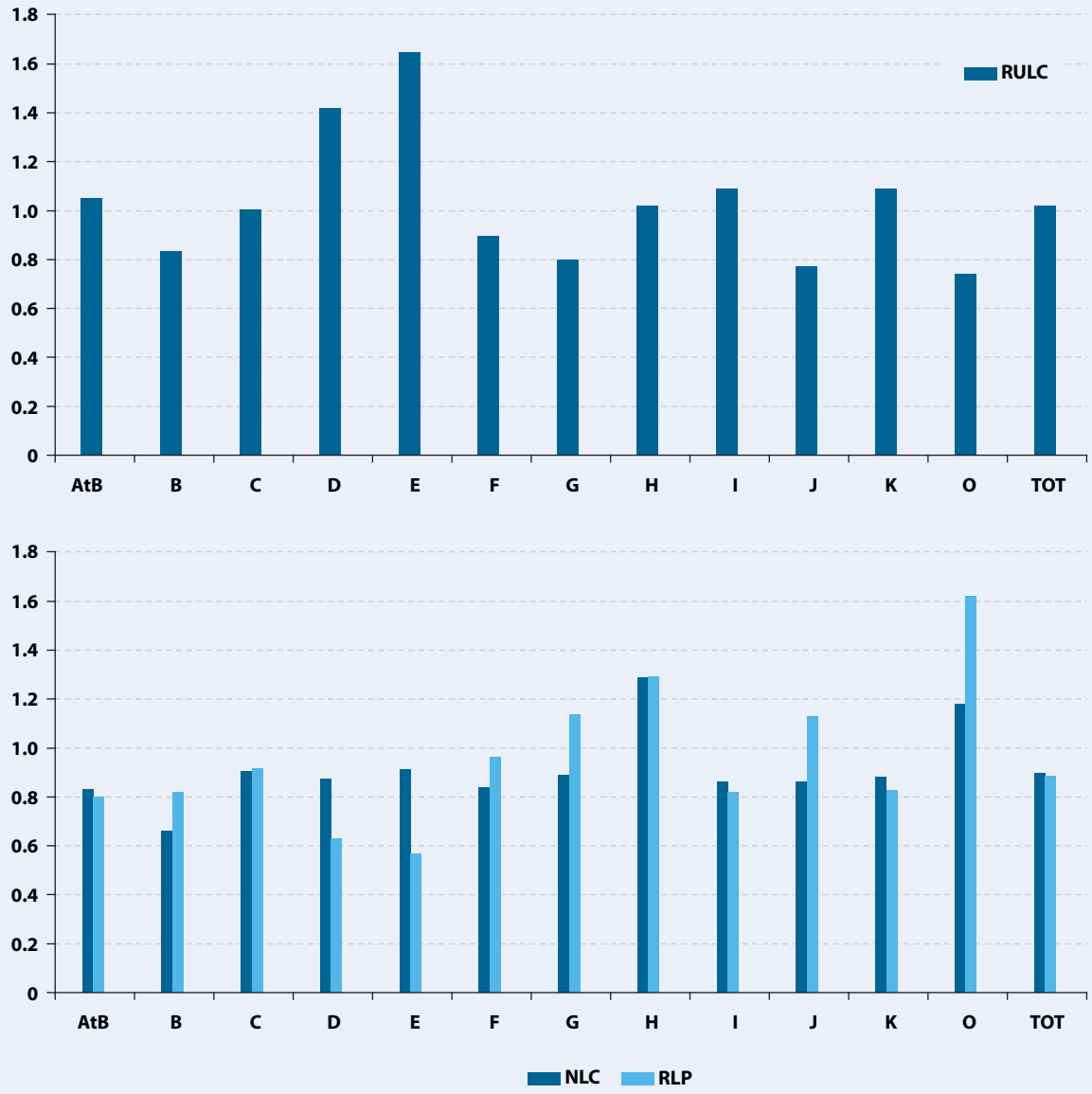
In Figure 1.7 the two outliers are the Office Machinery and Computer sector and Radio, TV and Telecommunications Equipment. The very favourable developments in ULC in these sectors have not materialised in external competitiveness as measured by RCA. The reason is to be found at least partially in ULC developments in these sectors in the US.

Indeed, absolute lower ULC levels do not automatically translate into a comparative advantage, because the levels abroad may be low in absolute terms as well. This can be better understood if we reason in terms of prices: from the perspective of prices, decreasing unit labour costs create a cost advantage. These lower production costs decrease pressure on prices, and lower prices in tradable markets are likely to increase a sector's exports, generating a higher RCA for the sector, unless its ULC decreases even further abroad. That is precisely the usefulness of relative unit labour costs (RUCL), an index that considers ULC relative to major trade partners.

Using the EU KLEMS database Kang et al. (2009) examines RUCL in Europe with respect to the US. While the paper focuses on NACE 1-digit industries, for manufacturing they present more detailed results. Appendix – Table 1.5 shows that in Electrical and Optical equipment and Machinery n.e.c. (categories that include computers and radio and TV equipments) the average European ULC has increased significantly relative to the US and relative to other sectors over the period 1995-2001 compared to 2001-2005. This would explain why these two particular subsectors appear as outliers in Figure 1.7. The rapid growth of productivity appears to be more than compensated by the evolution of labour costs and productivity in the US.

The relationship between ULC and RCA is relevant when the motive for trade is comparative advantage, whether originating in technological differences or in different factor proportions. The EU and the US, however, are two economies with very similar characteristics so it is not surprising that most of their trade is intra-industry trade. In this context ULC is less informative because

Figure 1.8: Labour costs, productivity and RULC – EU-15 relative to US 1995-2001



Relative unit labour costs (RULC), nominal labour costs (NLC) and labour productivity (RLP) in the EU-15 relative to the US in the period 1995-2005. Letters denote NACE Rev. 1.1 codes.
Source: Kang et al. (2009).

such trade is motivated by product differentiation and economies of scale, not comparative advantage. Except for extreme differences in relative productivity, as in the sectors mentioned above, no clear structure in sectoral ULC emerges from EU-US trade relationships. Figure 1.8 illustrates how RULC is close to one in most broad categories with the exception of Manufacturing, Energy and Wholesale and Retail Trade.

The larger deviations below one, indicating a European cost-advantage, are for services like Financial Intermediation. This may explain the higher European world market share for services: 26.9 per cent versus the US with 19.7 per cent and Japan with 6.1 per cent.

Two sectors, Manufacturing and Wholesale and Retail Trade, display somewhat surprising results. Within tradables, EU ULC levels in Manufacturing seem to be much higher than those in the US. The large economies of the EU, such as Germany, France or the United Kingdom, are responsible for driving RUCL so high in manufacturing[32].

Within non-tradables, the EU has lower ULC levels in Whole sale and Retail Trade which seems to go against common wisdom as this is a very dynamic sector across the ocean. The explanation may lie in the restrictions on opening

32 See Kang et al. (2009) for details on Member States, in particular for figures similar to our Figure 1.8 for each country.

hours and the less flexible labour markets in Europe. Large retailers in the US are open more days per year, requiring more labour to serve the same number of customers, and have access to relatively cheap labour in a flexible labour market. In contrast, European retailers meet the same customer needs in fewer days per week (and hence less hours worked) and cannot afford to become labour-intensive in a labour market with higher wages and more restrictions when it comes to resizing the labour force.

1.4. Productivity and the impact of a recession

This section speculates on the potential impact of the recession on competitiveness in the medium- to long-term. Even if the impact will depend on the length of the recession and on eventual policy measures, some general mechanisms are expected to be at work.

1.4.1. Measurement of productivity

As noted above, during economic turmoil the indexes that are normally used to assess competitiveness and, in particular, productivity, convey poor information about real changes in the ability of an economy to provide its workers with the capacity to produce value. The behaviour of these indexes is relatively mechanical and due to changes in the intensity of the use of factors, which are difficult to measure. But it does not reflect actual technical change, whick explains why productivity and total factor productivity drop so sharply at the beginning of a recession but recover relatively quickly.

The behaviour of labour productivity is due to labour market rigidities combined with the optimal behaviour of economic agents during a recession. Recessions are associated with increasing uncertainty about future business conditions. If resizing the labour force entails adjustment costs, instead of adapting immediately to lower demand, firms will react by hoarding labour: first, in a labour market with asymmetric information about both vacancies and job seekers, labour hoarding preserves good matches that may be difficult to reproduce; second, if there is an important learning-by-doing component in a worker's productivity, labour hoarding may also preserve firm-specific human capital that will be costly to rebuild; finally, tight regulation of the labour market may induce firms to maintain the labour force unchanged. It should be noted that this behaviour is often encouraged by active labour market policies, like labour sharing schemes aimed at keeping workers in employment.

The final impact on productivity is clear: the level of activity of the firm falls by a larger extent than the labour force, inducing a sharp short-term drop in productivity. In a second stage, even in the presence of signs of recovery, firms may postpone any new hiring or investment projects, delaying recovery from the recession. Indeed, the increase in unemployment and the length of the recovery can be further explained by the reaction of firms to the increasing uncertainty typical of any recession. Bloom (2009) explores the possibility that firms optimally choose a wait-and-see strategy when uncertainty about business conditions coincides with adjustment costs[33]. This no-action strategy affects both the labour force and investment. If labour hoarding explains the initial drop in productivity, the reluctance to hire new workers will explain both the increase in unemployment, the duration of the recession in the labour market, and the surge in productivity before the peak level of employment is regained.

The theory is consistent with the observation by Hall (2005) that the rise in unemployment during recessions is less related to massive layoffs than to a freeze in new hirings, i.e. a drop in the matching rate.

The initial fall in labour productivity will also be influenced by the intensity of the use of capital. Again, in the presence of capital adjustment costs, firms will find it optimal to keep the installed capacity but use it less intensively or leave part of it idle. This reaction will not only reduce labour productivity but, since capital utilisation is difficult to measure, will also cause a drop in measured total factor productivity because labour and capital will react much less than output.

Finally, changes in the composition of production may affect average productivity. For instance, if sectors producing durables are more productive than those producing non-durables, the relatively deeper fall of durables consumption will increase the share of the less productive sectors at the expense of the more productive.

1.4.2. Effective changes in productivity

The firm behaviour described above may alter measured productivity in the short-run but will also have a real impact on productive efficiency. On the positive side, labour hoarding will preserve firm-specific human capital and the organisational network within the firm. Less capital utilisation will lead to slower physical depreciation.

On the negative side, postponed investment projects will decrease future productivity. It will extend the life of relatively obsolete equipment while missing the oppor-

33 Even without the classical explanations for labour hoarding, the no-action strategy can be optimal if there is uncertainty surrounding business conditions and resizing capital or labour comes at a cost. In such a case, for a sufficiently high level of uncertainty, inactivity may yield higher expected returns than hiring or firing. This is particularly true during recession, when there is a high degree of level of uncertainty about the size and length of the demand shocks perceived by the firms.

tunity to improve productivity through better reorganization of the production process and foregoing any eventual improvement in the quality embodied in new investment goods[34].

However, the impact of lower investment is potentially unequal across sectors: less innovation and obsolescence are more likely to be relevant in high-tech sectors with fast technical change or in sectors that use high-tech equipment as an input. The negative impact of low investment in other sectors may be partially offset by the drop in capital utilization, leading to less depreciation.

1.4.3. Selection mechanism

There are also productivity gains via the selection of more productive firms and the reallocation of resources to best performers, very much in the same way that international trade may drive out the worst performing firms as in Melitz (2003). For instance, Bresnahan and Raff (1991) argue that the restructuring of the car industry in the US during the Great Depression fostered the rise of large firms using more efficient mass production techniques to the disadvantage of smaller, less efficient firms[35].

In close connection with this mechanism and the notion of creative destruction, a recession may induce firms to develop or adopt better technologies in order to be better fit to survive the downturn. Furthermore, job destruction entails a reallocation of labour to the surviving (more productive) firms that will increase overall total factor productivity; see, e.g., De Loecker and Konings (2006) for evidence from the Slovenian transition to a market economy.

1.4.4. R&D intensity and innovation

Two opposing forces determine the innovative behavior of firms. On the one hand, a recession can be seen as a period of tough competition where innovation is the way to stay ahead of competitors. On the other hand, the short-run need to cut costs is more likely to affect activities with uncertain or no immediate returns. The second force seems to dominate when we observe R&D expenditures and, in general, innovative activities. Such activities indeed seem to be procyclical with the reduction of R&D expenditures being driven by the cost-cutting strategy usually followed by firms during recessions[36].

The Innobarometer 2009 (European Commission (2009b)) finds that 59 per cent of surveyed firms do not report any changes in innovation-related spending during the beginning of the downturn, 22 per cent reported a cut-back in expenditures and only 9 per cent, mainly in high-tech sectors, indicate an increase in innovation. More interestingly, the survey finds a strong correlation between innovation-related spending and financial success, supporting the hypothesis that it is cost-saving that drives the decrease in average expenditures[37]. These results are consistent with previous evidence such as that in Geroski and Gregg (1997), reporting similar findings from an extensive survey of UK firms. Firms engaged in innovative activities during the 1990 recession in the UK were also those less affected and those who believed the recession was over. Aghion et al. (2007) corroborate this connection between procyclicality and credit constraints for French enterprises.

1.4.5. Sectoral shifts and networks

Changes in the composition of production may affect productivity if it involves sectors with different intensities in skilled labour. For instance, if production shifts from a low-skilled labour-intensive sector to a high-skilled labour intensive sector, productivity in the latter may drop because of the lower skills of the new workers. In close connection with this mechanism, a poor skill match may depress productivity for a relatively long period until skills are built-up with experience.

Another channel through which productivity can decrease is the loss of organisational capital: as firms fail along the production chain, the productivity of the surviving firms will be directly and negatively affected but in addition they will have to devote time and resources to rebuild providers' networks or distribution channels if it is retailers that fail[38]. This is not technical change strictly speaking because once the networks are rebuilt productivity would be expected to be back to normal; nevertheless, the effect is real and will depress total factor productivity and labour productivity in the medium-term.

34 In some sectors this has direct consequences for European policy priorities. For instance, the energy and transport sectors have been particularly hit by the crisis compromising investments that are necessary to reduce future greenhouse gas emissions.

35 Geroski and Gregg (1997) tone down the selection argument noting that short-term conditions unrelated to technological efficiency, such as cash-flows or leverage, may play an important role in determining which firms are going to disappear. Along these lines, OECD (2009) stresses the failure of the selection mechanism in demand- versus supply-driven recessions.

36 Even in the case in which it may be optimal for R&D expenditures to be procyclical, Barlevy (2007) argues that they may be too procyclical in the presence of externalities. That would be a case for government support to R&D in times of crisis.

37 Cost saving is more important in small and low-revenues firms. Among those firms that innovate, when asked about the reasons for doing so, large firms declare energy efficiency to be a major motive. That is to say, even when innovation takes place, it seems to be directed to cost-saving. To have an idea of the orders of magnitude, a recent study DEFRA (2007) estimates a 0.6 per cent of GDP potential gain from low-cost/no-cost improvements in resource efficiency for the UK.

38 See Ohanian (2001) and references therein.

1.4.6. Impact on labour supply

The impact of a recession on productivity is also channelled by the consequences for workers and their reaction to the recession. In those countries where recessions are characterised by high rates of unemployment, an obvious negative effect is linked to the depreciation and loss of human capital. In addition, to the extent that the unemployed become outsiders, they have less power in wage-setting processes which may in turn explain why they become long-term unemployed thus exacerbating the loss of human capital[39]. On the positive side, however, human capital accumulation can be expected to intensify during a recession. Younger people may decide to postpone entry into the job market by extending their period of education, while firms facing low levels of activity may encourage workers to engage in on-the-job training.

All in all, a recession does not necessarily have a negative impact on long-term productivity growth and therefore GDP growth; there are powerful mechanisms boosting productivity as well[40]. Furthermore, a good understanding of these mechanisms may help clarify policy targets during a recession in order to keep an eye not only on the recovery but also on future developments[41]. This is precisely the rationale behind the second pillar of the European Economic Recovery Plan discussed in the next section.

1.5. Getting out of the crisis

Exceptional times require exceptional measures. This crisis has triggered the largest and most widely coordinated policy reaction among countries and institutions in decades.

1.5.1. A resolute response

The current crisis is characterised by the dangerous combination of a real recession with a banking crisis. However, decisive intervention by the European Central Bank from the outset of the crisis as well as action by national governments to back financial institutions seem to have prevented any major breakdown in the European financial system[42]. Two years after the outbreak of the crisis monetary policy continues to be lax and interest rates remain at historically low levels, the focus being on providing liquidity to the system and restoring credit conditions. National governments have intervened directly to strenghten the financial system: guaranteeing deposits, lending to banks to recapitalize them and launching programmes to purchase bad assets.

There is a growing consensus on countering moderate recessions with an active monetary policy targeting the interest rate and a passive fiscal policy allowing the automatic stabilizers to work. In deep recessions like the current one, however, most households make considerable adjustments to their consumption-savings plans, so monetary policy alone is ineffective and automatic stabilisers are not sufficient to boost short-term demand. Being exceptional, the current crisis has consequently triggered substantial public intervention in terms of both scope and magnitude.

1.5.2. The European Economic Recovery Plan

In December 2008 the European Commission proposed and the European Council agreed the European Economic Recovery Plan (EERP), a call for action to face the crisis which is guiding public intervention all across Europe[43].

The plan is inspired by a guiding set of principles grouped in two pillars. The first pillar is a major injection of purchasing power in order to stimulate demand. The plan recommended a fiscal package of 1.5 per cent of EU GDP over the period 2009-10, 1.2 per cent from the Member States and 0.3 per cent from European institutions. By mid-2009 the fiscal stimulus exceeded this target and was around 2.1 per cent. Taking into account the effect of automatic stabilisers, the size of the package is 5 per cent of EU GDP or some €600bn over 2009-10[44].

The second pillar aims to reconcile short-term action with long-term competitiveness. That is to say, exceptional measures taken to tackle the crisis should be consistent with the EU's medium-term structural reform

39 In Blanchard and Summers (1989) this is one of the hypotheses behind the theory of hysteresis in unemployment. The Great Depression in the US, as an extreme natural experiment, provides evidence in this direction: Cole and Ohanian (1999) note how wages in manufacturing were unusually high throughout the entire period.

40 Historically structural breaks in the path of growth are rare. Nordhaus (2004) concludes that for the entire post-WWII period, only the crisis of the 1970's caused a change in the growth trend of our economies; the so-called "productivity slowdown".

41 Along these lines, European Commission (2009a) examines in detail the possible impact of the crisis on potential output, and how active policies can lead to quite different long-run scenarios.

42 The reaction of governments and European institutions to the crisis was faster than in previous instances; Hoshi and Kashyap (2008) warn of the difficulties in dealing with a banking crisis, but comparing the US response today to that of Japan in the 1990s, conclude that decisiveness is playing a key role in the incipient recovery in credit conditions.

43 "Communication from the Commission to the European Council: A European Economic Recovery Plan," Brussels, 26.11.2008. For a detailed description of the EERP and the Member States" response, see European Commission (2009d).

44 See the "Letter from the President of the European Commission to the President of the European Council," 15 June 2009, the note "Progress on the Implementation of the European Economic Recovery Plan" prepared for the European Council of 18-19 June 2009 and again European Commission (2009d).

agenda [45]. The emphasis at this point is to preserve the Single Market and integrate Europe further within international markets. It is indeed a temptation in bad times to turn to protectionism in order to shield those most affected by the recession through exposure to trade, but these measures would also hamper recovery and, if perpetuated, could hinder future growth. In contrast, the exceptional measures taken in Europe have been inspired by the idea of using the crisis as an opportunity for openness and reform[46]. In short, the current ongoing public intervention complies broadly with the strategic aims of the Lisbon Strategy: investing in R&D, the right skills, energy efficiency, clean technologies to speed-up the transition to a low-carbon economy, support for small and medium enterprises, and investing in infrastructure and interconnection in network grids in order to promote efficiency and innovation.

These two pillars are complemented by the determination to protect the most vulnerable and to avoid long-term unemployment and the associated damages such as lasting scarring effects on young unemployed.

1.5.3. EERP tools

The principles above have inspired the policies actually put in place and determined the tools chosen. Spilimbergo et al. (2008) recommended that the response should be: diversified, combining direct spending, transfers and tax cuts; lasting, because of the uncertainty about the length of the recession; and revisable upwards, if the conditions require it, to show a commitment to help economic agents regain confidence.

The EERP is inspired by these principles, and is further coordinated to avoid "stowaway" effects and to profit from positive spillovers. It is being monitored by the European Commission to ensure that all measures taken comply with the Single Market principles.

Public spending is considered the most effective way to stimulate demand while preserving or even creating employment in the sectors directly affected. Consequently, and accordingly under the second pillar of the EERP, many public interventions take the form of direct investment or subsidies for investment in green energies or in network grids. Transfers are being directed to low-income households, more likely to actually spend the money, in line with the aim of protecting the most vulnerable and take various forms across the EU. For instance, many Member States have enacted special unemployment insurance schemes for those not covered by or extended of the regular subsidies.

Finally, fiscal incentives are being used to promote green energy and cleaner technologies while at the same time supporting critical sectors like the car industry. Small and medium-sized enterprises (SME) are targeted by measures to ease access to finance, shorten payment delays, and offer temporary reductions in social charges conditional on employment creation[47]. These measures also aim to protect workers and are complemented by the action to encourage flexible working-time to avoid lay-offs and to improve job placement and life-long learning[48].

1.5.4. Recovery plans of the EU's main trading partners

The scale of these interventions is proportional to the magnitude of the recession. Above, a figure of 5 per cent of GDP was mentioned for the EU, but similar figures can be found for most OECD countries. As for the composition of the fiscal package, most countries have combined spending and revenue in a fairly balanced way[49].

In particular, the fiscal package in the US amounts to a total of $787bn (€562bn) over the next ten years, with 75 per cent of the package falling in the 2009-10 period. As in Europe, this package goes hand in hand with deeper structural reforms, notably in education and training ($53bn), health care ($59bn) and infrastructure and science ($111bn). A sizeable share of the package ($43bn) is devoted to the electricity grid to foster more efficient and environmentally friendly power distribution.

1.5.5. Reforms for the future and EU coordination

As noted in Kaminsky and Reinhart (1999) and elsewhere, most major financial crises are preceded by financial liberalisation. In this instance, however, it was a *de facto* liberalisation: the development of new financial instruments (e.g. credit derivatives) and institutions (e.g. hedge funds) outgrew the regulation in force. It is not surprising, then, that the current emphasis in the discussion of long-

45 This vision is shared by many other government bodies and institutions. See, for example, the UK ministerial document *The Future of EU Competitiveness. From Economic Recovery to Sustainable Growth*, Department for Business, Innovation and Skills, June 2009. Combining short-term macroeconomic recovery and stabilization policy with longer-term institutional reform was also endorsed by the academics participating in the *Global Crisis Debate on VoxEU.org* (CEPR) summarised in http://voxeu.org/index.php?q=node/3354. See also the OECD paper "Strategies for Aligning Stimulus Measures with Long Term Growth".

46 For instance, the OECD (2009) mentions the opportunity to reform the car industry to produce cleaner means of transport, which is also the rationale behind most public incentives to invest in green energy. Note that this is in close connection with the discussion in section 1.4.3 above.

47 See again the note "Progress on the Implementation of the European Economic Recovery Plan" prepared for the European Council of the 18-19 June 2009. It may be recalled from the discussion in section 1.4 that cash-constrained SMEs are the most vulnerable firms during a recession.

48 See the note to the Economic Policy Committee: "First Preliminary Assessment of Employment and Social Policies to Soften the Impact of the Crisis," ECFIN/B3/GC-FP/D(2009)REP/51628.

49 With some exceptions like New Zealand, UK, the Netherlands or Ireland, which have relied mostly on tax cuts and other revenue measures; see the OECD note "Policy responses to the economic crisis to restore long-term growth: results of the OECD questionnaire," DSTI/IND/STP/ICCP(2009)/ADD/FINAL.

term reforms is on the regulation of financial markets. On one hand, the focus is on the regulation of alternative investment funds and on the transparency of derivatives markets. On the other hand, proposals have been made to strengthen supervision and to set up a cross-border framework to deal with financial institutions in distress[50]. The aims are a robust risk management and a macro-prudential approach to mitigate procyclical effects.

The depth and scope of the crisis have strengthened the case for EU policy coordination. In the short-term support to banks and firms hit by the crisis but operating across the entire EU entailed a risk of distorting the Internal Market; EU state-aid rules and Commission supervision provided the framework and the necessary action to prevent this possibility; national fiscal stimuli are complemented and boosted by accelerated transfers of Cohesion Funds and efforts to increase absorption capacity.

If the EU has successfully coordinated the response to the crisis, it should now coordinate an orderly exit and any steps towards the prevention of future crisis[51]. Structural reforms in product and labour markets should not only restore confidence in the short-term but put the basis for future sustained growth. For instance, in the labour market Member States have tried to maintain existing jobs through short-time working allowances, reduced social charges, and so on. However, the recession also provides a reminder of the rigidities that affect labour markets in many Member States. Reforms seem important at these times, not only to boost long-term competitiveness but to actively promote the recovery of employment (recall Figure 1.3 discussed in section 1.2.2). The emphasis here is on flexicurity, the combination of flexible hiring and firing with strong social protection for those in unemployment.

The current conjuncture stands as well as an opportunity to ease the transition to a sustainable low-carbon economy and to stimulate the creation of green jobs. Stimulus packages can be directed to renewable energies or to support R&D expenditures in resource efficiency [52]. These efforts can be complemented by indirect incentives like conditional subsidies or green public procurement. Indeed, the EERP puts the emphasis on a rapid take-up of green products and energy efficiency. The idea is to support and reinforce current initiatives like the Ecodesign or the Energy Labelling directives aimed at improving the environmental performance of products or help consumers make better choices respectively[53]. Resource efficiency in products is promoted through the goal of improving energy efficiency in buildings or the aim of developing clean technologies for cars and construction.

1.6. Conclusions

The crisis has lead to an unprecedented contraction in economic activity. The bursting of a large real-estate and stock-market bubble in the US but also in some European countries, notably the UK, Ireland and Spain, has put a halt to the strong growth path regained in 2006. The wealth contraction associated with the bubble burst has negatively affected consumption and, by extension, almost all economic activity. The crisis has been further exacerbated and spread by the financial crisis and the contraction in international trade.

At the sectoral level, we observe a strong impact in manufacturing and to a less extent in services. As in previous recessions, non-durables, energy and services contract less than durables and investment equipment goods, the latter being more affected by the adjustements made to savings and investment by households and firms respectively.

The potential impact of such a large recession on productivity in the medium- and long-term is ambiguous. Productivity will be negatively affected by firms freezing investment projects. Lay-offs will cause a loss of firm-specific human capital while unemployment is often associated with a depreciation of human capital. The destruction of supply-chain and distribution networks may divert resources from firms in order to rebuild these commercial relations, which will have a negative impact on productivity until the networks are restored. In addition, in bad times many firms turn to cost-saving strategies, usually reducing innovation activities. On the positive side, some firms, particularly those whose business model heavily relies on innovation, may intensify innovative activities as a way forward. A recession can also help in selecting the most productive technologies and business practices, thus boosting long-term productivity.

The crisis can also have a positive impact on productivity to the extent that it provides the momentum for structural reforms. The European Economic Recovery Plan is guided by two principles: to stimulate demand but also to make short-term action compatible with the structural reform agenda as set out in the Lisbon Partnership for Growth and Jobs. A large share of the stimulus package is devoted to fostering flexicurity in labour markets, clean technologies to speed-up the transition to a sustainable low-carbon economy, the promotion of green energy, and investment in network industries including broad-

50 See the Presidency Conclusions of the European Council of the 18-19 June 2009.

51 See again European Commission (2009d) and the report European Economy 2009 "Economic crisis in Europe: causes, consequences and challenges".

52 During recessions firms are already likely to engage in innovation efforts in resource efficiency in processes for the sake of cost-cutting; recall section 1.4.4 above.

53 See the communication "on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan" COM(2008)397.

band data networks and the electricity grid. All these measures aim to boost productivity and make the EU a front-runner in sectors and technologies of the future.

References

Aghion, P., P. Askenazy, N. Berman, G. Cette and L. Eymard (2007), "Credit constraints and the cyclicality of R&D Investmens : evidence from France", Mimeograph, Department of Economics, Harvard University.

Barlevy, G. (2007), "On the Cyclicality of Research and Development", *American economic Review*, 97(4), 1131-1164.

Blanchard, O.J. (2004), "The economic future of Europe", *Journal of economic perspectives*, 18(4), 3-26.

Blanchard, O.J., and L.H. Summers (1989) "Hysteresis in Unemployment", NBER Working Paper No. 2035.

Bloom, N. (2009), "The impact of uncertainty shocks", *Econometrica,* 77(3), 623-685.

Bresnahan, T.F., and D. M.G. Raff (1991), "Intra-industry heterogeneity and the Great Depression: The American motor vehicles industry, 1929-1935", *Journal of Economic History*, 51(2), 317-31.

Brunnermeier, M.K. (2009), "Deciphering the Liquidity and Credit Crunch 2007-08", *Journal of Economic Perspectives,* 23(1), 77-100.

Cole, H.L., and L.E. Ohanian (1999), "The Great Depression in the United States from a neoclassical perspective", *Federal Reserve Bank of Minneapolis Quarterly Review*, 23(1), 2-24.

Conesa, J.C., T.J. Kehoe, and K.J. Ruhl (2007), "Modeling Great Depressions: The Depression in Finland in the 1990's", *Federal Reserve Bank of Minneapolis Quarterly Review* 31, 16-44.

Corrado, C., and L. Slifman (1999), "Decomposition of Productivity and Unit Costs", *American Economic Review*, Papers and Proceedings, 89(2), 328-332.

De Loecker, J., and J. Konings (2006), "Job reallocation and productivity growth in a post-socialist economy: Evidence from Slovenian manufacturing", *European Journal of Political Economy*, 22(2), 388-408.

DEFRA (2007), "Quantification of the business benefits of resource efficiency", an Oakdene Hollins report to the UK Department for Environment, Food and Rural Affairs.

Dullien, S., and U. Fritsche (2007), "Does the Dispersion of Unit Labour Cost Dynamics in the EMU Imply Long-Run Divergence?: Results from a Comparison with the United States of America and Germany", *International Economics and Economic Policy*, 5(3), 269-295.

European Commission (2008), "EU performance in the global economy", DG Trade.

European Commission (2009a), "Impact of the current economic and financial crisis on potential output", DG for Economic and Financial Affairs, Occasional Papers.

European Commission (2009b), "Innobarometer 2009", DG Enterprise and Industry.

European Commission (2009c), "EU Industrial Structure 2009", *Performance and Competitiveness,* DG Enterprise and Industry.

European Commission (2009d), "The EU's response to support the real economy during the economic crisis: an overview of Member States' recovery measure", DG ECFIN Occasional Paper 51.

European Commission (2009e), "The Evolution of EU and its Members" Competitiveness in International Trade", DG Trade.

Feldstein, M. (2008), "Did Wages Reflect Growth in Productivity?", Paper presented at the Annual Meeting of the American Economic Association.

Gáková, Z., and L. Dijkstra (2008), "Labour mobility between the regions of the EU-27 and a comparison with the USA", European Commission, DG Regional Policy, Regional Focus paper No. 02/2008.

Geroski, P., and P. Gregg (1997), "Coping with Recession. UK Company Performance in Adversity", *Cambridge University Press*.

Gjerstad, S., and V.L. Smith (2009), "From Bubble to Depression?", *Wall Street Journal*, 6 April 2009.

Gordon, R.J. (1990), "The Measurement of durable goods prices", Chicago, *University of Chicago Press.*

Gordon, R.J. (2005), "Apparel Prices 1914-93 and the Hulten/Brueghel Paradox", NBER Working Paper No. 11548.

Greenwood, J., Z. Hercowitz, and P. Krusell (1997), "Long-run implications of investment-specific technological change", *American Economic Review*, 87(3), 342-362.

Grilo, I., and J.M. Irigoyen (2009), "A note on the role of manufacturing in the economy: beyond its share", Mimeo, DG Enterprise and Industry, European Commission.

Hall, R.E. (2005), "Job Loss, Job Finding, and Unemployment in the U.S. Economy over the Past Fifty Years", *NBER Macroeconomics Annual*, 101-137.

Hooper, P., and E. Vrankovich (1995), "International Comparisons of the Level of Unit Labour Costs in Manufacturing," International Finance Discussion Papers 527, Board of Governors of the Federal Reserve System.

Hoshi, T., and A.K Kashyap (2008), "Will the U.S. Bank Recapitalization Succeed? Lessons from Japan", NBER Working Paper No. 14401.

IMF (2004) "Three Current Policy Issues", chapter II in *World Economic Outlook 2004*.

IMF (2007) "The Globalisation of Labour", chapter 5 in *World Economic Outlook 2007*.

Kang, L., M. O'Mahony, and C. Robinson (2009), "Cost competitiveness in Europe and China – Unit Labour Costs Relative to the US", Mimeo, National Institute of Economic and Social Research, University of Birmingham.

Koopman, R., Z. Wang, and S-J. Wei (2008), "How Much Of Chinese Exports Is Really Made In China? Assessing Domestic Value-Added When Processing Trade Is Pervasive", NBER Working Paper No. 14109.

Krugman, P.A. (1994), "Competitiveness: A Dangerous Obsession", Foreign Affairs, 73(2), 28-44.

Magnien, F. (2002), "The measure of GDP per capita in purchasing power standards (PPS): A statistical indicator tricky to interpret", Statistics Directorate, OECD.

Melitz, M.J. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, 71(6), 1695-1725.

Michelacci, C. and J. Pijoan-Mas (2007), "The Effects of Labour Market Conditions on Working Time: the US-EU Experience", CEPR Discussion Paper No. 6314.

Nordhaus, W. (2004), "Retrospective on the 1970s Productivity Slowdown", NBER Working Paper No. 10950.

OECD (2009), "Responding to the crisis – Fostering Industrial Restructuring and Renewal", Directorate for Science, Technology and Industry, DSTI/IND(2009)1/REV1.

Ohanian, L.E. (2001), "Why Did Productivity Fall So Much during the Great Depression?", *American Economic Review*, 91(2), 34-38.

Potter, S., A. Sahin, and R. Sela (2005), "Was the 2001 Recession Different in the Labour Market?", Mimeo.

Prescott, E.C. (2004) "Why Do Americans Work So Much More than Europeans?", Federal Reserve Bank of Minneapolis Quarterly Review, 28(1), 2-13.

Reinhart, C.M., and K.S. Rogoff (2008), "Is the 2007 US Sub-Prime Financial Crisis So Different? An International Historical Comparison", *American Economic Review*, 98(2), 339-344.

Reinhart, C.M. and K.S. Rogoff (2009), "The aftermath of financial crises", *American Economic Review Papers and Proceedings*, 99(2), 466-472.

Sala-i-Martin, X., J. Blanke, M. Drzeniek Hanouz, T. Geiger, I. Mia, and F. Paua (2008), "The Global Competitiveness Index: Prioritizing the Economic Policy Agenda", Chapter 1.1 in "The Global Competitiveness Report 2008-2009", World Economic Forum.

Sapir, A. (2003), "An agenda for a growing Europe – Making the EU Economic System Deliver", Report to the President of the European Commission.

Sbordone, A. M. (2002), "Prices and Unit Labour Costs: A New Test of Price Stickiness", *Journal of Monetary Economics* 49, 265-92.

Schweitzer, M. (2004), "Economic Restructuring and the Slow Recovery of Employment. The Role of Occupations", Mimeo, Federal Reserve Bank of Cleveland.

Solow, R.A. (2009), "How to Understand the Disaster", *New York Review of Books*, 56(8). Retrieved 20 May 2009 from http://www.nybooks.com/articles/22655.

Spilimbergo, A., S. Symansky, O. Blanchard, and C. Cottarelli (2008), "Fiscal Policy for the Crisis", IMF Staff Position Note SPN/08/01.

Stiglitz, J.E., A. Sen, and J.P. Fitoussi (2009), Report by the Commission on the measurement of economic performance and social progress.

Ten Raa, T,. E.N. and Wolff (2001), "Outsourcing of Services and the Productivity Recovery in U.S. Manufacturing in the 1980s and 1990s", *Journal of Productivity Analysis*, 16(2), 149-165.

Turner, A.G., and S.S. Golub (1997), "Towards a System of Multilateral Unit Labour Cost-Based Competitiveness Indicators for Advanced, Developing, and Transition Countries", IMF Working Paper No. 97/151.

Wilén, H. (2008), "R&D Expenditure and Personnel", Statistics in focus 91/2008, Eurostat.

Appendix – Table 1.5: Relative unit labour costs (RULC) 1995-2001 and 2001-2005, by EU country, relative to US

Country	Time period	Food, Drink and Tobacco (15t16)	Textiles, textile products, leather and footwear (17t19)	Wood, wood products, pulp, paper, publishing and printing (20t22)	Coke, refined petroleum products and nuclear fuel (23)	Chemicals, rubber and Plastics (24t25)	Other non-metallic mineral products, basic and fabricated metal products (26t28)	Machinery NEC, Electrical and Optical equipment (29-33)	Transport Equipment (34t35)	Manufacturing NEC (36)
Austria	1995-2001	1.40	1.84	1.35	2.13	1.02	1.32	1.91	1.40	1.58
	2001-2005	1.16	1.54	1.09	0.53	0.87	1.43	2.00	1.37	1.50
Belgium	1995-2001	1.31	0.98	1.31	2.76	0.83	1.04	1.66	1.47	1.04
	2001-2005	1.29	1.03	1.13	1.63	0.81	1.14	1.90	1.50	1.11
Czech Republic	1995-2001	0.68	1.05	0.51	3.14	0.43	0.53	0.87	0.79	0.82
	2001-2005	0.84	1.07	0.56	2.07	0.53	0.81	1.23	0.90	0.86
Germany	1995-2001	1.39	1.75	1.26	5.37	1.27	1.17	2.10	1.71	1.54
	2001-2005	1.40	1.65	1.09	1.30	1.10	1.20	2.29	1.88	1.60
Denmark	1995-2001	1.64	1.36	1.69	4.82	1.25	1.51	2.33	3.34	0.99
	2001-2005	1.88	1.62	1.70	5.29	1.33	1.79	2.81	4.01	1.17
Estonia	1995-2001	1.09	1.17	0.85	1.87	0.90	0.66	1.71	0.79	0.92
	2001-2005	1.59	1.89	1.32	1.03	1.15	1.11	3.30	1.43	1.45
Greece	1995-2001	1.23	0.74	0.95	0.79	1.13	0.67	1.31	1.66	0.60
	2001-2005	1.38	0.98	0.95	0.20	1.61	0.71	1.62	1.85	0.69
Spain	1995-2001	1.16	0.82	0.87	1.01	0.75	0.66	1.31	0.94	0.84
	2001-2005	1.22	1.03	0.88	0.40	0.79	0.77	1.73	1.12	0.91
Finland	1995-2001	1.43	1.52	0.78	2.17	0.88	0.91	1.35	2.23	0.91
	2001-2005	1.08	1.65	0.75	0.40	0.95	1.06	1.42	2.49	0.95
France	1995-2001	1.44	1.48	1.23	0.97	0.94	1.17	1.70	1.35	1.15
	2001-2005	1.43	1.43	1.11	0.32	0.83	1.31	1.76	1.51	1.12
Hungary	1995-2001	1.10	0.98	0.76	1.51	0.74	0.73	0.85	0.71	0.59
	2001-2005	1.85	1.35	0.83	1.36	1.01	0.95	0.91	0.88	0.71
Ireland	1995-2001	0.90	1.26	0.54	1.21	0.22	0.77	1.09	2.11	
	2001-2005	0.76	1.25	0.46	0.46	0.18	0.96	1.12	2.24	
Italy	1995-2001	1.07	0.94	0.83	1.45	0.68	0.53	1.53	1.29	
	2001-2005	1.16	1.21	0.87	1.12	0.78	0.65	2.30	1.62	
Lithuania	1995-2001	0.92	0.95	0.86	1.99	0.67	0.68	1.86	1.51	0.66
	2001-2005	1.17	1.33	0.92	1.11	0.66	0.84	2.27	1.38	0.81

Country	Time period	Food, Drink and Tobacco (15t16)	Textiles, textile products, leather and footwear (17t19)	Wood, wood products, pulp, paper, publishing and printing (20t22)	Coke, refined petroleum products and nuclear fuel (23)	Chemicals, rubber and Plastics (24t25)	Other non-metallic mineral products, basic and fabricated metal products (26t28)	Machinery NEC, Electrical and Optical equipment (29-33)	Transport Equipment (34t35)	Manufacturing NEC (36)
Latvia	1995-2001	0.97	1.72	0.91	1.91	0.94	0.69	1.86	1.54	
	2001-2005	0.93	1.54	0.87	0.33	0.82	0.58	1.96	1.54	
The Netherlands	1995-2001	1.04	0.91	1.65	2.77	0.68	0.93	2.01	1.34	1.76
	2001-2005	1.04	0.94	1.75	0.90	0.63	1.09	2.46	1.39	1.92
Poland	1995-2001	0.88	0.66	0.66	0.91	0.47	0.74	1.57	1.33	1.03
	2001-2005	0.73	0.64	0.60	2.72	0.42	0.74	1.49	1.19	0.87
Portugal	1995-2001	1.33	0.94	0.85		0.64	0.63	1.54	1.34	1.48
	2001-2005	1.42	1.13	0.95		0.72	0.73	1.87	1.51	1.86
Sweden	1995-2001	1.56	2.06	0.94	1.85	0.83	1.10	1.65	1.43	2.18
	2001-2005	1.55	2.20	0.93	0.57	0.75	1.24	1.77	1.21	2.10
Slovenia	1995-2001	3.36	3.15	2.62	14.30	1.70	1.48	2.96	2.72	1.72
	2001-2005	4.55	3.89	2.52	17.32	1.85	1.70	3.48	3.14	1.98
Slovakia	1995-2001	0.62	1.17	0.61	0.42	0.44	0.55	1.19	0.75	0.58
	2001-2005	0.60	1.61	0.56	0.50	0.39	0.57	1.73	0.75	0.36
United Kingdom	1995-2001	1.66	1.55	1.84	1.82	1.13	1.36	1.58	1.72	0.84
	2001-2005	1.81	1.63	2.17	0.87	1.34	1.57	1.92	2.06	1.00

Source: Kang et al (2009).

CHAPTER 2
EU and BRICs: Challenges and opportunities for European competitiveness

2.1. Introduction

The term BRICs[54], is the common label for the four largest fast growing emerging countries: Brazil, Russia, India and China. Their common features include a large territory and population, low income levels, but also fast economic growth resulting in the emergence of a prosperous local middle class. Notwithstanding the current global crisis, their catching-up process is expected to continue, creating both new opportunities and numerous challenges for the rest of the world and for the European Union in particular. This chapter shows that, while sharing common features, the individual BRIC countries are in fact fairly heterogeneous, posing quite different challenges and calling for specific policy responses on the side of their partners, especially the EU[55]. Opportunities for trade and investment in the large and rapidly expanding BRIC markets are obvious, and companies from the EU are already well positioned there. Major challenges include cost competition in product markets, changing patterns in global commodity flows (energy, metals and food), non-tariff barriers to trade, regulatory deficiencies, e.g., concerning intellectual property rights, and various institutional impediments to foreign investment. Distinct political systems, especially as far as state involvement in the economy is concerned, also require different policy responses towards individual BRICs.

This chapter is organised as follows. Section 1 deals with foreign trade in goods and services and with FDI and knowledge flows between the BRICs and the EU. For comparative purposes, the corresponding flows between the BRICs and the rest of the world, in particular with the US and Japan, are reported as well. Section 2 contains a summary of four country studies briefly analysing the key features of the economic development models of the individual BRICs. Section 3 focuses on Russia and Brazil and their respective roles in the EU's energy import needs. The final section concludes and discusses some policy implications.

2.2. Trade in goods and services, FDI and knowledge flows

2.2.1. Trade in goods

This section starts with the overall position of the EU and the BRICs in world trade and moves subsequently to a more detailed analysis of regional, commodity and industry-specific trade specialisation patterns.

2.2.1.1. Global Trade in goods

The EU is the world's leading exporter of goods. In 2007, extra-EU exports amounted to about 17% of total world exports. The EU is also the second largest importer, closely behind the US. The rapid growth of Chinese exports over the past two decades has made China advance to second place a as world exporter. The global market shares of the Triad (EU, US and Japan) have all significantly decreased over the period 1995-2007 (see Figure 2.1).

The decline in the Triad's global market shares coincides with the emergence of new players on the world markets. These new players include all four BRICs. With regard to goods' trade, the prominent role of China as an exporter stands out.

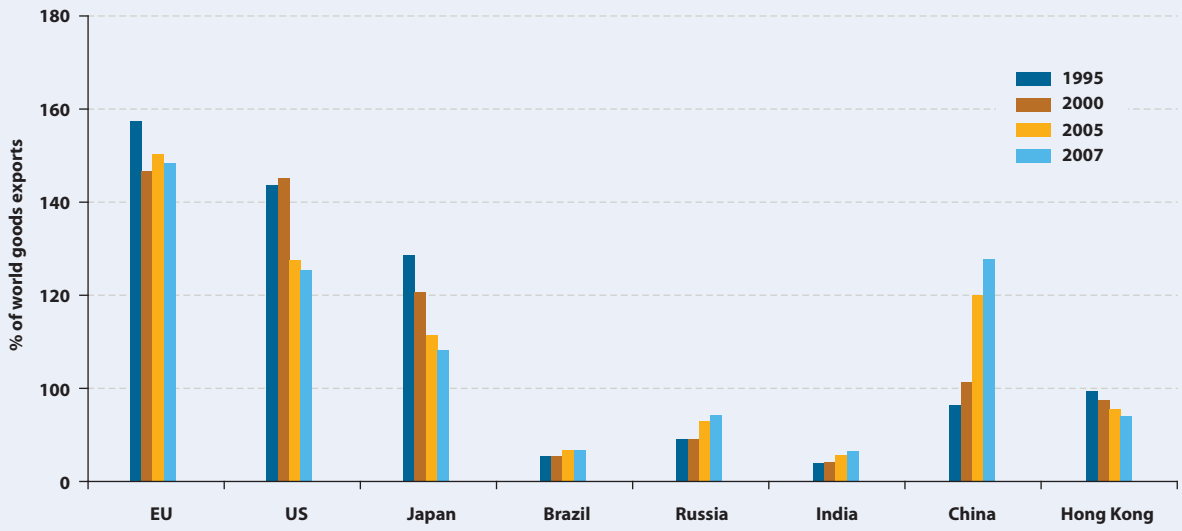
2.2.1.2. Bilateral trade relations between Triad countries and the BRICs

The EU's leading role in international trade also extends to bilateral relations between the Triad and the BRICs. EU companies make intensive use of this trade channel to serve the BRICs markets and are also quite successful as compared to the US and Japan. Russia has become

54 First used in 2001 by Jim O'Neill, chief economist at the investment bank Goldman Sachs (see Goldman Sachs 2003 and 2007).

55 For more details see the background study prepared for this chapter.

Figure 2.1: Global market shares in goods



Source: IMF, Directions of Trade, wiiw calculations. Calculation of market shares is based on extra-EU exports only.

the EU's main export partner among the BRICs, China the main import partner. However both the EU and the US have a large bilateral trade deficit with China. There are several factors contributing to China's strong export performance. One is that the Triad countries are providing China with the necessary capital goods, technology and know-how to diversify and upgrade domestic industrial and export capacities.

With a share of 17-18% in world trade, the EU is indeed a trading giant. Yet about two thirds of EU trade represent intra-EU trade, which is not included in the above percentages. With intra-EU trade included in the trade analysis, the BRICs accounted for just 6% of total EU exports in 2008 – less than EU exports to the US (6.2 %) –although their share has doubled since 2000[56]. The growing importance of the BRICs is even more visible in EU imports (11.6% of total EU imports in 2008), largely due to China (5.9%). The analysis of trade statistics shows that China and Russia are the EU's main trading partners among the BRICs and thus represent key challenges. The higher share of BRICs in some EU countries' exports and imports results largely from their trade exposure to Russia. These differences may have important implications for the formulation of common EU policies: Member States with less exposure have a lower stake in policy formulation regarding particular BRICs and/or may be guided less by purely commercial interests than by other issues (security and environmental concerns, human rights, etc)[57]. Conversely, the EU is the most important trading partner for the BRICs – especially for Russia, Brazil and India (Figure 2.2).

2.2.1.3. Sectoral composition of EU-BRICs goods trade

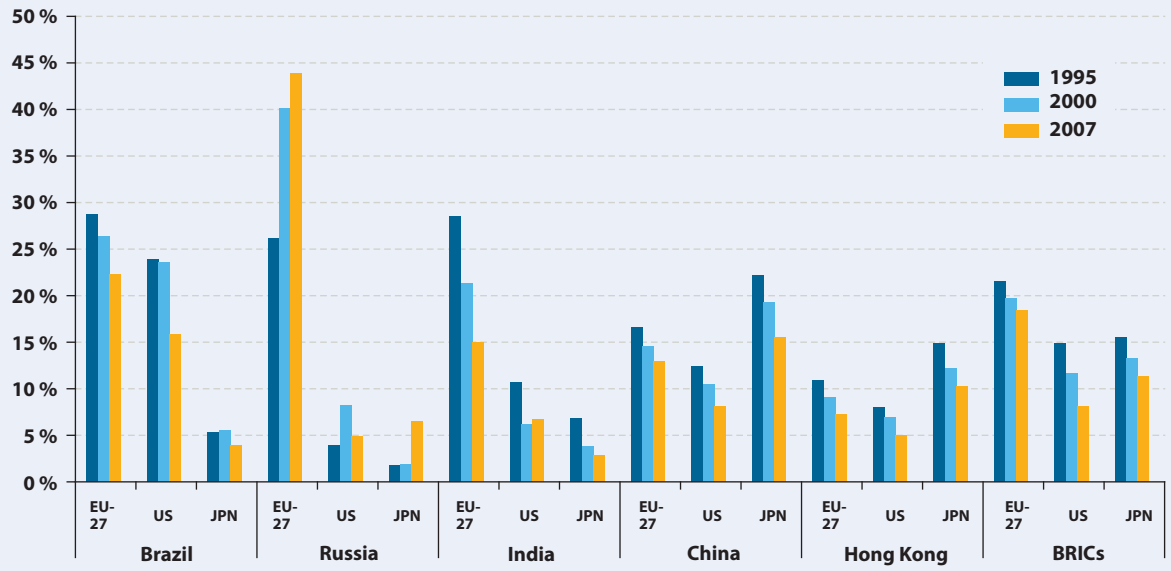
About 90% of overall EU exports of goods represent manufacturing industry products. In goods exports to the BRICs, the focus on manufacturing is even more pronounced. The only exception is exports to India where the share of manufacturing amounted to just 78% of total EU exports in 2007. EU imports from the BRICs are somewhat more diversified, although manufacturing prevails as well, especially in imports from India and China. Apart from manufacturing, imports of mining products are important in particular from Brazil (17.8% of EU imports in 2007) and especially from Russia (52.1 % of EU imports from Russia mostly crude oil and natural gas). Imports from China consist almost exclusively of manufacturing products, while agriculture plays a more prominent role only in EU imports from Brazil.

EU manufacturing exports are underrepresented in trade with the BRICs (in terms of differences in individual industries' shares relative to the structure of overall EU exports in 2007) in food products and beverages (NACE 15, except with Russia), in coke and refined petroleum (NACE 23) and in chemicals (NACE 24). On the other hand,

56 The rest of this section is based mainly on data from Eurostat's Comext database. The subsequent analysis covers total EU trade (both intra- and extra-) in order to look not only at the EU as a whole but also at the performance of individual EU countries (e.g. new Member States relative to BRICs). Table A1 in Annex provides an overview of EU trade with individual BRICs, the Triad and the rest of the world (RoW) during the period 2000-2008.

57 The Baltic states and several other NMS may serve as an example: despite their strong trade exposure to Russia they are less prone to compromise on trade for the sake of other policy issues.

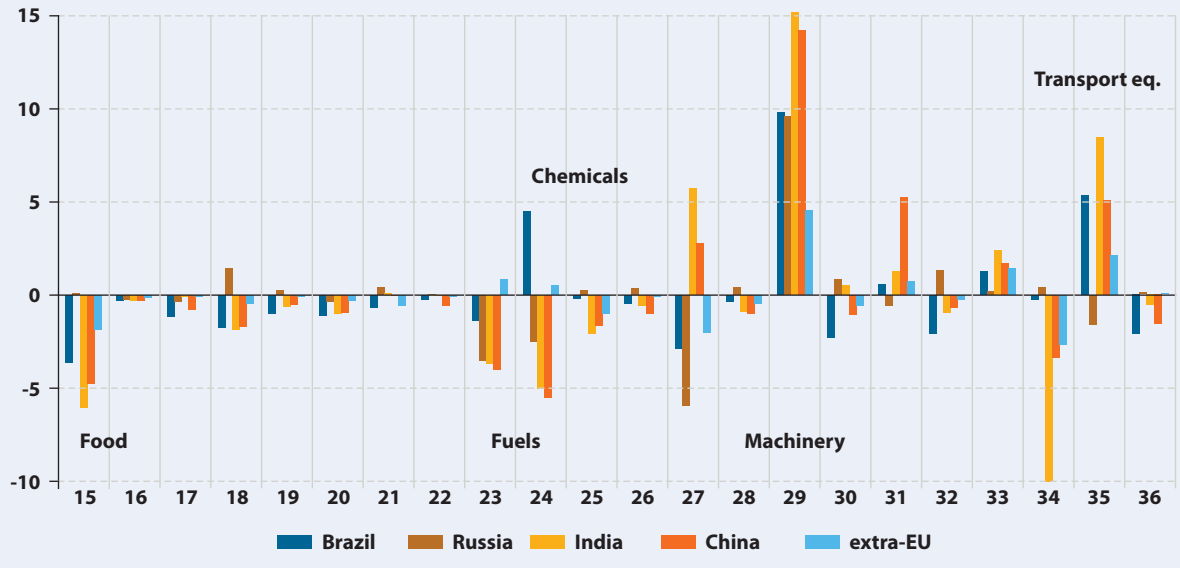
Figure 2.2: Shares of the Triad in BRIC goods imports (in % of total imports)



Source: UN Comtrade, own calculations.

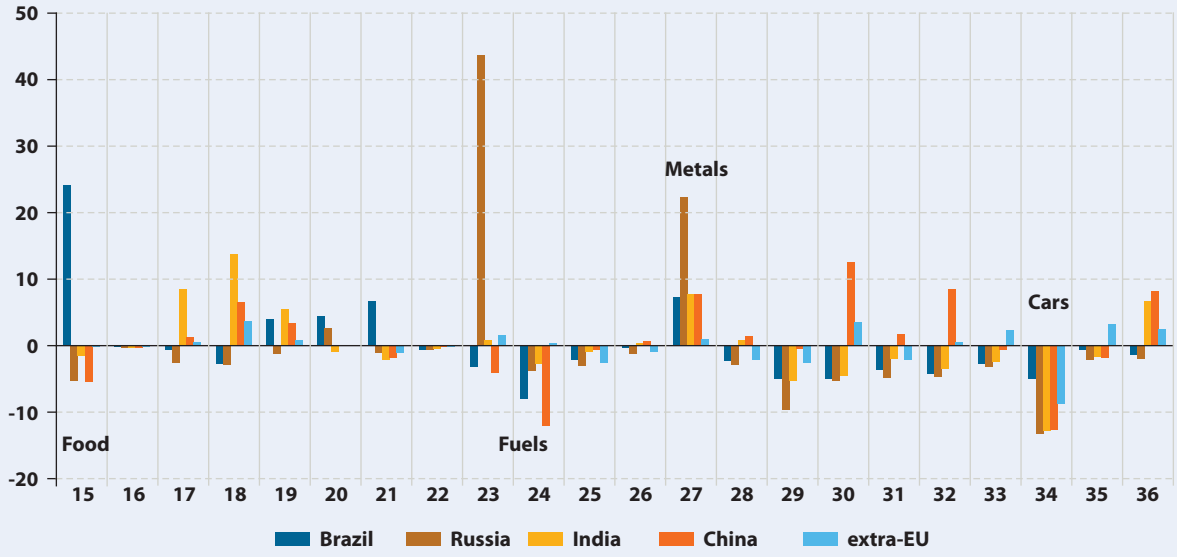
the EU has a strong specialisation (above-average export shares) with regard to the BRICs in exports of machinery and equipment (NACE 29) and in other transport equipment (NACE 35). China is also an important market for EU exporters of electrical machinery and apparatus (NACE 31), see Figure 2.3a. As shown in Figure 2.3b, the structure of EU imports from BRICs is dominated by just a few industries: food and beverages (NACE 15) from Brazil and coke and refined petroleum (fuels: NACE 23) along with basic metals (NACE 27) from Russia (note that this is in addition to unprocessed energy products such as oil and gas). Office machinery (NACE 30) and radio, TV, communication equipment (NACE 32) dominate imports from China. Imports from India show a relative specialization on textiles (NACE 17), wearing apparel (NACE 18) and furniture (NACE 36). Already at this level of detail one can see the impressive technological upgrading of China's exports compared to other BRICs.

Figure 2.3a: Structure of EU manufacturing exports to the BRICs by NACE* 2-digit industries (differences from the structure of total EU exports in pp, 2007)



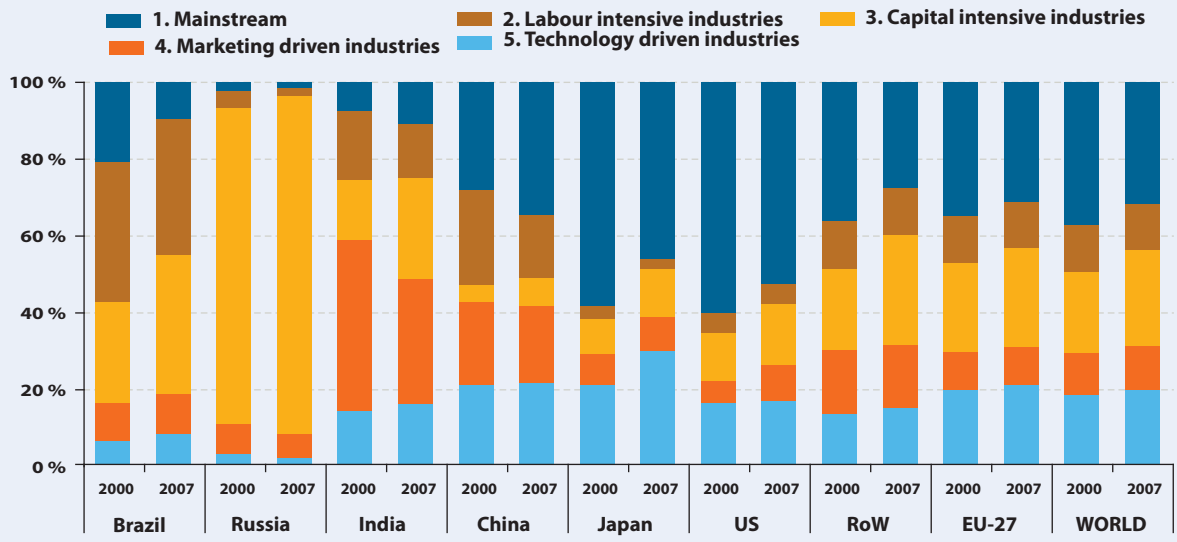
Source: Eurostat Comext, wiiw calculations.
* NACE Rev. 1.1

Figure 2.3b: Structure of EU manufacturing imports from BRICs by NACE* 2-digit industries (differences from the structure of total EU imports in pp, 2007, note different scale)



Source: Eurostat Comext, wiiw calculations.
* NACE Rev. 1.1

Figure 2.4a: EU-27: Imports by industry groups (Taxonomy I)

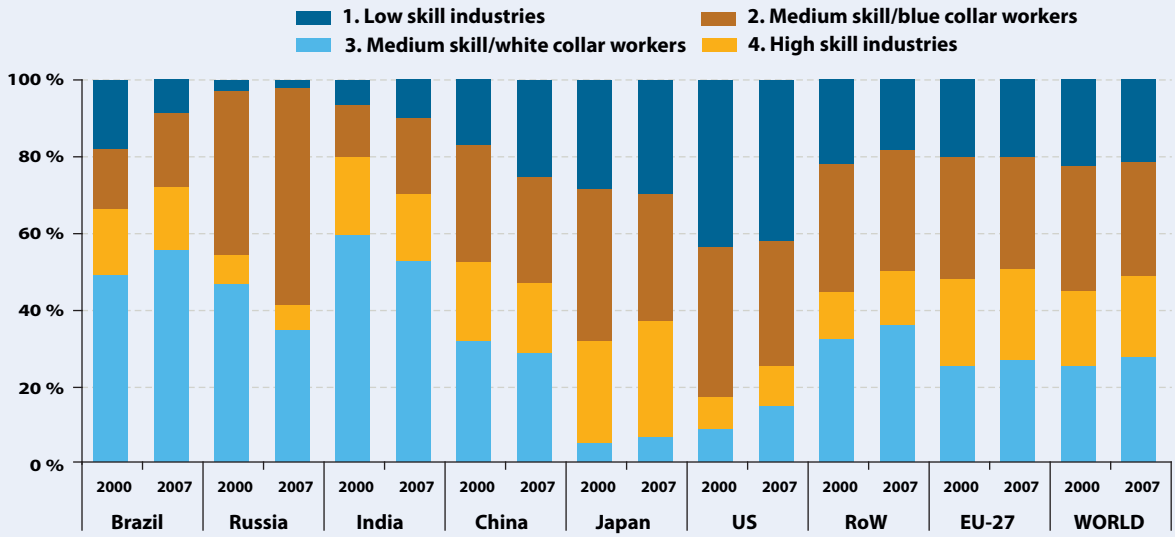


Source: Eurostat Comext, wiiw calculations.

The analysis of EU trade at the more detailed (NACE 3-digit) level employs a classification of industries according to factor inputs (Taxonomy I) and labour skills (Taxonomy II see Peneder 2003)[58]. Figure 2.4a shows the structure of EU imports by industry groupings classified according to factor inputs and the shares of individual groupings in total EU imports (Taxonomy I). In EU imports from Brazil and Russia the capital-intensive industries prevail, just as labour-intensive industries prevail in imports from India. However, the share of these groups of industries in EU imports from China is much lower whereas the technology-driven industries are increasingly dominating: in 2007, the share of this group of industries in EU imports from China was already higher than in intra-EU imports.

58 The list of 3-digit NACE industries and their allocation to industry groupings according to both taxonomies can be found in the Annex. The structures of EU exports are not discussed here because there are no large differences between the BRICs and other regions (technology-driven, capital-intensive and mainstream industries prevail in EU exports – the data are shown in the Annex).

Figure 2.4b: EU-27: Imports by industry groups (Taxonomy II)



Source: Eurostat Comext, wiiw calculations.

The low-skill industries dominate in EU imports from Brazil and India (Figure 2.4b), medium-skill industries in imports from Russia (refined petroleum is included here). EU imports from China are divided into low- and medium-skill industries (both with declining shares) while the group of high-skill industries recorded rapidly rising shares between 2000 and 2007 again providing evidence for China's technological upgrading. The labour skills structure of EU imports from China is becoming increasingly like the structure of intra-EU trade.

2.2.1.4. Revealed comparative advantages of BRICs and the EU

All BRICs have revealed comparative advantages (RCAs) in trade with the Triad in labour-intensive industries[59]. They also have positive RCAs in marketing-driven industries (except for Russia in trade with the EU and the US, and for Brazil in trade with Japan). In the case of China, the RCAs point towards a (small) comparative advantage in technology-driven industries. The trade specialisation patterns of the BRICs are far from identical: Brazil has positive RCAs in marketing-driven (food processing) and in labour-intensive (textiles) industries. Russia has positive RCAs only in capital-intensive industries, mostly due to strong exports of refined petroleum and diverse metal products. Russia is an exception among the BRICs in this respect, since it has a comparative disadvantage in labour-intensive industries in trade with the EU and the United States. The relative strength of China in exporting technology-driven industries is fully in line with other findings on Chinese trade[60] as well as with other studies on the trade effects of globalisation (e.g. Baumann and di Mauro, 2007). India's distribution of RCAs is very similar to those of Brazil.

From the EU point of view, the RCA patterns in trade with the BRICs are also rather diverse. There are positive RCAs in mainstream and technology-driven industries in EU trade with Brazil and India both in 2000 and in 2007. There are also positive RCAs in all industry groupings except capital-intensive industries in EU trade with Russia. Last but not least, negative RCAs in both labour-intensive and marketing-driven industries persisted in EU trade with China between 2000 and 2007. Moreover, the initial (small) positive RCA in technology-driven industries turned negative between 2000 and 2007 – another sign of China's technological upgrading.

Competition patterns in EU markets are also analysed by looking at changes in import prices (so-called unit value

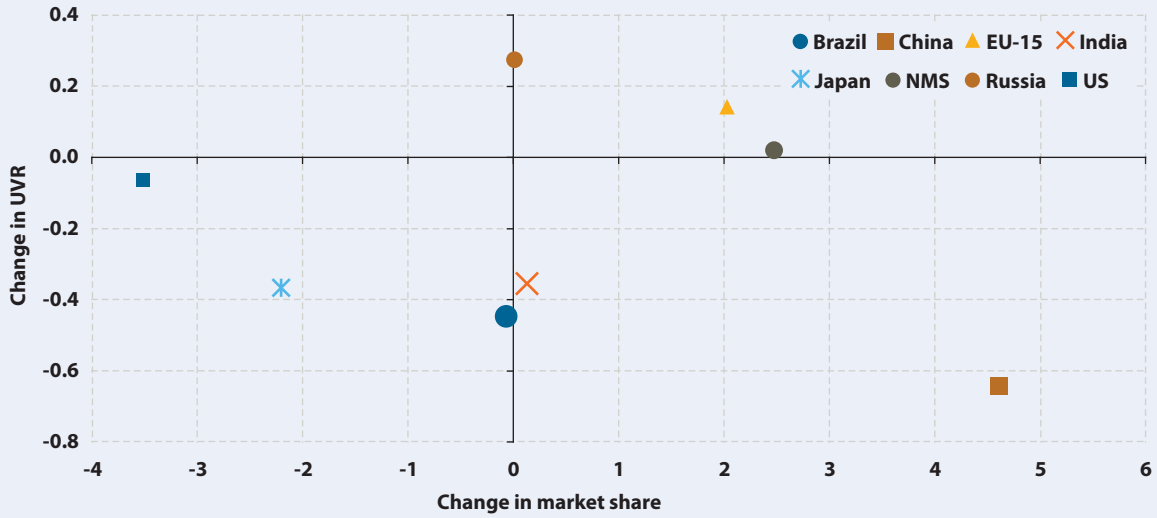
59 The RCA analysis here is again based on the industry classification by Peneder (2003). Not captured is the possibility that within, for example, a technology-intensive industry, the labour-intensive production steps are located in the BRICs with the aim to re-export the output. The UN Comtrade database is used for computing BRIC RCAs. RCAs are calculated according to Balassa (see Balasssa, 1965):

$$RCA_{ci} = 100 \cdot \ln\left(\frac{\frac{X_{ci}}{M_{ci}}}{\frac{\sum_{c} X_{ci}}{\sum_{c} M_{ci}}}\right),$$

- where X (M) are exports (imports), c denotes a partner country and i the respective industry-grouping (RCAs were calculated from individual 3-digit NACE industry trade data). Positive (negative) RCA values indicate a comparative (dis) advantage. The use of a different RCA index (e.g. Lafay's – see Baumann and di Mauro 2007) would lead to similar conclusions regarding comparative advantages.

60 China's exports are found to be technologically more advanced than its level of income would suggest (Rodrik, 2006) and its export bundle is more similar to those of developed countries than those of countries with similar income levels (Schott, 2006).

Figure 2.5a: Competition on the EU market in technology-driven industries changes in import prices and market shares, 2000-02 compared to 2005-07



Source: Eurostat Comext, wiiw calculations.

ratios – UVRs – see Box A1 in the Annex to this chapter) and market shares during the period 2000-2007 for the same industry groupings used above. For this purpose, the average changes in UVRs and market shares for each country (group) for the periods 2000-2002 and 2005-2007 have been calculated in order to smooth out possible outliers. The results for selected industry groupings are shown in Figure 2.5a (technology-driven industries) and in Figure 2.5b (high-skill industries).

China, but also India and even Russia (as well as the new Member States) have been successful in price competition in high-skill industries and gained market shares in the EU. China has recorded the most impressive market share gains in virtually all industry groupings with falling UVRs. Moreover, China has also been quite successful in the technological upgrading of exports and is emerging as the main competitive challenge for the EU.

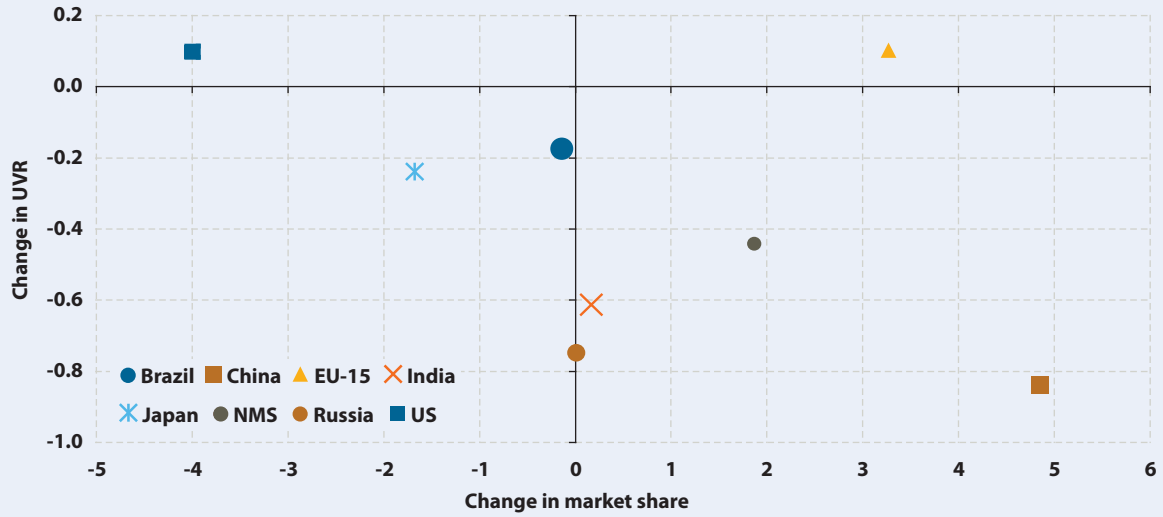
A distinctive feature of Chinese trade is the high share of parts and components, particularly on the import side. In contrast, this form of trade integration is much less developed in Russia and also in India[61]. The split-up of trade according to broad economic categories, which reflect different stages of production, also shows that China's and India's trade is characterised in contrast to Russia's by a very low share of imports of consumption goods. Chinese data document that since 2002 more than half of Chinese exports can be attributed to the activity of foreign investment firms. The impact of the activities of multinational corporations (MNCs) on Chinese foreign trade has to be borne in mind when interpreting export patterns. In the context of competitiveness it certainly makes a difference whether EU firms lose or actually relocate export shares to their Chinese affiliates or whether these market shares are truly lost to "genuine" Chinese manufacturers. The share of the EU in China's inward foreign direct investment (FDI) is only 7%-10%[62]. Nevertheless the EU is, together with the Asian newly industrialised countries (NICs) (14%) and Japan (7%), one of the major FDI investors in China, once FDI from Hong Kong and off-shore centres is substracted[63]. Indeed, much evidence indicates that China's bilateral trade balances and RCAs reflect to a large extent the comparative advantages and competitiveness of foreign firms exporting from China. Previous analysis of "genuine" Chinese exports, i.e., excluding exports by foreign investment firms suggests that their skill content has not changed substantially so China in some sense continues to specialize mainly in labour-intensive goods (Amiti and Freund, 2008). A considerable part of Chinese economic activity in manufacturing is accounted for by foreign-owned firms, which may influence the developments of revealed comparative advantages.

61 For an analysis of the role of trade in parts and components in shaping Chinese trade patterns see background study, section 1.1.8. In a similar contrast to China, the role of intra-industry trade in Russia is extremely low – see Fertö and Soos (2008).

62 Figures are the average for the period 2004-2007 according to Chinese data (7 %) and combined Eurostat/UNCTAD data (10%).

63 If FDI from Hong Kong (likely to be predominantly round-tripping capital) and FDI from offshore centres, whose ultimate source country remains unknown, is subtracted, the relative shares of the EU and other major FDI investors are about double the shares indicated because Hong Kong and offshore centres account for about half of total Chinese inward FDI. For more details see section 1.3.2 (Box 1.3.2) of the background study.

Figure 2.5b: Competition on the EU market in high-skill industries changes in import prices and market shares, 2000-02 compared to 2005-07



Source: Eurostat Comext, wiiw calculations.

2.2.2. Trade in services

Trade in services is much less important than trade in goods, as measured by both absolute volumes and shares in GDP (in the EU, on average less than 10% of GDP compared to 32% for goods trade)[64]. The BRICs' share in global services trade is much lower than that of the EU. China and India are the biggest services traders among the BRICs – together they account for almost 60 % of total BRICs services trade. Japan is the only country where the share of BRICs in services imports is relatively high (see Table 2.1). In the EU and US, the shares of the BRICs in services imports are only about 4%, which is lower than their share in goods imports. However, if we compare BRIC services trade with extra-EU imports, then the share of BRICs increases to about 9%. The new Member States (NMS) import relatively more services from BRICs than do the old Member States (EU-15): the share of the BRICs in total NMS services imports is 4.2%, which is 0.5 percentage points higher than in the EU-15.

All BRICs have been increasing their services exports much faster than the EU, the US or Japan. India is the absolute leader in terms of growth rates – its annual services export grew more than five-fold during 2000-2007. Services exports by China and Russia increased four-fold during that period.

From the BRICs' perspective, the EU is quite an important market for service exporters (the shares of the EU in services exports range from 13% for Hong Kong to over 40% for Russia), and in the case of China and Hong Kong the EU's share has been growing. The importance of the BRICs for EU service exporters has been increasing as well: in 2007, the share of BRICs in total EU services exports exceeded that of the NMS (4.6% versus 4.2%), while the share of BRICs in extra-EU services exports reached 11%.

China and Russia specialise in transport services on the EU market, with Russia having acquired an additional strong specialisation in construction services. The current pattern of BRICs' specialisation on the NMS market is similar to that on the EU-15 market. However, in contrast to the EU-15, the pattern of specialization has changed noticeably on the NMS market since 2000, when China and India specialized in exports of other business services. These trends in specialisation together with the much faster development of intra-EU services trade (extra-EU trade of the NMS actually having fallen during 2003-2007)[65] may indicate that the recent EU enlargement has resulted in strong trade diversion effects for services, possibly due to the decrease in bar-

64 Some caution is necessary when comparing trade in goods with trade in services since there is a risk of bias in favour of goods' trade. Some «trade in goods» contracts might include also a service component (e.g. R&D), especially when multinational companies are involved, leading trade in goods in the official statistics to be slightly overestimated and services underestimated. Also, when the source data for trade in goods is foreign trade statistics, because it includes processing trade on gross basis and processing might be understood as a service rather than trade in goods, it again somewhat inflates the trade in goods data making it not completely comparable with Balance of Payments data which are the source for trade in services. These biases are however far from changing the higher magnitude of trade in goods relative to services.

65 In NMS extra-EU services imports decreased by 24% and exports by 22% while intra-EU services exports increased by 264% and exports by 276% in the period 2003-2007.

Table 2.1: Geographical structure of services imports in 2007, %

Importers by columns	Brazil	China	Hong Kong*	India	Russia	Japan	US	EU-27	EU-15	NMS-12
Brazil	-	…	0,4	…	0	0,2	0,8	0,4	0,4	0,1
China	…	-	23,7	…	0,3	5,1	0	1	1,1	1
Hong Kong	…	25,8	-	…	0,1	3,8	1,4	0,8	0,8	0,2
India	…	…	0,9	-	0,4	0,4	2	0,5	0,6	0,1
Russia	…	…	0,2	…	-	0,3	0	0,9	0,8	2,8
Total BRICS	**…**	**25,8**	**25,2**	**…**	**0,8**	**9,7**	**4,2**	**3,7**	**3,7**	**4,2**
Japan	1,6	6,4	7,6	2,2	0,5	-	5,3	1,3	1,4	1
US	26,8	7,9	13,2	18,2	5,2	27,2	-	12,5	12,9	6,5
EU-27	23,7	18,8	12,6	19,5	43,5	16,7	38,7	63,3	72,2	63,9
EU-15	23,3	18,6	12,5	19,2	34,7	16	37,4	59	59,2	57,1
NMS-12	0,5	0,2	0,1	0,3	8,8	0,8	1,2	4,9	4,2	15,1
Other	48,3	41,2	41,6	60,4	58,7	47,1	53,1	23,5	22,9	31,2
Total	100	100	100	100	100	100	100	100	100	100

* Data are for 2005.
Source: TSD, own calculation.

riers to services trade with the EU in the NMS after their EU accession.

2.2.3. FDI flows between the EU and BRICs

The magnitude of EU outward FDI flows reflects the *ability* and *propensity* of EU firms to internationalise their business activities. FDI is therefore a valuable indicator of the *corporate competitiveness* of firms in the EU vis-à-vis foreign competitors. At global level, the EU emerges as the most important investor. In 2007 extra-EU FDI by EU firms increased to EUR 484 billion (in comparison, US and Japanese FDI amounted to EUR 229 billion and EUR 54 billion, respectively). The EU has also been the largest recipient of FDI, attracting EUR 360 billion from outside the EU in 2007, more than twice the amount of the inflows into the US economy. Since the competitiveness of the EU crucially depends on the *corporate* competitiveness of both domestic and foreign firms operating in the EU, there is a positive relationship between inward FDI and the competitiveness of the EU. Bilateral FDI flows document the coincidence of two forms of competitiveness: *corporate* competitiveness, i.e., high relative productivity of firms in the source country, and *locational* competitiveness, i.e., the relative attractiveness of the host country's economy for potential FDI investors. The EU is the world's most important provider of FDI and has 55 of the 100 largest non-financial MNCs domiciled on its territory (UNCTAD, 2008a).

2.2.3.1. FDI relations with the BRICs

The share of EU FDI going to the BRICs remains small, and has increased only moderately since 2002. But the EU is an important source of FDI for all BRICs (mirroring the situation with trade). The EU is by far the most important investor in Russia and Brazil, accounting on average for 57% and 53%, respectively, of the total FDI in the period 2004-2007. For the Asian BRICs, the share of the EU is much lower, ranging from 31% in India to only 10% in China. This is explained by the large intra-regional FDI flows and by the importance of off-shore centres and round-tripping. Based on the number of investment projects, the role of the EU is more significant.

The BRICs have large and growing domestic markets and have made efforts, albeit to varying degrees, to improve the investment climate in their economies. These factors have advanced the BRICs to the top five most attractive locations for FDI in recent UNCTAD surveys (UNCTAD, 2008). Consequently, EU FDI flows to the BRICs increased steadily over the period 2001-2007, particularly to Russia and Brazil (see Annex Table A4). In terms of the number of projects recorded in "FDI Intelligence from Financial Times Ltd" (*the fDi database*), the development is even more dynamic and continued in 2008 the world-wide slump of FDI[66]. China and India, lagging behind in terms of the amounts received, emerge as the main targets in terms of number of projects. This difference is mainly due to the fact that FDI projects in Russia and Brazil are more capital-intensive, which in turn is explained by the industry distribution of inward FDI.

2.2.3.2. FDI position in the BRICs

Among the Triad, the EU emerges as the largest provider of FDI in each of the BRICs. In Russia and Brazil,

66 This section is based on two major sources of data: the Eurostat Foreign Direct Investment Database (Eurostat) which records realised FDI flows according to balance of payments principles, and FDI Intelligence from Financial Times Ltd, which is based on information from press reports and can thus be taken as investment commitments.

Figure 2.6: Motives of EU-15 investors in the BRICs

Source: FDI Intelligence from Financial Times Ltd.

the amounts invested by EU firms were seven to eight times the amount of FDI undertaken by US firms in these countries (average 2005-2007). The average flows from the EU to China over the same period amounted to EUR 6.6 billion, more than twice the amount from the US. Japan, which has a strong Asian focus in its outward FDI, recorded average FDI flows of EUR 4.9 billion to China during the same period. It is interesting to note that the EU has a stronger position as an investor in the BRICs than as an exporter.

While the strong FDI links between the EU and Russia are to be expected due to the proximity of the two markets (and is also found in trade in goods and services), a favourable position of EU firms in Brazil compared to US firms is also patent, and in contrast to the findings for services trade. The strong position of the EU in the BRICs is confirmed by the fDi database, which also shows the EU to be the major investor in the BRICs, way ahead of the United States[67].

Germany and the United Kingdom are the EU's main FDI investors in the BRICs, followed by France and the Netherlands. In terms of the amounts invested, Spain also ranks among the top five investors. The strong presence of EU firms in Brazil is mainly the result of FDI from Spain, a country with close historical links with South America, and Germany, which is a major and geographically well diversified provider of FDI. When looking at the number of projects, Italy also emerges as an important investor for the BRICs, whereas Spain appears to be less active. Portugal, the former colonial power in Brazil, does not show up there as a major investor in terms of value, but has the highest number of investment projects.

2.2.3.3. Sectoral structure of FDI in the BRICs

As with global outward FDI, the EU's FDI stocks owned in the BRICs are overall skewed to the services sector (see Annex Tables A5). However, FDI in manufacturing continues to play an important role especially in China and India. In terms of both the number of projects and accumulated stocks, the manufacturing sector accounts for approximately one third of total EU stocks owned in the BRICs, whereas the share of the services sector is around 60%. The dominance of services over manufacturing is in line with the structure of the EU economy, but in stark contrast with the relative importance of these two broad sectors in international trade, confirming the importance of direct investment in the internationalisation of services. Indeed, as services are typically more difficult to trade across borders, settling in BRICs through FDIs is the main means for EU service companies to get access to BRIC markets. In this context, the importance of FDI in financial intermediation stands out.

2.2.3.4. Foreign investors target mainly local regional markets

Of the more than six thousand EU investment projects covered by the fDi database, 1382 provided information concerning the markets that the activity serves. One third targeted only the domestic market of the host country, another third the Asia-Pacific market, and 7 % had a global reach. Only 63 projects aimed to serve European markets, which shows that outsourcing (the relocation of production with the intention to re-export back to Europe) motivated only a small fraction of EU investment projects in the BRICs. Most projects serving the EU market were located in Russia, geographically the nearest of the BRICs.

The reported motives for EU investments in the BRICs related to market conditions in the host country and sales location (Figure 2.6). Of the 1445 projects that supplied information, 45% chose the location due to the growth potential of the destination market, 17% due to the proximity to customers and only 7% due to low costs. The motivation of investors and the markets for their products reveal that European FDI in the BRICs is primarily market-seeking. It is more the growth of the market, and less the production cost, which motivates the decision to invest abroad. This motivation structure suggests that wage

67 In the analysis based on the fDi database, the EU comprises only the EU-15. Since investment activities by the new EU Member States in the BRICs are very low, this does not cause major distortions.

increases will not deter investors due to rising costs, but may rather attract them due to growing demand.

2.2.3.5. FDI of the BRICs in the EU

Outward FDI undertaken by multinational firms of emerging markets, including the BRICs, is a rather new phenomenon. The growth of FDI outflows from the BRICs began to accelerate markedly only at the beginning of the new millennium. Accordingly, all of the BRICs are relative latecomers with regard to outward FDI. Rapid growth in outward FDI flows has made Russia the most important investor among the BRICs in 2007, with outward FDI flows reaching EUR 33 billion. A strong pick-up is also observable for China and India, which recorded outward flows of EUR 16 billion and EUR 10 billion, respectively. Brazilian global outward FDI is rather volatile but shows a clear positive trend as well. Much less of an upward trend is discernible in the FDI flows from the BRICs to the EU, with the important exception of Russia. Rather than following a steady upward trend, inflows from Brazil, India and China into the EU show only single peaks in different years. In most years, however, BRIC FDI flows to the EU have remained at a low level. Hong Kong used to be an active FDI investor in the EU markets, but has lost this position due to disinvestments over the past three years. The combined amount of FDI flows received by the EU from the BRICs stood at EUR 5.4 billion in 2006 and EUR 12.3 billion in 2007, which was due to exceptionally high FDI from Russia (EUR 9.1 billion).

This implies that the BRICs are only a minor source of FDI for the EU, accounting for only 5.5% of extra-EU inward FDI flows during the period 2002-2007. The BRICs are underrepresented in the EU market in terms of FDI flows when compared to their share in global FDI. One major explanation for this pattern is that a major part of the BRICs' outward FDI, particularly from China and India, is resource-seeking, directed predominantly at the resource-rich countries of Africa, South America and Asia.

2.2.3.6. FDI, modes of market entry and competitive positions

The fact that BRIC FDI activity in the EU is very low implies that the local presence of firms from the BRICs is still the exception rather than the rule. Despite isolated examples, MNCs from the BRICs generally exert only very limited competitive pressure on EU firms via subsidiaries established in the EU. For manufacturing this is evidenced by the very low sales volumes of foreign affiliates of BRIC MNCs in the EU. Competition from the BRICs on the EU market is much fiercer via the trade channel. The low levels of FDI and the almost complete absence of foreign affiliate sales by BRIC firms in the EU can be seen as a competitive advantage for EU manufacturing firms. At the same time, however, this also means that BRIC FDI activities hardly create any additional employment in the EU.

In contrast, FDI in the BRICs has led to a strong local presence of EU firms in these markets and EU firms seem to compete intensively there via the sales of affiliates. For several EU Member States, sales by foreign affiliates of manufacturing firms in some BRIC markets already surpass their exports. For example, the sales of German manufacturing affiliates in Brazil (EUR 23 billion in 2006) exceed by far German merchandise exports to Brazil (EUR 6 billion in 2006). This shows that for EU firms FDI (together with subsequent sales by subsidiaries) is a major mode of entry and channel of competition in the BRIC markets.

2.2.3.7. Impact of the crisis on EU-BRIC FDI relations

The current global economic crisis, which among other things is expected to cause a 13% contraction of world trade during 2009 (OECD, 2009), will most likely trigger a drop in FDI due to falling global demand, excess capacities, difficulties with investment financing and a drop in subsidiary profits. Overcapacities will hinder FDI and cause its volume to shrink perhaps even more than the volume of global trade. The BRICs may have a privileged position in many respects. First of all, they are large economies where FDI is mainly attracted by local markets with growth expectations above the world average, with the possible exception of Russia. Local economic growth will allow FDI to grow if companies from crisis-hit countries are in a position to invest there. European multinationals may just concentrate on the very few countries in the world where they can expand sales, such as China, India or Brazil and shift investments there. A second likely consequence of the current crisis could be a gain in the relative importance of the BRICs' outward FDI at global level and also in the EU. Due to the crisis, there will be a lack of capital for expansion, which will negatively impact mergers and acquisitions. In contrast, if BRIC companies fare better than their European counterparts and their financial situation remains more robust, they may even invest in relatively cheap EU companies.

2.2.4. Knowledge flows between the EU and BRICs

The previous sections have analysed FDI and trade patterns between the EU and the BRICs. In the empirical literature on technology diffusion, FDI and trade have been found to increase the productivity of the receiving country. Therefore, they have been considered as channels for international technological diffusion or technological spillovers (Keller 2004). This section adds to the analysis presented above by exploring information on other channels for knowledge transfer: through analy-

Table 2.2: Trade in royalties and licence fees with the EU-25, 2006 (USD million)

Partner	Exports 2006	Exports 2006 share	Exports growth rate (2003-2006)	Trade balance 2006
World	49,334	100%	12%	-16,922
EU-25	19,881	40%	10%	
BRICs	*2,238*	*4.5%*	*31%*	*2,128*
Brazil	364	0.7%	30%	350
China	1,342	2.7%	33%	1,301
India	230	0.5%	23%	204
Russia	302	0.6%	29%	273

Source: Balance of Payment Statistics, OECD Statistics on International Trade in Services 2008, Volume II, Detailed Tables by Partner Country.

sis of international payments of royalties and licence fees, the international mobility of tertiary students, the international mobility of professionals, and the cross-border patent inventions. This section also evaluates the absorptive capabilities of BRICs, i.e., their ability to internalise and exploit knowledge developed elsewhere.

By and large, knowledge transfer ties between the EU and the BRICs are becoming increasingly important. The BRICs, in particular China, have also been drawing from the global pool of knowledge. China has become one of the major investors in R&D in the world[68]. Moreover, the country has also considerably intensified its knowledge ties with the world as well as with the EU. Even though knowledge ties between each of the BRICs and the EU have become stronger, the impressive pace of China and, to a lesser extent, India have resulted in an increase in their relative importance with respect to the EU, overtaking, in turn, the traditionally privileged position of Russia.

Regarding trade in royalties and licence fees (RLF), the US was in 2006 both the main provider and a net exporter. The EU, the second biggest RLF provider, was a net importer. However, with respect to BRIC countries, the EU enjoyed growing surpluses, with most knowledge flows to the BRICs through the RLF channel having an EU origin. Additionally, EU imports of RLF from BRIC countries have been declining, while EU exports to the BRICs have been increasing. Even though the BRICs represent a relatively small share in EU exports (4.5%), the EU has succeeded in attracting a higher proportion of the BRICs' growing demand for RLF. This has been largely due to the EU's success in attracting demand from China, which, among the BRIC countries, has been the major purchaser of EU RLF as well as the EU export destination with the highest growth rate.

Turning to the international mobility of students, the EU was the main destination for Russian students, though other BRIC students still prefer more often to enrol in US universities. In particular, the US hosted the bulk of the Indian, Chinese and Brazilian students. However, this pattern might change in the future since the EU has succeeded in attracting an increasing proportion of BRIC enrolments. BRIC student demand for tertiary education increased at the impressive average annual rate of 20% during the period 1999-2003. Among the BRICs, China registered the highest number of enrolments, the highest growth rate, and the highest mobility ratio. Among European countries, the UK hosted the largest number of BRIC students, in particular from India and China[69].

With respect to the international mobility of professionals, the US is undoubtedly the preferred country of residence for highly qualified foreign workers. This especially applies to BRIC migration. Except for Russians, the US was the preferred location of highly educated BRIC workers, attracting 83% of the highly qualified Chinese workers, 82% of Indians, and 50% of Brazilians.

Among the BRICs, India was the major country of origin for highly qualified workers both in the Triad and in the EU (mainly in the UK for the latter). On the basis of Eurostat labour surveys, BRIC skilled migrants employed in the EU grew at an annual average rate of 10% over the period 2000-2007 – mainly due to the increase in skilled migration to Spain from Brazil. Given the importance of professional mobility in explaining "tacit" knowledge transfer internationally comparable data would provide important insights.

Overseas innovation activities by MNCs are analysed by gathering data on patents where the country of the owner (applicant) differs from the country of the inventor. The data reveal that the majority of patents owned by EU firms are also invented in the EU. Knowledge creation is still much less internationalised than the production of goods. EU patents originating outside the EU mostly come from the US, Switzerland, Canada, and

68 Chinese R&D expenditures more than doubled as a share of GDP between 1996 and 2006 (to 1.42% of GDP in 2006).

69 A more general and thorough discussion of the implications of highly skilled migration to the EU can be found in the separate chapter on migration in this Report.

Figure 2.7: Distribution of BRIC students among main destinations

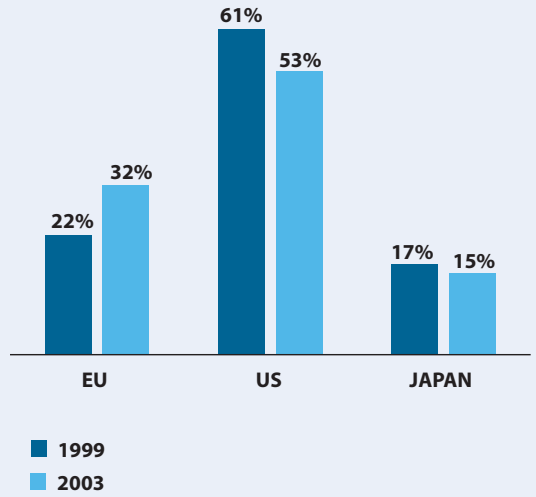
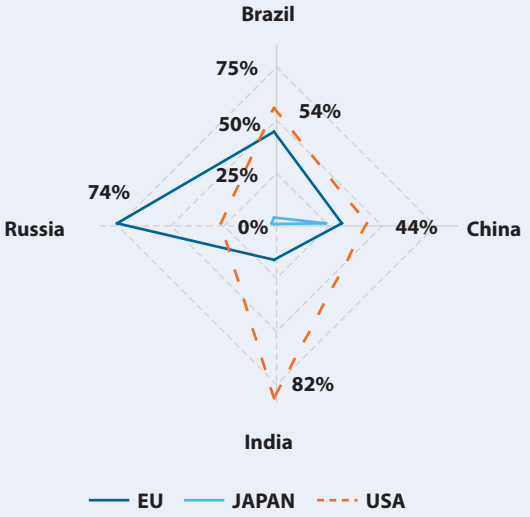


Figure 2.8: Distribution of BRIC students among main destinations (2003), by BRIC countries



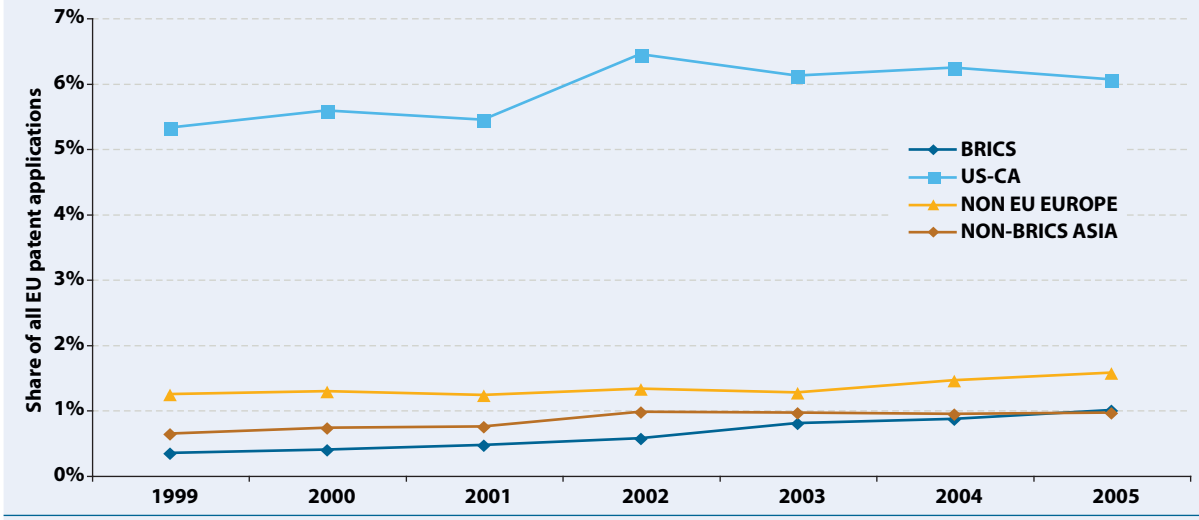
Source: OECD Foreign Student Enrolment Database, wiiw calculations.

Table 2.3: Foreign-born workers from BRICs in the Triad, year 2000

Country of residence	Number of foreign born workers, 1000 persons	Share in the Triad, %	Highly qualified foreign workers, 1000 persons	Share of highly qualified workers in the Triad, %	Ratio of highly qualified to foreign-born, %
EU	1,105	27	183	15	17
US	2,575	63	994	80	39
Japan	393	10	66	5	17
Triad	**4,073**	**100**	**1,243**	**100**	**31**

Source: OECD Migration Database, wiiw calculations.

Figure 2.9: Share of patents originating outside the European Union in all EU-27 patent applications, 1999-2005



Source: European Patent Office, own calculations.

Japan. The share of the BRICs in all patented inventions of the EU is just 1%, but rising fast. This increase is mainly due to activities in China.

The share of the other BRICs in EU patented inventions has remained constant over the past several years. Patents owned by BRICs but invented in the EU are still rare and conclusions are based on small numbers. With all due care, it can be concluded that Brazil and Russia are more oriented towards the EU, while India and China tend to use more inventions in the US.

2.3. BRICs' economic development models and implications for EU-policies

The BRICs show both similarities and differences in their interactions with the EU, the differences stemming largely from their different economic development models. Brazil is a domestically oriented service economy; the Russian economy is heavily dependent on energy exports; the Indian economy is essentially service-led, supported by exports; and China's economic development is driven by manufacturing exports and investment. The recent economic policies pursued by the BRICs and their plans for the future suggest a certain "convergence" in their development strategies. This section analyses the main economic characteristics and determinants of development for each individual BRIC country, focusing on parameters relevant to external relations, in particular with the EU. The final subsection gives a brief overview of the impacts of the current global financial and economic crisis on the BRICs and the measures taken to fight the crisis. Table 2.4.1 provides an extensive list of indicators for the individual BRICs, allowing for cross-country comparisons.

2.3.1. Common features of the BRIC economies

The BRICs are characterised by large territories and populations, relatively low income levels and fast economic growth. However, significant variations with respect to these common characteristics exist and further common features can be identified. In terms of territory, Russia is by far the largest country on earth, China ranks 3rd or 4th (area rank is disputed with the US), Brazil 5th and India 7th. In terms of population, China leads with 1.3 billion inhabitants, closely followed by India with 1.1 billion. Brazil, with a population of 190 million, ranks 5th, and Russia with 143 million ranks 9th. Both India and Brazil have a very young and fast growing population, while the Russian population is declining and the Chinese population is growing slowly. The latter two countries face ageing problems similar to Europe's.

Income and wage levels in the BRICs are all significantly lower than in the EU, but the range is wide: Russia and Brazil classify as "upper-middle-income countries", according to the definition of the World Bank; China is a "low-middle-income country"; and India is a "low-income country". In terms of GDP per capita (measured in PPP), Russia stood at 50% of the EU-27 average, Brazil 32%, China 18% and India 8.5% in 2007. Average monthly gross wages (at exchange rates) amounted to EUR 418 for Brazil, EUR 388 for Russia, EUR 207 for China and only EUR 71 for India. In terms of GDP converted at exchange rates, China is by far the biggest market among the BRICs. Chinese GDP amounted to EUR 2467 billion in 2007, about 20% of EU-27 GDP, comparable to Germany. The combined share of the other three BRICs was only 20%, each about 7% of EU-27 GDP. Over the period 2000-2007, the BRICs' GDP expanded significantly faster than the EU's. The annual average growth rate for China was 10.1%, for India 7.6%, for Russia 5.3%, and for Brazil 3.4%. Over a medium-term perspective, the catching-up process in the BRICs is expected to continue and their role in the global economy will further increase.

Income distribution is very unequal in all BRICs (Gini coefficients range from 0.37 in India to 0.57 in Brazil). The top 10% income earners receive more than 30% of all incomes and a sizeable, prosperous middle class is emerging. This leads to very fragmented markets, which European companies doing business in the BRICs have to bear in mind.

The role of the state in all BRIC economies is substantial, with frequent direct and indirect state interventions. In general, the state plays a much more prominent role in Russia and China than in India or Brazil. At the same time, the BRICs score relatively low when it comes to regulatory quality, rule of law, control of corruption and political stability (see "Institutional and policy framework" indicators in Table 2.4.1).

Inward FDI is considered an important means to support the catching-up process, and the BRICs represent an attractive location for foreign investors. However, various restrictions, such as controls on the extent and proportion of shares held or the existence of protected sectors are still in place, although to varying degrees and changing over time. Outward FDI stocks held by the BRICs are still small, but rising rapidly. Average tariff levels in the BRICs are low, but tariff peaks still exist and numerous non-tariff barriers (NTB) have gained importance. Brazil, India and China are members of the World Trade Organisation (WTO). Russia's WTO membership is still pending.

All BRICs are important regional economic players, and are also global players in certain fields (e.g. Brazil in biofuels, Russia in energy supply, India in IT services and China in manufacturing). Finally, all BRICs aim to upgrade their industrial structures towards higher value-added and technology-intensive products, fre-

quently supported by government programmes and specific industrial policies. A trend towards increased R&D expenditures can be observed.

2.3.2. Different models of economic development

2.3.2.1. Brazil

Brazil is currently following the model of a domestically oriented service-driven economy, with a relatively large private sector and foreign direct investment playing an important role. The private sector generates more than 80% of GDP. In 2007, the country was the second largest recipient of FDI among emerging markets, just after China. FDI inflows amounted to EUR 24 billion and the stock of FDI reached 19% of GDP. A large part of this stock goes back to the privatization wave in the 1990s, including the privatisation of public services and telecommunications but several large industrial complexes as well.

After travelling down a bumpy road for many years, the Brazilian economy has entered a more sustainable growth path since the beginning of the new millennium, backed by an IMF stabilisation programme first and the prudent macroeconomic policy of the Brazilian government later on. A credit boom, allied with various social programmes, has increased the purchasing power of many low-income earners. The subsequent rise in household consumption together with an increase in investments and public spending explain to a large part the significant GDP growth in the period 2000-2007. On the supply side, the expansion was largely supported by domestic services. In 2007, the services sector had a dominant share of 66% in GDP. Industry had a share of 28% and is highly concentrated[70] in a few competitive technology-intensive sectors, such as aerospace, biofuels and automotives (none of them very prominent on EU markets). The share of exports of goods and services in GDP is relatively small, amounting to just 12% and 1.7 % of GDP, respectively.

The neglect of infrastructure, persistently high income inequality, a large informal sector, low productivity and little innovation are important drawbacks. To tackle some of these problems, the Brazilian government has launched two important initiatives, which have also consequences for external economic relations. In May 2004, the government announced a new "Industrial, Technological and External Trade Policy", intended to create a more favourable environment for industrial development and facilitate entrepreneurship. In the short term, the government aims to reduce existing restrictions on trade. In the medium to long term, it intends to foster the development of key activities and technologies that would increase Brazil's international competitiveness (DIEESE, 2005)[71]. In 2008, the government announced new tax incentives for investment, R&D, and exports. The new programme also contains four macro-targets: (i) to increase the ratio of investment to GDP; (ii) to stimulate innovation via an increase in private R&D; (iii) to increase the share of Brazilian exports in world exports; and (iv) to increase the number of SME exporters. To reach these targets, horizontal policies, sectoral programmes and public support focusing on long-term "strategic themes", such as strengthening SMEs, regional integration, integration with Africa, etc., will be used[72].

The long-term prospects of the Brazilian economy look relatively bright. The most accepted scenario before the current global crisis was annual average GDP growth between 3% and 4% in the next ten years (Ernst & Young, 2008; IEA, 2006). But it may grow faster if the above mentioned reforms are implemented successfully and less if the current global economic crisis slides into a prolonged recession.

Regional economic cooperation and relations with the EU

Brazil plays a key role within Mercosur and in the negotiation of free trade agreements with third countries (including the EU). The EU is currently negotiating a free trade agreement with Mercosur.

2.3.2.2. Russia

The Russian economic development model has undergone significant changes in the past two decades during the transition from a centrally planned to a market economy. A phase of excessive liberalisation in the 1990s was followed by a phase of "recentralisation" after 1998 and a strengthening of the role of the state. In 2007, the private sector generated 65% of GDP, a similar proportion as in China. The rapid expansion of the economy during the period 2000-2008 was largely due to surging international commodity prices, in particular for oil and gas, which pushed up export revenues, incomes, employment and thus domestic consumption, and to a lesser extent investment as well. On the supply side, growth was supported by services and by residential construction whereas industry and agriculture expanded relatively less. FDI supported growth and economic restructuring as well, but the stock of FDI is still small due to many sectoral restrictions (e.g. in energy and other minerals) as well as a number of institutional impediments.

70 In 2004, SMEs represented 99% of the number of firms and 65% of all formal employment in the country, but their value added amounted to only 35%. By comparison, the US had a similar proportion of SMEs (98%), but with a value added amounting to 65% (FIESP, 2005).

71 The main measures announced in the PITCE industrial policy can be found in DIEESE (2005).

72 For details of the new industrial policy, see MDIC (2008) or IEDI (2008).

The large windfall gains from high world market prices for energy and metals enabled the government to repay most of its outstanding debts and to accumulate large foreign exchange reserves, to initiate several national development projects targeting infrastructure, housing, the health sector, education and agriculture and, after prolonged discussions, to implement industrial policy measures aiming at the modernisation and diversification of the economy.

The shadow sides of the commodity price boom were (apart from growing nationalism and a revival of certain Soviet stereotypes): high inflation, strong appreciation of the rouble without a corresponding increase in productivity, and rising inequality. However, the main shortcoming of the model has been the high dependence on the oil price. The main challenge for the Russian economy in the medium and long run is whether it will succeed in replacing energy exports as the key growth driver by developing other sectors and how it will cope with the acute demographic crisis (the population is projected to decline by about 8 million in the coming decade).

Major threats to sustained growth are a consistently low oil price (for instance due to a prolonged global recession) and institutional bottlenecks hindering the implementation of the New Industrial Policy. Failed diversification may lead to a gradual erosion of international competitiveness, due to real appreciation, rising wage costs and sluggish improvements in labour productivity. Russia's pending membership in the WTO has been repeatedly delayed. With falling export revenues in the aftermath of the global financial crisis, the envisaged ambitious modernisation and restructuring investment plans will have to be scaled down. Forecast GDP growth for 2009 fluctuates between -8% to +2% (the consensus average is -4%), but a modest recovery is expected for 2010. In the medium and long run, GDP is expected to grow by 4-6% on average (Development Centre, 2009).

Regional economic cooperation and relations with the EU

Russia is a leading member of the Commonwealth of Independent States (CIS), which includes 12 of the former 15 Soviet Republics (excluding the Baltic States). With the EU, Russia concluded a "Partnership and Cooperation Agreement" in 1995, which expired in 2007 but was prolonged automatically. In parallel, negotiations on a "Strategic Partnership Agreement" are taking place. Major challenges for the negotiations include energy issues, EU (and NATO) Eastern enlargement and the EU's (Eastern) Neighbourhood Policy, where EU and Russian interests clash.

2.3.2.3. India

India has a highly diverse and extremely complex social structure and economy, extending from labour-intensive handicraft to a wide range of modern industries, from low-productivity informal services to highly skilled and capital-intensive "new" services. Linguistically, it has the most diverse population in the world, with 14 official languages other than English and social divisions extending beyond religious and ethnic groups to caste divisions.

The phase of high growth in India began in the 1980s. Since then, development has been essentially service-led and supported by services exports, which have a much higher share in GDP (8%) than in the other BRICs. The boom in services was triggered by private (market) services rather than public services, comprising a vast mass of differentiated, but largely unorganized low-productivity activities. Services exports were driven by software, IT and other business services. With a share of 66% (in 2006) in total services exports India has become the world's top exporter of computer and information services[73]. Despite recent growth, merchandise exports are still relatively low (10% of GDP) and export success has been restricted to a few sectors (see section 1). There are some signs that India is becoming part of the "Asian supplier network"[74].

The rapid development of the Indian economy was supported by various government measures to liberalise the economy, both internally and externally. These include the privatisation of state assets (while leaving a substantial proportion under state control), various trade liberalisation measures, a shift to market-determined exchange rates and the liberalisation of current account and some capital account transactions, including the easing of rules for FDI. Changes in the FDI regime were substantial, with the government moving from fairly strict controls to a much more liberal regime based on relatively easy permissions and a small "negative list". Foreign ownership up to 100% is allowed under the automatic route, without approval, in most sectors and activities. But the FDI stock is still low and much of the new investment inflow is not "greenfield" investment but acquisition by private equity firms, making it essentially portfolio investment.

The negative sides of the Indian economic development model include a high surplus of labour, a large informal sector, very low wages, a low level of general education and technical qualifications in particular, and a shortage or even lack of all types of infrastructure. The increase in employment is due mainly to self-employment, especially in the countryside, and only a tiny minority (around 5-6%) of India's workforce is employed under formal work contracts in the organised sector. Yet

73 However, there is a high degree of concentration of such exports to just a few countries (the US accounting for 61% and the UK for 18% of India's IT-BOP export revenues in 2006-2007 – see Reserve Bank of India, 2009).

74 The most dramatic increase in manufacturing exports has been to China, in supplying metals and other intermediates for further processing for the US and European markets.

despite very low school enrolment at all levels, India's population is sufficiently large to make even the small minority of highly educated workers appear significant by international standards. There are at least a hundred million actual or potential young workers in urban and semi-urban areas with some skills or qualifications that can be tapped for productive work[75].

To tackle some of these problems and to sustain growth in the future, the Indian government has significantly increased funding for education and is pushing infrastructure investment as well. Several new government programmes support the ailing rural economy. The most prominent example is the National Rural Employment Guarantee Act, which promises 100 days of employment to every rural household. It has now been extended to cover all districts of India after demonstrating its enormous potential and the possibility of very large positive multiplier effects in several parts of India[76]. The so-called Bharat Nirman programme is devoted to expanding rural infrastructure.

India's longer-term growth prospects will largely depend on whether it can reap its potential "demographic dividend". The essential source of this dividend is the decline in dependency ratios and an increase in worker-population ratios, which, even in the case of little or no increase in labour productivity, would lead to improved output performance and growth. However, this will depend crucially on the ability to educate and find productive employment for India's bulge of young people.

Regional economic cooperation and relations with the EU

India is a member of the South Asian Free Trade Agreement, it has signed bilateral FTAs with Thailand and Sri Lanka and is looking for closer links with the ASEAN Free Trade Area. Negotiations for an FTA with the EU are currently in progress.

2.3.2.4. China

China's economic system is a "socialist market economy", with markets occupying a pivotal role, but public ownership, a direct government role in the economy (e.g. subsidies, credit controls, export licences) and industrial policy being an integral part of the system. Currently, the private sector is estimated to produce about 65% of GDP. China's fast economic growth has been driven mainly by manufacturing exports and investment. FDI plays an important role, especially for exports (more than 50% of exports are produced by companies under foreign ownership). In 2007, goods exports accounted for a share of 36% in GDP, the highest of all BRICs, with more than 90% of this taken up by manufacturing (see section 1). However, a large part of these exports is "processing trade", based on imported intermediates. The share of investment in GDP is extremely high (42% in 2007) and infrastructure investment accounts for an important part of this. The most decisive step in China's opening-up policy was the country's accession to the WTO in December 2001: tariffs were slashed and investment rules were eased. But with lower tariffs, non-tariff barriers have gained in importance and significant restrictions on FDI have remained with regard to the proportion of shares held and the field of activity[77]. Also, China has not yet joined the WTO "Agreement on Government Procurement" (GPA).

As exports have been rising much faster than imports, China runs massive surpluses (mainly with the US and the EU) and has accumulated huge foreign exchange reserves. To counter these imbalances, in July 2005 China abandoned the dollar peg and shifted to a system of managed float, with reference to a basket of currencies in which the dollar still has big weight. In particular, 70% of Chinese foreign exchange reserves are held in dollar-denominated assets. In September 2007, with the aim of investing its foreign exchange reserves more effectively, the Chinese government set up a so-called "sovereign wealth fund". As with other sovereign wealth funds, for instance that of Russia, this has roused concerns in other countries that investment strategies will favour the wider strategic goals of the Chinese government rather than purely commercial interests. In addition, direct investment by Chinese public and private enterprises is being promoted by the so-called "go abroad" policy. So far, the most spectacular Chinese investments have been made outside Europe, mainly to acquire raw material resources, but there are examples of acquisitions of European companies as well[78].

Despite generating fast growth for over three decades, the Chinese system has come under criticism recently because of rising income inequalities, environmental degradation, rapidly increasing energy demand and large external imbalances. A new model of "qualitative growth" has been propagated by the Chinese government since 2003, emphasising domestically oriented growth, industrial restructuring towards higher value-added industries, cleaner and more energy-efficient technologies, and more balanced regional and sectoral

75 In particular, because much of higher education is conducted in English, there is a significant body of educated workers proficient in English.

76 There are already calls for extending the Employment Guarantee Act to the urban areas as well.

77 The government regularly publishes the so-called "Catalogue for the guidance of foreign investment industries". The catalogue classifies industries for potential investment as prohibited, restricted (for instance, only permitted in a joint venture with a Chinese partner) or encouraged (investment the government wants to support, sometimes with incentives). Investment that does not fit into one of these three categories is considered permissible, but there are no policy support incentives.

78 Low asset prices due to the current financial and economic crisis will probably make European companies more attractive for Chinese investors.

development. To support this policy, a revised "Industrial Restructuring Catalogue" and a new "Catalogue for the guidance of foreign investment industries" have been drafted, to encourage, for instance, investment in modern agriculture, resource conservation and environmental protection, advanced technologies and new materials.

China's long-term growth prospects are predominantly positive, as there is a long list of opportunities in support of high growth, such as continued urbanization, improvement of the institutional and regulatory framework, restructuring and technological upgrading of industry, new fields for industrial activity (e.g. renewable energy, environmental technologies) and increased regional trade resulting from closer regional economic cooperation. Depending on the weights attached to the different challenges and opportunities, assessments of the future outlook for the Chinese economy vary. However, most current estimates of China's long-term GDP growth until 2020 range between an annual 6% and 9% average[79]. This is also in line with the Chinese government's growth target of 7-8% per year. The question is whether and how the current global crisis will affect these estimates. If the crisis is over in one or two years, little will change, but if the world slides into a prolonged recession, this will probably result in 1-2 percentage points less growth in China than otherwise – still an impressive performance.

Regional economic relations and relations with the EU

China is an important regional player engaged in various regional cooperation programmes within the ASEAN+3 (Japan, Rep. Korea, China) framework. In 2010, a free trade agreement between China and ASEAN will become effective. China's relations with the EU are still based on the "EEC-China Trade and Economic Cooperation Agreement" from 1985. Since 2007, the two parties have been negotiating a "Partnership and Cooperation Agreement" (PCA). Major issues on the Chinese side include: the EU's arms embargo and restrictions on "dual use technologies" (in force since 1989), full market economy status, and antidumping and other discriminatory practices applied by the EU against China.

2.3.3. Impacts of the global crisis on the BRICs

Initial hopes that the BRICs would be able to "de-couple" from the economic slowdown in the Triad countries have not materialised. The main mechanism of transmission has been rapidly declining exports and the corresponding multiplier effects: decreasing FDI and plummeting stock prices. In some countries (Russia, India and Brazil), there has been a significant outflow of financial capital as well. China is the BRIC country most dependent on foreign trade, with exports reaching a GDP share of 36 % in 2007. Nearly half of Chinese exports go to the Triad. In the early stages of the crisis China was successful in penetrating new markets including the other BRICs to substitute for declining demand from the Triad, but with the crisis turning global this strategy is no longer sustainable[80]. The Russian economy is highly dependent on energy exports and thus has suffered in particular from the declining real demand and falling prices for oil in the wake of the crisis. India and Brazil are both more domestically oriented economies with exports representing only around 10% of GDP, and were thus less severely affected by the fall in external demand.

To fight the crisis, all countries have adopted financial and/or fiscal measures. Brazil is focusing on financial measures to shelter its currency and to secure credit supply, but has introduced cuts in taxes on capital goods and durable consumer goods to stimulate domestic demand as well. Russia has launched a comprehensive rescue package for domestic banks, and supports the exchange rate and consumption by drawing on its accumulated reserves and raising new debt (the combined costs of these measures amount to some 10% of GDP). India is trying to keep credit supply alive in order to support domestic demand and to speed up infrastructure investment. China has adopted a massive fiscal stimulus package and various rescue measures, including increased expenditures on infrastructure, consumer subsidies and support for its ailing export industries.

Russia is so far the most affected economy because of both declining demand and lower prices for oil. China appears to be least affected due to its massive stimulus policies and the huge domestic market. In the short term, the crisis may delay restructuring processes in the BRICs, but in the medium and longer term it is likely to reinforce existing development plans and make these economies stronger and more independent. The latest IMF forecasts in July 2009 suggest a growth rate in 2009 of -1.3% for Brazil, -6.5% for Russia, 5.4% for India and 7.5% for China. But national forecasts are more optimistic for Brazil, India and partly China as well (the reverse is true for Russia). Several statistical indicators suggest

79 IMF (2004) estimated a GDP growth rate of 7.6% for the period 2002-2020; Justin Lin Yifu, chief economist of the World Bank, forecast a long-term growth rate of about 8% when he was still head of Beijing University's China Center for Economic Research in 2007 (quoted from Harvard Business Review's Chinese edition in *China Daily*, 2-4 May 2008). A growth model estimated by Chinese researchers suggests growth rates between 6.7% and 9.3% for the period 2008-2020, depending on different policy options, such as government sector reform, investment in education, and improvement of the social security system (see Wang, Fan and Liu (2009), quoted in Wang and Fan (2009a)).

80 In 2007, the share of the BRICs in Chinese exports reached 5.2%. In 2008, it went up to 5.8% but in the first five months of 2009, down again to 4.9%. However, Brazilian exports to China (Chinese imports from Brazil) boomed: according to Brazil's industrial and foreign trade authorities, the country's export to China in March 2009 amounted to USD 1737 billion, a 134.6% leap from a year earlier. That means China has surpassed the US and become Brazil's largest export market. The value of China-Brazil trade increased to USD 3.2 billion in April 2009, more than Brazil's trade of USD 2.8 billion with the US (China Daily, 20 May 2009).

that three of the BRICs economies might be bottoming out earlier than the advanced economies, whereby government stimulus measures seem to be playing a crucial role. In the case of Brazil, for instance, sales of durable consumer goods have returned to pre-crisis levels, investment in the first quarter of 2009 was up 19%, and money from abroad is flowing in again. On the supply side, construction is doing well and industry is recovering. In India, industry is showing signs of revival as well, and the government is continuing with tax cuts and other incentives for corporations. In China, the strongest positive signal comes from fixed asset investment, boosted by public expenditures. Investment increased by about 30% in the first quarter of 2009, faster than in the same period last year. Private consumption, which slowed significantly at the beginning of the year, is picking up as well. Industry, which suffered the heaviest slump of all sectors in the economy, seems to have hit bottom at last. A significant rebound in stock prices can be observed in all BRIC countries.

Table 2.4.1: BRIC List of Indicators Year 2007 (if not mentioned otherwise)

	Brazil	Russia	India	China [1)]
MACRO INDICATORS				
Size of the economy				
Land area, 1000 km²	8515	17075	3288	9600
Population, average, mn	189 2006	143 2006	1110 2006	1321 2006
- Population aged 0-14, % of total	27.6 2006	14.9 2006	32.5 2006	21.1 2006
- Population aged 15-64, % of total	66.2 2006	71.4 2006	62.4 2006	71.1 2006
- Population aged 65 and above, % of total	6.3 2006	13.7 2006	5.0 2006	7.8 2006
GDP in EUR at exchange rates, EUR bn	973	946	759	2467
GDP in EUR at exchange rates, EU27=100	7.9	7.7	6.2	20.0
GDP in EUR at PPP per capita	7839	12400	2108	4464
GDP in EUR at PPP per capita, EU27=100	31.5	49.8	8.5	17.9
Distribution				
Gini coefficient (based on all household incomes)	0.56 2006	0.40 2002	0.37 2005	0.47
Share of top 10% income earners, % of total	44.9 2005	30.6 2002	31.1 2005	34.9 2004
Role of the state				
Private sector, % of GDP	83 [2)] 2006	65	80	65
Employees in private enterprises, % of total	96.1 2006	56.4	95.4	75.0
Demand side factors, foreign trade				
Exports of goods, % of GDP	12.0	27.4	9.6	36.0
Imports of goods, % of GDP	9.0	17.3	14.5	28.3
Exports of services, % of GDP	1.7 2006	3.0	8.2	3.6
Imports of services, % of GDP	2.6 2006	4.6	4.7	3.8
Current account, % of GDP	0.1	5.9	1.6	11.0
Share of Investment, % of GDP	17.7	24.7	39.7	42.3
Share of final consumption, % of GDP	80.7	66.5	46.0	48.8
Effectively applied tariff, %	12.2	8.3	14.0	8.8
Foreign direct investment				
FDI inward stock, EUR bn	172	34	52	516
FDI inward stock, % of GDP	19.0	3.6	7.3	22.5
FDI outward stock, EUR bn	43		21	54
Human resources and research				
Total number of persons employed, mn	87	68	450	770
Average gross monthly wages, EUR	418	388	71	207
School enrolment secondary, % of relevant age group	106 2006	91 2006	54 2006	76 2006
School enrolment tertiary, % of relevant age group	24 2006	70 2006	11 2006	22 2006
Number of researchers, per 10000 persons employed	10 2004	63 2006	3 2000	16
R&D expenditures, % of GDP	1.11	1.07 2006	0.75	1.49
IT expenditure, % of GDP	6.4 2006	3.2 2006	6.1 2006	5.4 2006

	Brazil	Russia	India	China [1]
Physical Infrastructure				
Roads, total network, km per 1000 km²	188 [2006]	55	1020	373
Rail-lines, total route, km per 1000 km²	3	5	33	8
Air transport, registered carrier departures worldwide, mn	560838 [2006]	421170 [2006]	453921 [2006]	1542564 [2006]
Fixed and mobile phone subscribers, per 100 population	84	146	23	69
Internet subscribers, per 100 people	4	21	1	11
Institutional and policy framework				
Regulatory quality, (score -2.5 to + 2.5)	-0.04	-0.44	-0.22	-0.24
Rule of law, (score (-2.5 to + 2.5)	-0.44	-0.97	0.10	-0.45
Control of corruption, (score -2.5 to + 2.5)	-0.24	-0.92	-0.39	-0.66
Political stability index, (score -2.5 to + 2.5)	-0.22	-0.75	-1.01	-0.33
Economic freedom index, (score 0-100; top=100) [3]	56.7	50.8	54.4	53.2
Country risk ranking, (1-157), rank [4]	63	61	59	54
SECTORAL INDICATORS				
Share of agriculture, % of GDP	6.0	4.1	16.3	11.3
Share of industry, % of GDP	28.1	33.1	26.7	48.7
Share of services, % of GDP	66.0	51.1	55.7	40.1
Market services, % in total services	66.0	77.5	75.0	61.0
DEVELOPMENT INDICATORS				
Population projection for 2020				
- Total population, mn	209	135	1367	1431
- Population aged 0-14, % of total	20.1	16.7	26.7	18.7
- Population aged 15-64, % of total	70.4	67.9	67.0	69.6
- Population aged 65 and above, % of total	9.6	15.4	6.3	11.7
Average annual growth rates, %				
- GDP(2000-2007)	3.4	5.3	7.6	10.1
- Agriculture (1995-2007)	4.1	1.4	3.2	3.9
- Industry (1995-2007)	2.3	4.3	6.1	11.2
- Services (1995-2007)	2.9	.	8.7	10.2
GDP growth, 2009 (IMF forecast), %[5]	-1.3	-6.0	4.50	6.5

Notes: 1) Excluding Hong Kong and Macao – 2) Total revenues of private enterprises, share in % – 3) 100-80: free; 79.9-70: mostly free; 69.9-60: moderately free; 59.9-50: mostly unfree; 49.9-0: repressed – 4) Euromoney country risk rating, March 2008. Rank 1 represents the lowest and rank 157 the highest risk – 5) IMF, World Economic Outlook, April 2009 and July 2009.

2.4. The role of the BRICs in the EU's future energy needs: partners and competitors

2.4.1. Global oil and gas demand

Oil and gas demand is forecast to continue to rise over the next few decades. Scenarios from the IEA's latest World Energy Outlook (2008 edition) envisage a rise in global oil consumption from 4 billion tonnes of oil equivalent (btoe) in 2006 up to around 5 btoe in 2030. Slightly more than half of that increase is predicted to come from China and India, which, together, may be consuming over 1 btoe by 2030. However, a small decrease is forecast for both the EU and the US. The picture for natural gas is somewhat different. Total demand is forecast to rise more strongly in relative terms (approximately by 50% as compared to 25% for oil), bringing total demand from around 2.4 btoe in 2006 to around 3.6 btoe in 2030. The other major difference is that China and India are, and are predicted to remain, only quite modest consumers. The growth in gas consumption up to 2030 is forecast to occur primarily in the Middle East. In all, the economic rise of China and India is leading to a substantial re-distribution in relative market shares for oil, but not for gas.

2.4.2. EU net import demand and the 20-20-20 Initiative

The 20-20-20 Initiative calls for the EU, by the year 2020, to achieve a 20% cut in greenhouse gas emissions as compared to 1990 levels, a 20% improvement in energy efficiency, and "a 20% share" of renewables in the energy mix. According to various scenarios, the EU's *demand for net imports* of oil, gas and coal under the initiative should be at levels similar to those seen in 2005 by the year 2020.

This represents a major departure from even very recent energy demand scenarios, and the change is particularly significant for natural gas. Without the initiative, demand for net imports of natural gas is predicted to be in the range of around 380-450 billion cubic metres (bcm) per year by 2020 (depending on mid-term oil price scenarios ranging from USD 61 to USD 100 per barrel). With the Initiative, that range narrows and falls to a range of 284 to 337 bcm, as compared to 298 bcm in 2005.

2.4.3. Russian oil and gas reserves and production

Russia holds around 6.4% of the world's oil reserves and around 25% of the world's gas reserves. Furthermore, it is the world's biggest gas producer and the second biggest oil producer. Russia has so far benefited greatly from being outside OPEC, as it was able to take full advantage of soaring oil prices and increased production over the 1999-2007 period. However, the expansion of production has declined markedly in recent years, reaching a peak of 9.44 million barrels per day (mbd) in 2007. In 2008, the country's oil production even fell slightly, to 9.36 mbd. Further growth would require large-scale investments in distant and challenging locations (notably in eastern Siberia). The partial re-nationalization of the oil sector has also hampered efficiency in the sector.

Inefficiencies are even more characteristic of the strongly monopolised Russian natural gas sector, which is dominated by the state-controlled Gazprom. The depletion of Gazprom's mature gas fields, and delays in the exploitation of new fields have led some observers to predict that Gazprom's production might plunge markedly in the next decade. At the same time, there are a number of factors arguing against the "supply crunch" scenario: future extraction from new fields; the possibility of increasing supplies from Central Asia; the sizeable potential for energy saving within Russia; the possibility of reducing leakages and flaring; and the likely increased readiness of the Russian authorities to attract foreign capital, technology and know-how, as the current crisis is biting into Gazprom's financial resources.

2.4.4. EU-Russia energy relationship

Although Russia signed the EU Energy Charter back in 1994, it has never ratified it, giving grounds to claims that the country is not bound by its provisions. This effectively closes the Russian pipeline network to foreign investment. In addition, the energy sector in Russia is defined as "strategic", imposing official limits on foreign participation in this particular area. Conversely, Russian investments in the EU energy sector has been generally constrained as well. That said, there are important European investments in the Russian energy sector, notably: a venture to develop the Shtokman offshore gas deposit; the production-sharing agreement Sakhalin-2; and the development of the Yuzhno-Russkoye gas deposit. Substantial Russian investments in the EU include participation in the gas sector of Hungary, Slovakia, Germany and Italy. There are also important gas pipeline projects, in particular Nord Stream (a joint venture between Gazprom, EON, BASF and Gasunie) and South Stream (a joint venture between Gazprom and ENI).

In addition, three important issues deserve special attention: (1) the possible creation of a "gas OPEC"; (2) the possibility of Russia cooperating with OPEC in the current environment of low oil prices; and (3) Russia's efforts towards diversifying its energy exports away from Europe to Asia. Due to regional fragmentation of the market for natural gas, any worldwide gas cartel is unfeasible, while any cartel confined to the EU would require numerous (and difficult) renegotiations of existing long-term contracts. Russia's participation in OPEC proper (the oil cartel) is almost equally problematic. The recent history of Russia-OPEC relations has been essentially a history of non-cooperation. Also, half of the Russian oil industry is privately owned, which makes it more difficult for the government to coordinate its efforts with those of the OPEC governments. As for Russia's publicly-stated aspirations to diversify its energy exports away from Europe (most notably to Asia and particularly China) this has limited potential as well. Currently, there are only minor oil exports to China (just 0.3 mbd), although some new transport infrastructure is under construction or planned. The prospects of Russian gas exports to China are less encouraging, as the Chinese side insists on gas prices that are too low compared to Russian production costs.

The EU's gas market is *de facto* segmented along national lines. This segmentation is further strengthened by the domination of pipeline-bound imports and long-term supply contracts. This structure yields a lock-in effect, which makes liberalisation of the EU's internal gas market difficult to achieve, as a blocking minority of Member State governments have felt that (full) liberalisation would make their situation less favourable. This phenomenon was noted when the European Commission tried to introduce ownership unbundling and the "third country clause" in late 2007. While a compromise solution has now been found, the debate on unbundling suggests that bilateral relations between some Member States and Russia may continue to dominate over broader arrangements between the EU as a whole and Russia.

The Second Strategic Energy Review is another major institutional development on the EU side. Many aspects of the Review have the prospect of further disruptions of Russian supplies firmly in mind, and the particularly vulnerable NMS occupy an important place in the Commission's vision for infrastructure investments. In particular, the need for such investments was illustrated by the

heavy economic losses incurred by Bulgaria during the latest supply cut-off in January 2009. The most recent and potentially most far-reaching change on the EU side is, however, the Joint Declaration signed on 23 March 2009 between the European Commission, the Government of Ukraine, the EBRD, the EIB and the World Bank. Russia has strongly criticised the EU-Ukraine agreement, and has in essence argued that it makes little sense to make decisions on gas transit infrastructure without the agreement of the supplier (see also CEPS, 2009).

2.4.5. Biofuels and the EU-Brazil energy relationship

Bioenergy is among the renewable energy sources often considered to play a key role in the short run in reducing carbon emissions. Global production of biofuels amounts to 62 billion litres, equal to about 1.8% of total global transport fuel consumption in energy terms. Brazil and the US account together for almost three-quarters of global biofuels supply. The main biofuel produced in Europe is biodiesel, representing 80% of production. Europe is the world's biggest producer, accounting for almost two-thirds of world output. Germany, France and Italy are the largest biodiesel producers and users. The EU's biofuels sector has undergone very rapid growth with a 28.2% annual production increase since the year 2000. In Brazil, bioethanol represented 40% of the light fuels consumed (gasoline plus bioethanol) in 2005. In that year, total installed production capacity was 18 billion litres of bioethanol. The country has also received a huge inflow of FDI in this area. From 2002 to 2007, more than EUR 1.6 billion was invested by foreigners in the Brazilian bioethanol sector.

Biofuels production and trade are, however, subject to quite significant support policies at national level in many countries. The use of biodiesel is much more dependent on public support than the use of bioethanol. According to an OECD study (OECD, 2008), the removal of these policies would substantially affect the (private) profitability of biofuel production and use in those countries where production costs are particularly high. Bioethanol production would be less affected, given the more efficient industries in the US and particularly in Brazil. By contrast, world biodiesel production (dominated by the EU industry) would decline by more than a quarter after removal of all support policies and grow much more slowly thereafter. Consequently, three core issues will affect the future of biofuels production and trade for the European Union. One is the ongoing work on standardisation (together with Brazil and the US) which should facilitate trade; the second is the extent to which the EU and its Member States will continue to support domestic production and in what ways; the third is the extent to which the EU will consider lowering trade barriers for imports of biofuels, with Brazil as a potential major source country.

2.5. Conclusions

Both the increasing weight of the BRIC economies and their rising and varying scope of interactions with the EU call for special policy treatment, in particular regarding industrial and trade policies, energy security, intellectual property rights, etc[81]. The type and scale of the challenges for EU policies are largely shaped by each BRIC's model of economic development.

The foremost challenge for the EU is the strong role of the state in the BRIC economies (taking the form of various subsidies, privileged access to bank loans or raw materials, or tax preferences, especially for the state-owned enterprises), which makes BRIC exports to the EU more competitive and impairs the competitiveness of EU companies on both home and third markets. State presence is particularly high in Russia and China, and has increased recently also in reaction to the global crisis. Dumping on EU and third markets is a greater challenge in the case of an export-driven economy like China, while in domestically oriented economies like India and Brazil, unfair competition on the home markets figures prominently. These issues have to be raised emphatically in the ongoing dialogues with the BRICs, such as the negotiations of a new "Partnership and Cooperation Agreement" between the EU and China or the new EU-Russia "Strategic Partnership".

Other challenges arise from the weak regulatory framework and various institutional impediments in the BRICs, such as the uneven enforcement of laws, non-tariff barriers to trade including certification procedures and standards, and environmental regulations and labour laws that often discriminate against foreign (EU) companies. Thus, the implementation of rules, as much as the rules themselves, poses a major challenge for EU policy. Prominent examples are intellectual property rights protection and its enforcement in China, labour legislation in India and Russia, and environmental regulations in both Russia and China. To improve the situation, the EU should continue to share its experience in these fields and its methods of implementation with the BRICs.

81 This is reflected in the numerous EU strategies and policy papers relating to individual BRICs, the ongoing negotiations for a "Partnership and Cooperation Agreement" (PCA) with China and a "Strategic Partnership" (SP) with Brazil and the aim of upgrading or replacing the existing PCA with Russia with an SP. With India, after conclusion of an SP in 2004, a "Free Trade Agreement" has been under negotiation since 2007. In addition, there are various joint committees, high-level dialogues and negotiations as well as scientific and technical cooperation programmes. The EU's New Industrial Policy, "Implementing the Community Lisbon Programme: A policy framework to strengthen EU manufacturing towards a more integrated approach for industrial policy" (COM(2005) 474 final), includes several cross-sectoral initiatives on competitiveness, energy and the environment, intellectual property rights, better regulation, industrial research and innovation, market access, skills and managing structural change. In addition, the Commission has proposed seven new initiatives targeting specific sectors, e.g. information and communication technologies, mechanical engineering and biotechnology, with the aim of supporting adaptability and structural change in order to boost the competitiveness of EU manufacturing "especially in the light of increasing strong competition from China and Asia".

Although FDI is welcome in all BRICs, many impediments to doing business still exist, in particular in sectors that are considered less advanced, where there is a state monopoly or when they have been declared "strategically" important. Typically, the services sector (in particular banking, insurance and telecommunications), raw materials (oil, mining of minerals) and certain high-tech sectors related to defence (e.g., airplane, space or nuclear technologies in Russia) pose the biggest problems. Restrictions on FDI are frequently linked to "National Development Plans", a national "Industrial Policy", as in China, or "national security" as in Russia. Recently, new comprehensive industrial policies have been launched in both Brazil and Russia with the aim of using public-private partnership tools. India, has implemented new ambitious development programmes that will bear fruit in the years to come. These plans offer opportunities for EU companies as well.

Judged by the relative weight of the sectors, the biggest challenge for EU policies is probably industry (especially manufacturing) with regard to China, business services with regard to India, agriculture (and biofuels) with regard to Brazil, and energy imports and transit (especially gas) in relations with Russia. But manufacturing is going to play an increasing role in relations with India, Brazil and probably Russia as well, and outsourcing of services will gain importance with China. In a longer-term perspective, "industrial upgrading" efforts in all BRICs pose the most serious challenge for EU policies, including R&D policies at national and bilateral level. Infrastructure investment and related policy areas, such as public procurement, and the above-mentioned public private partnerships (particularly in Russia), will gain importance in the light of the BRICs' new development plans and industrial policies, with a focus on improving infrastructure and diversification of the economy. Environmental regulations and energy policy issues may play a role in this context as well.

Regarding energy relations, rising and potentially competing demand for energy resources is coming from China and India, especially for oil and to a much lesser extent for gas. Russia and Brazil, on the other hand, are relevant suppliers of energy (oil, gas and to a minor extent biofuels as well). In the EU's energy relations with China and India, supporting energy efficiency and the use of renewable energy sources will therefore be important. In the case of Russia, energy security, in relation to the EU's internal energy market regulations, and energy transit issues represent the major challenges, also for EU external (Neighbourhood) policies. With respect to Brazil, important issues are the standardisation of biofuels (which should facilitate trade), subsidisation, and tariff barriers.

Enhanced regional economic cooperation, especially in Asia, will pose new challenges for EU policies with the BRICs in future as well. This is particularly relevant not only in Asia, where regionalism is on the rise, but also in the EU's Eastern Neighbourhood. A free trade agreement between China and ASEAN will become effective in 2010 and India is seeking closer links with the ASEAN Free Trade Area (AFTA) as well. Geopolitical strategies, in particular the contest for influence on the post-Soviet space, will play an important role in shaping EU relations with Russia, and the successful conclusion of the ongoing negotiations for a Free Trade Agreement between the EU and Mercosur will not only facilitate economic relations with Brazil but also challenge Brazil's privileged position in Latin America. The ongoing bilateral negotiations between the EU and the individual BRICs should help avoid impending trade diversion and potential conflicts.

The ongoing catching-up process in the BRICs and their rising population (with the exception of Russia) will lead to a greater demand for more sophisticated and high-quality consumer goods, which will provide ample opportunities for EU exports and market seeking FDI in these fields. However, small and medium (SME) European enterprises in particular may lack appropriate information on far-away markets and also typically face more problems in investing in more distant locations than larger companies. Thus, special SME support for market research and investment similar to that provided in the EU Asia-Invest programme would be of great benefit where the BRICs are concerned[82]. In particular, with a broadening of the range of products exported, non-tariff barriers to trade such as unnecessary trade-restricting regulations and procedures or different norms and standards, will gain in importance. The BRICs should thus be encouraged to adopt existing international standards or to seek common approaches on standards and norms with trading partners where possible.

On the import side, competition from the BRICs in high value-added and technology-driven manufacturing products will increase on both the EU market and on third markets. This chapter again confirms that China has already set off on this path (see also Baumann and di Mauro, 2007). The new outward-looking policy in Brazil and the new industrial policy in India, with ambitions to become part of the "Asian supplier network" and to diversify the economy, point in the same direction. Due to rising R&D expenditures in the BRICs (especially in China), competitive pressure on the EU may also increase in certain high-tech areas where the individual BRICs choose to specialise. But on the other hand, new opportunities for technical and scientific co-operation and for knowledge flows between the EU and the BRICs will emerge. To stay ahead, EU companies will have to accelerate their technological development. In this con-

82 The Asia–Invest Programme was launched in 1997 as an initiative of the European Union to promote and support business co-operation between the EU Member States and Asia.

text, EU initiatives to support innovation and to promote investment in R&D will be indispensible.

On the positive side, the envisaged restructuring and technological upgrading of the BRICs will absorb a large amount of investment goods, where the EU has a comparative advantage with respect to the BRICs and is expected to keep it in the future. As in the case of consumer goods, special support for SMEs with regard to market research and direct investment would encourage more European enterprises to tap new distant markets.

Also, all BRICs have ambitious plans to increase infrastructure investment, such as transport infrastructure in Brazil, Russia and India and investment to increase energy efficiency and protect the environment in China and for power generation and telecoms in India. This will open up many new opportunities for EU suppliers in these fields. However, foreign enterprises are often discriminated in public procurement processes. The alleged preferential treatment of domestic bidders by China as part of its "stimulus package" hit the headlines only recently[83]. The EU should thus support China's accession to the WTO Government Procurement Agreement (GPA) as soon as possible. Also, for investment goods even more than in the case of consumer goods, the insufficient protection of IPR is an important issue, particularly in China. Appropriate EU policies to secure IPR protection thus seem essential for the further expansion of EU exports in this field.

Finally, China evidently intends to follow a more domestically oriented development model in the future, which is expected to somewhat reduce its competitive pressure in international markets and provide additional opportunities for EU exporters. But Brazil, India and Russia, on the other hand, are striving for a more outward-oriented policy in the years to come, which may increase competitive pressure from their side. This has to be taken into account from a longer-term EU policy perspective as well.

References

Amiti, M., and C. Freund (2008), "The anatomy of China's export growth", Policy Research Working Paper Series 4628, The World Bank.

Balassa, B. (1965), "Trade Liberalisation and Revealed Comparative Advantage", The Manchester School of Economic and Social Studies, No. 33, pp. 99-123.

Baumann, U., and F. di Mauro (2007), "Globalisation and Euro Area Trade. Interactions and Challenges", Occasional Paper Series, European Central Bank, No. 55, March.

CEPS (2009), "European Neighbourhood Watch", No. 47, Centre for European Policy Studies, April.

Development Centre (2009), "Macroeconomic Forecasts for Russia", Moscow, April.

DIEE-SE – Departamento Intersindical de Estatística e Estudos (2005), "Política Industrial no Brasil: o que é a nova política industrial?", Nota Técnica, No. 11, December.

Ernst & Young (2008), "Sustainable Brazil: Economic Growth and Consumption Potential", Análises & Perspectivas – Brasil.

Fertö, I., and K.A. Soos (2008), "Intra-Industry Trade Between the Old EU and the NMS Before Enlargement", in Grinberg R., P. Havlik and O. Havralyshyn (eds), *Economic Restructuring and Integration in Eastern Europe. Experiences and Policy Implications,* Nomos, Baden-Baden, pp. 95-118.

FIESP – Federação das Indústrias do Estado de São Paulo (2005), "A Competitividade e o Desenvolvimento Econômico: algumas sugestões para reflexão", DECOMTEC Report, October.

Goldmann S. (2003), "Dreaming with BRICs: The Path to 2050", *Global Economics Paper* No. 99.

IEA (2006), *World Energy Outlook 2006*, International Energy Agency, Paris.

IEA (2008), *World Energy Outlook 2008*, International Energy Agency, Paris.

IEDI – Instituto de Estudos para o Desenvolvimento Industrial (2008), "A Política de Desenvolvimento Produtivo", IEDI Report, May.

IMF – International Monetary Fund (2004), *World Economic Outlook*, April

Keller, W. (2004), "International Technology Diffusion", *Journal of Economic Literature*, Vol. 42, No. 3, pp. 752-758.

MDIC – Ministry of Development, Industry and Foreign Trade (2008), "Inovar e Investir para Sustentar o Crescimento", Presentation of the Brazilian Industrial Policy, Brasília, retrieved from: http://www.desenvolvimento.gov.br/pdp/index.php/sitio/inicial.

OECD (2008), "Economic Assessment of Biofuel Support Policies", Organisation for Economic Co-operation and Development, Paris.

OECD (2009), "OECD Economic Outlook, Interim Report", Organisation for Economic Co-operation and Development, Paris, March.

83 China's "Buy Chinese" decree with EUR 360 bn stimulus package risks US protection row. The Telegraph, 17 June 2009 (http://www.telegraph.co.uk).

Peneder, M. (2003), "Industry classifications, aim, scope and techniques", *Journal of Industry, Competition and Trade*, Vol. 3, No. 12, pp. 109-129.

Reserve Bank of India (2009), "India's Foreign Trade: 2008-09 (April to December)", *Reserve Bank of India Bulletin*, March, pp. 495-507.

Rodrik, D. (2006), "What's so special about China's exports?", NBER Working Paper 11947.

Schott, P.K., (2006), "The Relative Sophistication of Chinese Exports", NBER Working Paper 12173.

UNCTAD (2008), "Transnational Corporations and the Infrastructure Challenge", World Investment Report, Geneva.

UNCTAD (2008a), World Investment Prospects Survey 2008-2010, New York and Geneva.

Wang X., F. Gang, and L. Peng (2009), "Transformation of Growth Pattern in China and the Growth Sustainability", Economic Research (in Chinese), No. 1, Beijing.

Wang X., and F. Gang (2009a), "The road of China's economic transformation: past, present and future", wiiw monthly Report 2009/6.

Annex

Table A1: Overview of total EU goods trade

EU-15

	Exports						Imports						Trade Balance		
	EUR bn			shares			EUR bn			shares			EUR bn		
Partner	2000	2007	2008	2000	2007	2008	2000	2007	2008	2000	2007	2008	2000	2007	2008
Brazil	16.6	20.7	25.5	0.7	0.6	0.7	17.6	31.3	34.1	0.7	0.9	0.9	-1.0	-10.6	-8.6
Russia	19.9	74.0	85.1	0.8	2.1	2.4	45.7	109.0	126.0	1.8	3.1	3.4	-25.8	-35.0	-40.9
India	13.4	28.4	30.1	0.5	0.8	0.8	12.4	24.9	27.5	0.5	0.7	0.8	1.0	3.5	2.6
China	25.5	69.2	75.3	1.0	2.0	2.1	70.3	211.0	223.7	2.8	6.0	6.1	-44.8	-141.8	-148.4
BRICs	**75.4**	**192.3**	**216.0**	**3.0**	**5.5**	**6.1**	**146.0**	**376.2**	**411.3**	**5.8**	**10.7**	**11.3**	**-70.6**	**-184.0**	**-195.3**
Japan	44.9	42.5	41.0	1.8	1.2	1.1	87.1	72.0	68.3	3.5	2.0	1.9	-42.2	-29.5	-27.3
USA	232.5	253.3	241.0	9.3	7.3	6.8	199.0	175.2	179.5	7.9	5.0	4.9	33.4	78.0	61.5
RoW	477.6	675.8	710.9	19.0	19.4	19.9	513.4	685.3	739.9	20.3	19.4	20.2	-35.8	-9.5	-29.0
EU-15	1556.1	2065.2	2073.9	62.1	59.2	58.1	1478.7	2012.8	2014.9	58.6	57.0	55.1	77.5	52.4	58.9
NMS-12	121.3	260.7	277.3	4.8	7.5	7.8	100.2	215.5	231.0	4.0	6.1	6.3	21.1	45.2	46.0
EU-27	1677.4	2324.5	2359.8	66.9	66.6	66.1	1578.9	2223.1	2255.9	62.5	62.9	61.7	98.5	101.4	103.9
exEU-27	830.4	1163.8	1208.9	33.1	33.4	33.9	945.6	1308.7	1399.0	37.5	37.1	38.3	-115.2	-144.9	-190.1
WORLD	2507.9	3488.2	3568.7	100.0	100.0	100.0	2524.5	3531.8	3654.9	100.0	100.0	100.0	-16.6	-43.5	-86.2

NMS-12

	Exports						Imports						Trade Balance		
	EUR bn			shares			EUR bn			shares			EUR bn		
Partner	2000	2007	2008	2000	2007	2008	2000	2007	2008	2000	2007	2008	2000	2007	2008
Brazil	0.3	0.6	0.9	0.2	0.2	0.2	1.0	1.4	1.5	0.5	0.3	0.3	-0.8	-0.8	-0.6
Russia	2.8	15.1	20.1	1.9	3.8	4.6	18.1	35.0	47.3	9.5	7.5	9.1	-15.2	-19.9	-27.2
India	0.3	1.1	1.4	0.2	0.3	0.3	0.5	1.4	1.9	0.3	0.3	0.4	-0.2	-0.3	-0.5
China	0.4	2.7	3.1	0.2	0.7	0.7	4.4	20.6	24.0	2.3	4.4	4.6	-4.0	-17.8	-20.9
BRICs	**3.7**	**19.5**	**25.5**	**2.5**	**4.9**	**5.8**	**23.9**	**58.3**	**74.7**	**12.6**	**12.5**	**14.4**	**-20.2**	**-38.8**	**-49.2**
Japan	0.6	1.3	1.4	0.4	0.3	0.3	5.0	6.2	6.5	2.6	1.3	1.3	-4.4	-4.8	-5.1
USA	5.7	8.1	8.3	3.9	2.0	1.9	7.3	6.1	6.9	3.8	1.3	1.3	-1.5	2.1	1.4
RoW	19.0	56.4	64.6	12.8	14.2	14.6	23.4	54.9	63.7	12.3	11.8	12.3	-4.4	1.6	0.9
EU-15	99.0	236.2	252.7	67.1	59.3	57.2	111.2	267.6	281.5	58.7	57.4	54.3	-12.2	-31.4	-28.8
NMS-12	19.6	76.9	88.6	13.3	19.3	20.1	18.8	74.1	84.3	9.9	15.9	16.3	0.8	2.8	4.3
EU-27	118.7	312.8	341.8	80.4	78.6	77.4	130.0	341.0	366.4	68.6	73.1	70.7	-11.4	-28.2	-24.6
exEU-27	29.0	85.4	99.8	19.6	21.4	22.6	59.5	125.4	151.8	31.4	26.9	29.3	-30.5	-40.0	-52.0
WORLD	147.6	398.3	441.6	100.0	100.0	100.0	189.5	466.5	518.2	100.0	100.0	100.0	-41.9	-68.2	-76.6

EU-27

	Exports						Imports						Trade Balance		
	EUR bn			shares			EUR bn			shares			EUR bn		
Partner	2000	2007	2008	2000	2007	2008	2000	2007	2008	2000	2007	2008	2000	2007	2008
Brazil	16.9	21.3	26.3	0.6	0.5	0.7	18.7	32.7	35.5	0.7	0.8	0.9	-1.8	-11.4	-9.2
Russia	22.7	89.1	105.2	0.9	2.3	2.6	63.8	144.0	173.3	2.3	3.6	4.2	-41.0	-54.9	-68.2
India	13.7	29.5	31.5	0.5	0.8	0.8	12.8	26.3	29.4	0.5	0.7	0.7	0.8	3.2	2.1
China	25.9	71.9	78.4	1.0	1.9	2.0	74.6	231.6	247.6	2.7	5.8	5.9	-48.8	-159.6	-169.2
BRICs	**79.1**	**211.8**	**241.4**	**3.0**	**5.4**	**6.0**	**169.9**	**434.6**	**485.8**	**6.3**	**10.9**	**11.6**	**-90.8**	**-222.8**	**-244.4**
Japan	45.5	43.8	42.4	1.7	1.1	1.1	92.1	78.1	74.8	3.4	2.0	1.8	-46.6	-34.4	-32.4
USA	238.2	261.4	249.4	9.0	6.7	6.2	206.3	181.3	186.3	7.6	4.5	4.5	31.9	80.1	63.1
RoW	496.6	732.2	775.4	18.7	18.8	19.3	536.8	740.1	803.7	19.8	18.5	19.3	-40.2	-7.9	-28.3
EU15	1655.2	2301.4	2326.6	62.3	59.2	58.0	1589.9	2280.4	2296.5	58.6	57.0	55.0	65.3	21.0	30.1
NMS12	140.9	337.6	365.8	5.3	8.7	9.1	119.0	289.6	315.5	4.4	7.2	7.6	21.9	48.0	50.3
EU27	1796.1	2637.3	2701.7	67.6	67.9	67.4	1708.9	2564.1	2621.9	63.0	64.1	62.8	87.2	73.2	79.8
exEU27	859.4	1249.2	1308.6	32.4	32.1	32.6	1005.1	1434.1	1550.7	37.0	35.9	37.2	-145.7	-184.9	-242.1
WORLD	2655.5	3886.5	4010.3	100.0	100.0	100.0	2714.0	3998.2	4172.6	100.0	100.0	100.0	-58.5	-111.7	-162.3

Note: differences in EU27 and the sum of EU15 and NMS12 are due to reporting errors.
Source: Eurostat-Comext, wiiw calculation.

Box A1 Unit value ratios to calculate quality positioning

The calculation of relative unit values of traded products is based on the COMEXT trade database at the most detailed 8-digit level. Denoting the value of exports to the EU of commodity i by country c in year t by v_{it}^c and the quantity (measured in tons) by x_{it}^c, the export unit value is defined as

$$u_{it}^c = v_{it}^c / x_{it}^c \qquad (1)$$

The unit values of country c's exports to the EU are then compared to the unit values of total EU imports (from the world, including intra-EU trade) by calculating the logs of the unit value ratios

$$r_{it}^c = Ln\left(u_{it}^c / u_{it}^{EU}\right) \qquad (2)$$

where u_{it}^{EU} denotes the unit value of total EU imports for a particular commodity i in year t. Taking the logarithm of $\left(u_{it}^c / u_{it}^{EU}\right)$ ensures a symmetric aggregation across products for ratios larger and smaller than 1 (see below). In logs, the ratio is thus larger (smaller) than zero if the export unit value of country c is larger (smaller) than the unit value of total EU imports.

Information is not presented here at the very detailed (8-digit) product level but the unit value ratios are aggregated to the level of (3-digit NACE) industries and further to industry groupings. This is done by constructing a weighted sum of the unit value ratios r_{it}^c across the products belonging to a particular industry j (or an industry group). The weight used for a particular commodity i in such an aggregation is the share of its export value in the industry's exports of country c. Denoting the set of commodities i belonging to an aggregate j (industry or industry grouping) by $I(j)$, the weights are calculated as

$$w_{it}^c = \frac{v_{it}^c}{\sum_{i \in I(j)} v_{it}^c} \qquad (3)$$

The unit value ratio for a particular aggregate j is then

$$r_{jt}^c = \sum_{i \in I(j)} r_{it}^c w_{it}^c \qquad (4)$$

This measure can be interpreted analogously to the unit value ratios for a particular commodity as mentioned above.

Source: Landesmann and Wörz (2006).

Table A2: Taxonomy used in industry classifications (by factor and skill intensities)

	NACE Rev. 1.1	Taxonomy I factor inputs	Taxonomy II labour skills
Meat products	151	4	1
Fish and fish products	152	4	1
Fruits and vegetables	153	4	1
Vegetable and animal oils and fats	154	4	1
Dairy products; ice cream	155	4	1
Grain mill products and starches	156	4	1
Prepared animal feeds	157	4	1
Other food products	158	4	1
Beverages	159	4	1
Tobacco products	160	4	1
Textile fibres	171	3	1
Textile weaving	172	2	1
Made-up textile articles	174	2	1
Other textiles	175	1	1
Knitted and crocheted fabrics	176	1	1
Knitted and crocheted articles	177	1	1
Leather clothes	181	2	1
Other wearing apparel and accessories	182	2	1
Dressing and dyeing of fur; articles of fur	183	2	1
Tanning and dressing of leather	191	4	1
Luggage, handbags, saddlery and harness	192	4	1
Footwear	193	4	1
Sawmilling, planing and impregnation of wood	201	2	2
Panels and boards of wood	202	2	2
Builders carpentry and joinery	203	2	2
Wooden containers	204	2	2
Other products of wood; articles of cork, etc.	205	2	2
Pulp, paper and paperboard	211	3	3
Articles of paper and paperboard	212	1	3
Publishing	221	4	3
Printing	222	4	3
Coke oven products	231		
Refined petroleum and nuclear fuel	232	3	3
Nuclear fuel	233		
Basic chemicals	241	3	3
Pesticides, other agro-chemical products	242	5	3
Paints, coatings, printing ink	243	1	3
Pharmaceuticals	244	5	4
Detergents, cleaning and polishing, perfumes	245	4	3
Other chemical products	246	5	3
Man-made fibres	247	3	3
Rubber products	251	1	1
Plastic products	252	1	1
Glass and glass products	261	1	1
Ceramic goods	262	2	1
Ceramic tiles and flags	263	3	1
Bricks, tiles and construction products	264	2	1
Cement, lime and plaster	265	3	1
Articles of concrete, plaster and cement	266	1	1
Cutting, shaping, finishing of stone	267	2	1
Other non-metallic mineral products	268	1	1
Basic iron and steel, ferro-alloys (ECSC)	271	3	1
Tubes	272	1	1
Other first processing of iron and steel	273	3	1

	NACE Rev. 1.1	Taxonomy I factor inputs	Taxonomy II labour skills
Basic precious and non-ferrous metals	274	3	1
Structural metal products	281	2	2
Tanks, reservoirs, central heating radiators and boilers	282	4	2
Steam generators	283	2	2
Cutlery, tools and general hardware	286	4	2
Other fabricated metal products	287	1	2
Machinery for production, use of mechanical power	291	1	4
Other general purpose machinery	292	1	4
Agricultural and forestry machinery	293	1	4
Machine-tools	294	2	4
Other special purpose machinery	295	1	4
Weapons and ammunition	296	1	4
Domestic appliances n.e.c.	297	1	3
Office machinery and computers	300	5	4
Electric motors, generators and transformers	311	1	3
Electricity distribution and control apparatus	312	5	3
Isolated wire and cable	313	1	3
Accumulators, primary cells and primary batteries	314	1	3
Lighting equipment and electric lamps	315	1	3
Electrical equipment n.e.c.	316	2	3
Electronic valves and tubes, other electronic comp.	321	5	3
TV, and radio transmitters, apparatus for line telephony	322	5	3
TV, radio and recording apparatus	323	5	3
Medical equipment	331	5	3
Instruments for measuring, checking, testing, navigating	332	5	3
Optical instruments and photographic equipment	334	5	3
Watches and clocks	335	4	3
Motor vehicles	341	5	2
Bodies for motor vehicles, trailers	342	2	2
Parts and accessories for motor vehicles	343	3	2
Ships and boats	351	2	2
Railway locomotives and rolling stock	352	2	2
Aircraft and spacecraft	353	5	4
Motorcycles and bicycles	354	1	2
Other transport equipment n.e.c.	355	1	2
Furniture	361	2	2
Jewellery and related articles	362	2	2
Musical instruments	363	4	2
Sports goods	364	4	2
Games and toys	365	4	2
Miscellaneous manufacturing n.e.c.	366	4	2
Taxonomy I			
factor inputs			
1.Mainstream			
2.Labour-intensive industries			
3.Capital-intensive industries			
4.Marketing-driven industries			
5.Technology-driven industries			
Taxonomy II			
Labour skills			
1.Low-skill industries			
2.Medium-skill/blue-collar workers			
3.Medium-skill/white-collar workers			
4.High-skill industries			

Source: Peneder (2003).

Table A3: Trade in services in 2007, EUR billion

	Services exports	Services imports
Brazil	17.4	27
China	88.9	94.6
Hong Kong	61.8	31.1
India	65.5	38.2
Russia	28.7	43
Total BRICs	**262.2**	**233.9**
EU-27	1177.7	1024.7
NMS-12	*85.2*	*69.1*
EU-15	*1092.6*	*955.6*
EU-27-extra-EU	513.3	427
NMS12-extra EU	*23.5*	*19.7*
EU-15-extra-EU	*489.8*	*407.3*
US	359.8	275.9
JPN	110.9	115.7

Source: TSD.

Table A4: FDI flows from the EU in the BRICs

	FDI flows from the EU-27 to the BRICs (in EUR billion)						Share in total extra-EU outward FDI stocks		EU share in total FDI flows to the BRICs (in %)
Destination country	2003	2004	2005	2006	2007	2008	2003	2007	average 2005-2007
Brazil	2.1	5.7	8.4	6.5	15.3		2.9	3.1	53.2
Russia	7.7	6.0	9.7	10.8	16.7		0.7	2.3	56.9
India	0.8	1.6	2.5	2.5	5.4		0.3	0.6	30.9
China	3.2	3.9	6.1	6.7	7.1		0.9	1.2	10.4
Hong Kong	3.8	11.3	3.8	3.6	7.2		4.2	2.8	20.5
BRICs	**17.6**	**28.5**	**30.6**	**30.0**	**51.7**		**9.2**	**10.1**	

	EU-15 investment projects in the BRICs (Number of projects)						EU share of total projects in the BRICs (in %)			
Destination country	2003	2004	2005	2006	2007	2008	2003	2007	2008	average 2005-2007
Brazil	140	115	66	57	58	107	48.4	38.2	43.7	38.2
Russia	216	217	270	212	211	303	50.6	57.3	54.0	57.3
India	139	202	160	346	264	358	30.8	38.3	37.4	38.3
China	298	367	371	435	427	481	22.5	35.9	32.4	35.9
Hong Kong	35	36	38	60	56	62	38.5	38.4	30.7	38.4
BRICs	**828**	**937**	**905**	**1,110**	**1,016**	**1,311**	**32.1**	**39.9**	**38.0**	**39.9**

Remark: EU is EU-25 for 2001-2003 and EU-27 for 2004-2007 in Eurostat; EU is EU-15 in fDi database. China excludes Hong Kong. BRICs in this table includes Hong Kong.
Source: Eurostat, UNCTAD, US Bureau of Economic Analysis, FDI Intelligence from Financial Times Ltd.

Table A5: EU outward FDI stocks in the BRICs by economic activity in 2006, in EUR million

	Brazil	Russia	India	China	Hong Kong
Agriculture and fishing	**36**	**23**	**2**	**5**	**1**
Mining and quarrying	**714**	**9268**	**376**	**1223**	**121**
Manufacturing	**21898**	**15376**	**5901**	**15214**	**2447**
Food products	4307	2682	1177	825	109
Textiles and wearing apparel	409	45	37	194	84
Wood, publishing and printing	299	916	177	483	39
Refined petroleum products and other treatments	652	7777	632	384	220
Manufacture of chemicals and chemicals products	2986	823	1120	2796	182
Rubber and plastic products	1004	509	107	696	153
Metal products	4234	344	210	975	141
Mechanical products	1591	236	807	2169	1055
Office machinery and computers	13	-5	35	108	77
Radio, television, communication equipments	360	89	208	1166	13
Vehicles and other transport equipment	4406	825	573	2973	146
Electricity, gas and water	**863**	**270**	**146**	**278**	**10**
Construction	**386**	**380**	**22**	**55**	**97**
Services	**52877**	**24492**	**5559**	**14797**	**83333**
Trade and repairs	2015	2867	356	1958	2551
Hotel and restaurants	216	357	251	18	61
Transport and storage	1254	89	294	577	109
Telecommunications	205	913	88	28	1285
Post and courier activities	148	53	77	6	-402
Financial intermediation	26572	12664	3413	6771	72345
Real estate and business activities	21908	7164	1026	5363	7209
Real estate	*241*	*312*	*8*	*167*	*91*
Renting of machinery and equipment	*92*	*76*	*1*	*15*	*4836*
Computer activities	*195*	*146*	*323*	*123*	*143*
Research and development	*381*	*8*	*18*	*313*	*3*
Other business activities	*20997*	*6621*	*677*	*4742*	*2134*
Total	**78330**	**50226**	**12308**	**86401**	**86401**

Remark: EU is EU27. China excludes Hong Kong. Economic activities according to Eurostat nomenclature. Numbers do not add up to Total because of non-allocated activities. FDI outwars stocks are classified according to the activities of the non-resident enterprise, i.e. the enterprise in the respective BRIC country.
Source: Eurostat.

Table A6: EU inward FDI stocks owned by the BRICs by economic activity in 2006, in EUR million

	Brazil	Russia	India	China	Hong Kong
Agriculture and fishing	**2**	**4**	**-1**	**1**	**-7**
Mining and quarrying	**12**	**-5**	**6**	**5**	**17**
Manufacturing	**344**	**540**	**590**	**420**	**340**
Food products	212	31	408	31	-17
Textiles and wearing apparel	5	3	-2	19	69
Wood, publishing and printing	2	41	-1	24	46
Refined petroleum products and other treatments	1	3	9	0	29
Manufacture of chemicals and chemicals products	20	80	120	6	-122
Rubber and plastic products	7	12	-7	32	-35
Metal products	29	135	14	13	5
Mechanical products	108	23	12	27	94
Office machinery and computers	-58	13	1	236	44
Radio, television, communication equipments	6	109	3	8	97
Vehicles and other transport equipment	3	69	29	19	-6
Electricity, gas and water	**2**	**903**	**-2**	**1**	**-6**
Construction	**85**	**289**	**-3**	**13**	**2**
Services	**14168**	**12143**	**1463**	**3101**	**16317**
Trade and repairs	1939	1122	150	312	352
Hotel and restaurants	5	43	1	5	38
Transport and storage	48	116	10	98	284
Telecommunications	8	18	28	24	10283
Post and courier activities	6	4	-21	2	599
Financial intermediation	4004	3921	523	2452	2301
Real estat and business activities	8130	6368	741	197	2386
Real estate	*105*	*559*	*15*	*42*	*377*
Renting of machinery and equipment	*8*	*20*	*8*	*21*	*26*
Computer activities	*8*	*-3*	*286*	*3*	*99*
Research and development	*2*	*1*	*-2*	*-18*	*-6*
Other business activities	*8006*	*5789*	*435*	*150*	*1888*
Total	**14625**	**14571**	**2222**	**3566**	**17461**

Remark: EU is EU27. China excludes Hong Kong. Economic activities according to Eurostat nomenclature. Numbers do not add up to Total because of non-allocated activities. FDI outwars stocks are classified according to the activities of the non-resident enterprise, i.e. the enterprise in the respective BRIC country.
Source: Eurostat.

CHAPTER 3
Migration, skills and productivity

3.1. Introduction

This chapter looks at the relationship between the migration of high-skilled workers and productivity performance[84]. The literature on international migration has repeatedly emphasised that the extent and structure of migration has an important impact on the competitiveness of regions and countries. A number of studies have stressed that highly skilled migrants are an important resource pool, which can be used to strengthen national R&D systems as well as integration within international business networks, to increase entrepreneurial activity, to improve the integration of both sending and receiving countries within the international division of labour, to overcome bottlenecks in regional labour supply, and to support regional clusters of high-tech activity. A recent paper by Hunt and Gauthier-Loiselle (2008) cites literature that foreign-born individuals in the US account for about 26% of US Nobel prize recipients (Peri, 2007), 25% of the founders of venture-backed US companies (Anderson and Platzer 2006), 25% of new high-tech companies with more than one million US dollars of sales and 24% of international patent applications from the US (Wadhwa et al. 2007), although they account for only 12% of US residents.

In addition to these advantages it has also been argued that shifting the structure of migration to the more highly skilled may also have a positive impact on social security systems since they are less likely to represent a burden on national social security and transfer systems, due to their better integration within the labour markets of the receiving countries (see Chiswick, 2005)[85].

These potential advantages of high-skilled migration are also reflected in the policy arena. In the face of ageing European societies and growing needs for highly skilled labour, the developed market economies of the EU Member States are facing increased competition for highly skilled migrants. To effectively and promptly respond to this increasing demand for highly qualified immigrant labour in Europe – and to offset present and upcoming skill shortages in the light of Europe's rapid demographic ageing – the Commission presented in October 2007 a proposal for a directive on "conditions of entry and residence of third-country nationals for the purposes of highly qualified employment" (COM (2007) 637 final). This so-called "EU Blue Card" directive has been adopted by the Council on 25 May 2009 (Directive 2009/50/EC, OJ L 155, p. 17); it will be applicable in practice as of June 2011. This Blue Card system coexists with national procedures, which continue to be used by the Member States, and thereby merely offers an additional way of recruiting and admitting high-skilled migrants for work purposes. Furthermore, the European Commission (as evidenced for instance by the recent green paper on the European Research Area, see EC, 2007) also acknowledges that "it is essential to establish a single European labour market for researchers, ensuring effective 'brain circulation' within Europe and with partner countries and attracting young talent and women into research careers" (EC, 2007, p. 11). In addition, the October 2005 Directive on a specific procedure for admitting third-country nationals for the purposes of scientific research should contribute to easier international movements of researchers (Directive 2005/71/EC, OJ L 289, p. 15).

84 Throughout this chapter the term «migration» refers to both intra-EU mobility of EU workers and immigration by third-country nationals for labour purposes from countries outside the EU. In this context, it is important to recall that EU citizens, unlike third-country nationals, enjoy a fundamental right – granted to them by the EC Treaty – to move freely within the European Union, without any particular admission or integration requirement for their residence and work in another Member State. This constitutes a fundamental difference in comparison to the conditions third-country nationals have to fulfil under the existing EU and national immigration rules, before they can reside and work in an EU Member State. In policy making terms, the latter category is of higher interest as only the entry and stay of third-country workers can be actively steered by Member States according to their changing economic and labour market needs.

85 It should be mentioned that the literature has suggested that these advantages may be countered by the potential increase in wage pressures (and potentially unemployment rates) for high-skilled labour as well as potentially reduced incentives for training and education of the native population.

As, however, also pointed out by the European Commission's Employment in Europe Report (EC, 2008) increased migration brings with it new demands on economic policy. This applies in particular to the need to develop appropriate integration policies and – of particular importance for high-skilled migration – institutional arrangements to guarantee that highly skilled migrants can transfer skills across borders and apply their knowledge in the host economies.

Furthermore, migration incentives for the highly skilled may differ from those of the less skilled[86]. In particular, highly skilled individuals are likely to put more emphasis on the career aspects of migration in their decision to migrate (see for instance Ackers, 2005). Moreover, the migration of the highly skilled "has additional and complex aspects relating to research opportunities, work conditions and access to infrastructure" (OECD, 2007, p. 23). For students, issues such as the quality of training facilities and mobility grants may be more important determinants in their decision to become mobile (Trembley 2002) than income differentials, while for those highly skilled already in the workforce additional factors such as access to intra-firm arrangements to allow international mobility (for instance within multinational enterprises; cf. Hunt 2004) or generous family reunification rules may be much more important for migration decisions.

This chapter provides an overview of the extent and the potential effects of high-skilled migration to the EU-27. First of all it is investigated how many high-skilled migrants live in the EU, where these migrants come from, and how the European Union is positioned in the international competition for talent from third countries. Second, it examines how high-skilled migrants fare in European labour markets. To this end employment, unemployment and inactivity rates by skill groups are analysed as well as job-skill mismatch for natives and foreign-born in the EU. Finally, this chapter looks at the effects of high-skilled migration on multifactor productivity, gross value added and GDP per capita growth, and patenting activities at sectoral and regional levels.

3.2. Some results from the existing literature

In order to put the issues into context and to gain a first impression of the ability of the EU vis-à-vis some other countries to attract high-skilled migrants, Table 3.1 presents the distribution of native-born across education groups, and the share of foreign-born in each education group (Peri 2005). The table shows that Australia, Canada, Switzerland and the US have larger shares of foreign-born in the high-skilled group than the EU-15, and that the low-skilled group in the EU-15 has the largest share of foreigners (compared with the medium- and high-skilled group in the EU-15).

Despite the substantial academic and policy interest in the issues raised, there is to date only very little literature that focuses exclusively on high-skilled mobility. This applies in particular to the alleged positive effects of high-skilled mobility on receiving countries. In a recent survey of this literature, the OECD (2008) concludes, for instance, that in general there is a scarcity of research on the impact of high-skilled mobility on receiving countries and that the existing literature is plagued by data and methodological problems, which make it hard to identify these effects. This lack of research applies even more strongly to the EU than to the US.

Furthermore, much of the literature is quite controversial. For example, in the recent literature on the potential impact of high-skilled migration on receiving countries, there is a substantial debate centring on the question whether high-skilled foreigners are a substitute for or a complement to high-skilled native labour (see Ottaviano and Peri (2006) and Borjas et al. (2008) for two diametrically opposed views). This is essential for assessing the potential wage impact of high-skilled migration. Here results even for one and the same country (e.g. Germany – Brücker and Jahn 2008, D'Amuri et al. 2008, Felbermayer et al. 2008) depend very strongly on methodological choices and the data used. Nonetheless, a robust finding of most studies is that foreigners and natives are imperfect substitutes for each other overall, with previous immigrants being closer substitutes for recent arrivals. The findings for the high end of the skill distribution, however, remain controversial, ranging from perfect to relatively low substitutability between natives and foreigners.

These different results for substitutability or complementarity lead to relatively divergent assessments of the impacts of high-skilled migration on wages, with some authors finding positive and others negative effects. Here, however, even those studies that do find negative effects suggest a relatively mild impact on wages (as well as on unemployment), with even the highest estimates for European countries suggesting that an increase in the number of high-skilled migrants by 10% will lead to wage losses for high-skilled natives somewhere in the range of 2-4%, and some evidence indicating that the primary route by which highly skilled native workers escape from increased competition seems to be occupational mobility.

In addition, however, there is some conclusive evidence for a number of positive impacts of high-skilled

86 It is beyond the scope of this chapter to discuss migration motivations in great detail, but it should be mentioned that family reunion is also an important factor, and part of the migration will be related to the granting of refugee status for humanitarian purposes.

Table 3.1: Distribution of native-born and share of foreign-born across education groups

	Distribution of native-born across education groups			Share of foreign-born in each education group		
	Low	Medium	High	Low	Medium	High
Australia	0.450	0.163	0.388	0.204	0.268	0.268
Canada	0.309	0.371	0.320	0.192	0.179	0.238
Switzerland	0.256	0.552	0.192	0.321	0.152	0.277
US	0.219	0.511	0.270	0.234	0.101	0.139
EU-15	0.535	0.232	0.232	0.059	0.040	0.058
France	0.548	0.272	0.181	0.136	0.087	0.124
Germany	0.236	0.570	0.194	0.220	0.099	0.110
UK	0.512	0.287	0.201	0.080	0.086	0.160

Source: Peri (2005). The data refer to 1999/2000.

migrants. This applies in particular to the effects of high-skilled migration on innovation activities and to the positive trade- and FDI- generating effects of migration. With respect to innovation, quite an extensive literature, though almost exclusively focusing on the US, finds a positive association between both high-skilled migration and ethnic diversity and measures of innovation activities (see Hunt and Gauthier-Loiselle 2008, for a recent contribution). With respect to trade, by contrast, many contributions find a high degree of association between immigration and bilateral trade flows with estimates in general suggesting that a 10% increase in migration will increase bilateral trade by somewhere between 1% to 2% (see Combes et al. 2005, Parsons 2005, Girma and Yu 2002 for results for the EU or individual European countries). Similarly, the slightly smaller literature on FDI (Kugler and Rapoport 2005, Docquier and Lodigiani 2006, Javorick et al. 2006 and DeSimone and Manchin 2008) suggests an equally strong association between migration and FDI activities, where in particular high-skilled migrants seem to be instrumental in generating higher FDI.

Concerning the impacts on entrepreneurship and on productivity, the evidence is much more mixed. With respect to entrepreneurship much of the literature has focused on individual case studies, in particularly successful regions or industries. The few more general (mostly US-focused) studies that have become available recently (e.g. Wadhwa et al., 2007) suggest that migration contributes significantly to the founding of new enterprises and the development of entrepreneurial activity. With respect to productivity, the few existing studies (see e.g. Quispe-Agnoli and Zavodny 2002, Paserman 2008, Mas et al. 2008) often disagree and suggest that effects of migration are more often negative than positive, with positive effects mostly found in cases where a successful match between migrants' skills and the requirements of their employees was achieved at the level of the firm.

3.3. How important are high-skilled foreign-born workers for the EU and where do they come from?

Where do highly skilled migrants in the EU reside?

Looking at the structure of highly skilled migration it is found that for the EU-27 as a whole, the foreign-born are found to be an important source of human capital. According to data from the European Labour Force Survey (EU LFS[87]), 9.7% of the total tertiary-educated resident population (as opposed to 8.1% of the total resident population) in the EU-27 is foreign-born. The share of the highly skilled among the resident population born outside the EU is 21.1%, while for intra-EU migrants it is 23.0% (as opposed to 17.9% for the native-born population). The foreign-born thus contribute more than proportionately to the share of highly skilled in the EU.[88]

However, there is also substantial variation in migration experience in the EU-27 both with respect to receiving regions as well as with respect to sending regions. With respect to receiving regions highly skilled migration (as well as total migration) is strongly concentrated. Around 94.2% of all highly skilled foreign-born in the EU-27 live in the EU-15. Only around 5.8% reside in the new Member States (NMS) (cf. Table 3.2).

This high concentration also applies to individual EU-15 countries. The three largest receiving countries in the EU-27 (France, the UK and Spain) in sum account for 57.5% of the total foreign-born population in the EU-15 (Germany and Ireland are not included in the EU LFS

87 European Commission, Eurostat, European Union Labour Force Survey, quarterly data. Eurostat has no responsibility for the results and conclusions which are those of the researchers.

88 Notice that the group of countries and the period is different from the ones on which Table 3.1 is based, so the figures are not directly comparable. The data in Table 3.1 refer to 1999/2000 but this table allows for a comparison between the EU and some other non-EU OECD countries.

data set; see note Table 3.2) and 63.6% of the highly skilled. The foreign-born share in the total resident population (aside from the obvious outlier of Luxemburg) is higher than 15% in Austria and Sweden but below 10% in Denmark, Greece, Italy and Portugal and even below 3% in Finland.

This heterogeneity is also reflected in a number of important indicators for the structure of migration. For instance, EU LFS data suggest a pronounced heterogeneity among EU countries with respect to the human capital structure of migrants born in other EU countries and from migrants born outside the EU. In Austria and Greece, the share of the highly skilled among migrants born outside the EU (with 11.2% and 12.4% respectively) is clearly below the average for both the EU-27 and the EU-15, while the share of highly skilled migrants born in other EU countries is higher than average for Austria (24.5%) and only modestly below average for Greece (20.4%).

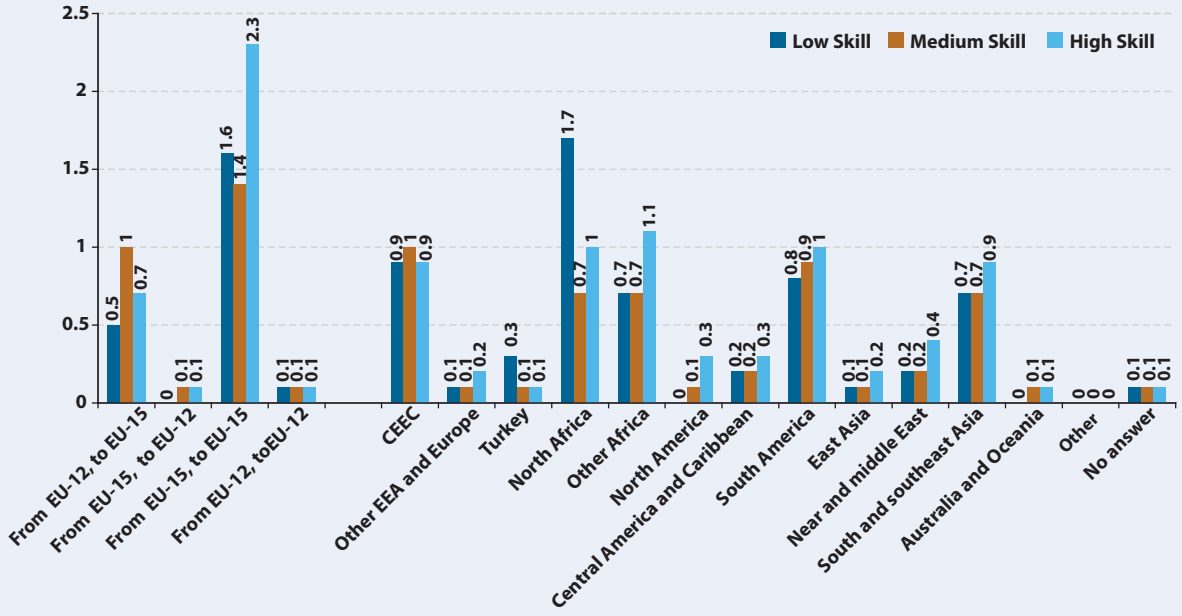
By contrast, in France and the NMS the share of the highly skilled among those born in other EU-27 countries is clearly below the average. On the other hand, the share of high-skilled migrants among those born outside the EU is relatively high in France. The only country with substantially lower shares of highly educated migrants born both outside and within the EU-27 is Italy. For the UK, Sweden, Luxemburg, Spain and Denmark the share of highly skilled is above average for persons born both in the EU-27 as well as in third countries. Thus, data on the structure of migration also suggests substantial variation in the structure of migration from different sending countries, which in turn reflect different historical ties and migration experiences among EU-27 countries.

Table 3.2: Foreign-born share in total population and share of total foreign-born population by receiving country and skill group

	Foreign-born share in total population				Share of total foreign-born in EU-27			
	Skill level							
	Low	Medium	High	Total	Low	Medium	High	Total
Total EU-27	8.0	7.6	9.7	8.1	100.0	100.0	100.0	100.0
Total EU-15	9.5	11.1	11.4	10.4	95.8	92.1	94.2	94.1
Austria	19.9	13.1	18.7	15.9	3.8	5.2	3.1	4.2
Belgium	14.1	9.6	11.0	11.9	4.9	2.8	4.2	4.0
Denmark	7.3	5.8	7.2	6.6	0.9	1.0	1.4	1.1
Spain	9.2	21.6	12.7	12.5	18.4	16.3	19.5	17.8
Finland	2.8	2.9	2.5	2.8	0.4	0.5	0.5	0.5
France	14.9	8.5	11.2	11.8	28.5	15.6	20.3	21.9
Greece	6.0	7.4	5.6	6.4	2.6	2.3	1.5	2.2
Italy	5.6	7.5	7.5	6.4	15.2	12.6	6.6	12.3
Luxembourg	36.9	31.9	52.9	38.1	0.5	0.5	0.7	0.5
Netherlands	11.1	12.6	10.1	11.5	5.0	6.6	5.7	5.7
Portugal	4.6	12.1	12.1	6.4	2.9	1.5	1.9	2.2
Sweden	17.7	14.2	17.1	15.8	2.5	4.8	5.1	3.9
UK	10.4	13.4	13.1	12.5	10.2	22.5	23.8	17.8
Total NMS	1.7	1.6	2.9	1.8	4.2	7.9	5.8	5.9
Bulgaria	-	0.3	0.7	0.3	0.0	-	0.1	0.1
Cyprus	12.8	17.1	20.7	16.4	0.3	0.4	0.6	0.4
Czech Republic	3.3	1.7	2.9	2.1	0.5	1.1	0.5	0.7
Estonia	11.2	17.2	20.3	16.7	0.2	0.9	1.0	0.7
Hungary	1.2	1.6	3.0	1.6	0.3	0.7	0.6	0.5
Lithuania	3.3	5.8	5.1	4.9	0.3	0.8	0.5	0.5
Latvia	10.4	14.2	17.1	13.7	0.5	1.4	1.0	0.9
Malta	3.4	6.5	7.9	4.3	0.1	0.0	0.0	0.1
Poland	2.0	0.8	1.1	1.1	1.5	1.5	0.9	1.4
Romania	-	-	-	0.1	-	-	-	0.0
Slovenia	9.3	7.5	6.3	7.8	0.4	0.7	0.3	0.5
Slovakia	0.7	0.6	1.3	0.7	0.1	0.2	0.1	0.1

Notes: Base population aged 15+, excluding Germany and Ireland, excluding unknown highest completed education and unknown country of birth (see section 2 for details of data construction). Low skilled = ISCED 0-2, medium skilled = ISCED 3,4, high-skilled = ISCED 5, Averages for 2006-2007. – = data provides too few observations to be reported.
Source: EU LFS.

Figure 3.1: Population aged 15+ by place of birth (share in total population residing in the EU-27), 2006/2007



Notes: Base population aged 15+, excluding Germany and Ireland, excluding unknown highest completed education (see section 2 for details of data construction). Low-skilled = ISCED 0-2, medium skilled = ISCED 3,4, high-skilled = ISCED 5,6. CEEC = other non EU central and Eastern European countries. EEA = European Economic area, EU-12 countries acceding the EU in 2004 and 2007, EU-15 = EU Member States before 2004, Averages 2006-2007.
Source: EU LFS.

Where do highly skilled migrants in the EU come from?

Looking at the sending regions, non-EU countries are a more important source of human capital for most EU countries than migrants from within the EU. 6.6% of the total tertiary educated resident population of the EU were born outside the EU. 2.5% were born in an EU country other than the one where they currently reside.

Highly skilled non-EU-born migrants primarily come from other (non-EU) European countries (in particular Eastern Europe), South and Southeast Asia, South America, and Northern and Other Africa (with each of these groups contributing more than 0.8% to the total highly skilled population residing in the EU). Highly skilled intra-EU migrants by contrast are often migrants from one EU-15 country to another EU-15 country (see Figure 3.1).

Table 3.3: Share of EU population aged 15+ by place of birth, duration of stay and highest completed education, 2006/2007

	Skill level					
	Low	Medium	High	Low	Medium	High
	duration of stay less than 10 years			duration of stay more than 10 years		
EU-born	25.4	48.7	25.9	42.6	36.5	20.9
of whom						
From EU-12 to EU-15	27.2	56.6	16.2	27.4	48.0	24.6
From EU-15 to EU-15	19.3	35.5	45.2	37.3	44.9	17.8
From EU-27 to EU-12	20.1	51.9	28.0	34.6	49.3	16.2
Non-EU-born	41.8	37.8	20.5	43.2	35.5	21.3
of whom						
Other Europe (including CEEC)	41.1	37.3	21.6	37.9	45.7	16.4
Turkey	64.1	29.5	(6.4)	66.2	27.4	6.5
North Africa	61.1	24.0	14.9	59.0	26.0	15.0
Other Africa	39.6	41.3	19.1	37.5	33.4	29.1

South & Central America Caribbean	39.7	40.7	19.6	35.3	39.8	24.8
East Asia	35.4	36.7	27.9	41.2	28.8	30.0
Near and Middle East	34.3	39.6	26.1	26.1	39.7	34.2
South and Southeast Asia	36.4	42.1	21.5	38.1	37.7	24.2
North America, Australia and Oceania (including other)	8.8	47.0	44.2	20.6	39.8	39.5
No answer	47.9	30.0	22.1	53.5	24.5	22.0
South and Southeast Asia	36.4	42.1	21.5	38.1	37.7	24.2
Australia and Oceania	10.2	52.0	37.9	22.5	47.0	30.5
Other	29.5	24.7	45.9	49.7	23.3	27.1
No answer	38.4	27.4	34.2	55.3	26.0	18.7

Notes: Base population aged 15+, excluding Germany and Ireland, excluding unknown highest completed education, excluding unknown duration of stay (see section 2 for details of data construction). Low-skilled = ISCED 0-2, medium-skilled = ISCED 3,4, high-skilled = ISCED 5,6. CEEC = other non EU central and eastern European countries. EEA = European Economic Area, EU-12 countries that joined the EU in 2004 and 2007, EU-15 = EU Member States before 2004, averages 2006-2007, values in brackets have a low reliability.
Source: EU LFS.

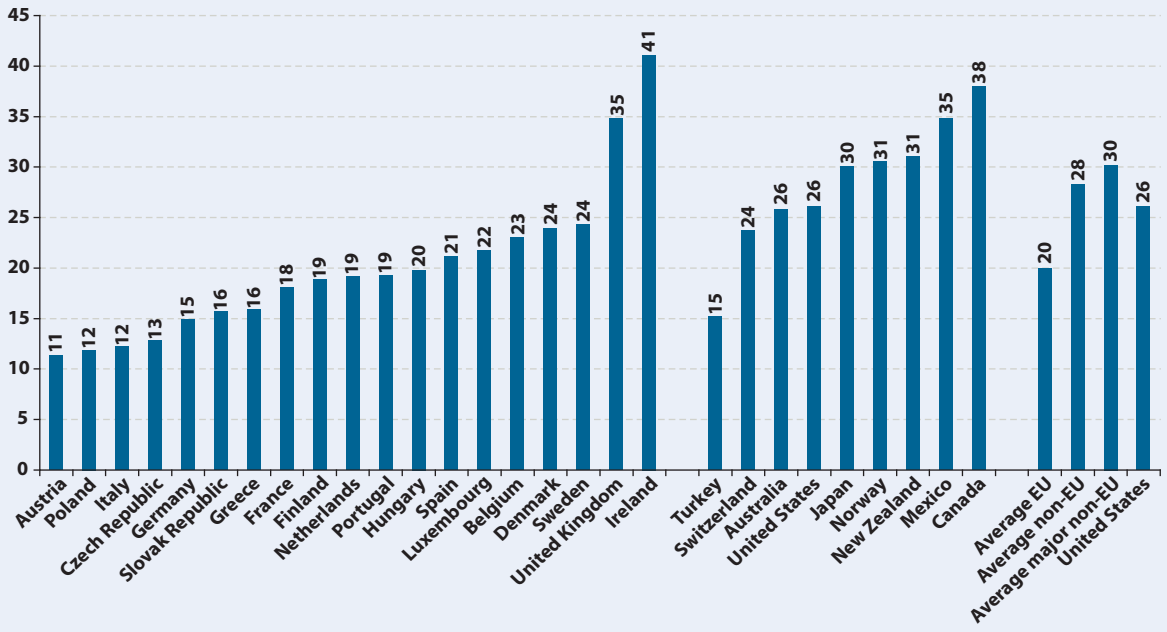
The evidence, however, also suggests that more recent migrants to the EU-27 (in the country of residence for less than 10 years) are not always more highly qualified than earlier migrants (cf. Table 3.3). More recent migrants from the main African and Asian and South American sending regions, are less well qualified than more established migrants from these regions. Thus, overall, the share of tertiary educated among non-EU-born residents living in the EU-27 for less than 10 years is 20.5%, compared with 21.3% among the more established non-EU born. The reason for this seems to be primarily a substantial share of low-skilled seasonal and temporary workers coming to the EU from many of the main non-EU source countries.

However, recent migrants from within the EU-27 are, substantially more highly qualified than more established migrants from the EU-27. Here the share of highly skilled among those residing abroad for less than 10 years is 25.9% (compared with 20.9% among migrants resident for more than 10 years).

3.4. How does the EU compare to other OECD countries?

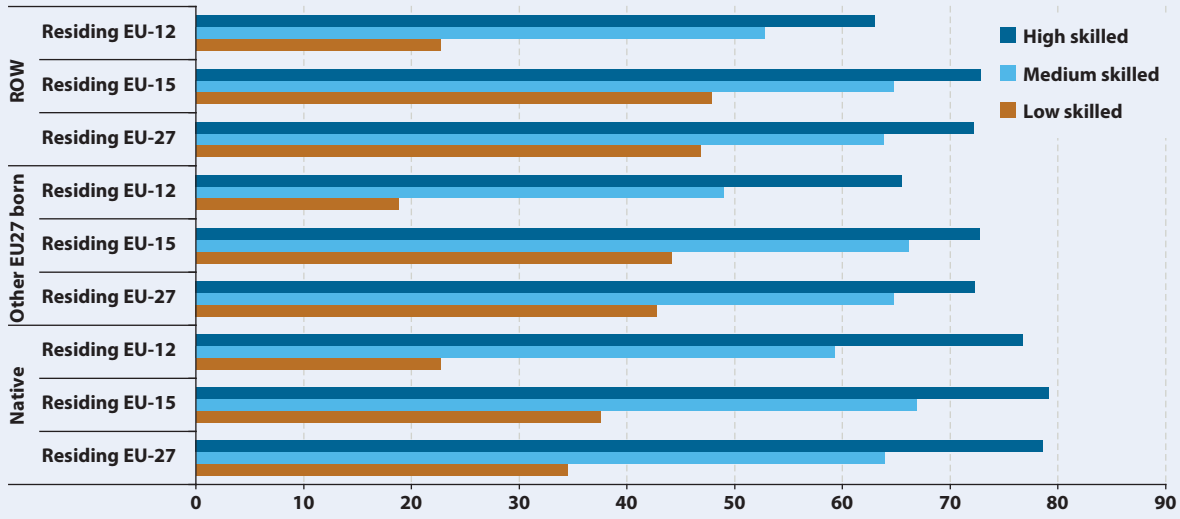
Comparing the skill structure of migrants in OECD countries suggests that EU countries are in general receiving a lower share of highly skilled migrants than non-EU

Figure 3.2: Share of highly skilled foreign-born among total foreign-born population in OECD countries



Notes: Excluding individuals with unknown education level, gender or place of birth. Major non-EU = Australia, Canada, New Zealand, United States.
Source: Database on Immigrants in OECD Countries (DIOC).

Figure 3.3: Employment rate of foreign and native-born by major sending and receiving regions and skill groups



Notes: Base population aged 15+ excluding native-born population, excluding Germany and Ireland, excluding unknown highest completed education and unknown country of birth (see section 2 for details of data construction). Low-skilled = ISCED 0-2, medium-skilled = ISCED 3,4, high-skilled = ISCED 5,6.
Source: EU LFS.

OECD countries, but that there is also substantial variation in this respect. Countries such as Ireland and the UK received more than 30% highly skilled migration, while others such as Austria, Italy and Poland received a very low share by international standards. Furthermore, the data also suggest that migrant selectivity in the EU is substantially lower than in the main non-EU OECD countries. Some EU countries (such as Austria, Poland and Italy) actually receive a negative selection of migrants in terms of the current skill structure in the sending countries.

Looking at potential explanations for these differences in EU-27 skill structure, the results of recent literature (see Belot and Hatton, 2008) suggest that a weakness of all EU OECD countries is the relative remoteness of the EU from Asian countries (with a high share of highly skilled migrants), which reduces the ability of the EU to attract high-skilled migrants. Other more policy-relevant factors such as differences in (post-tax) wage premia for high-skilled labour, financial constraints (affecting the skill mix from poor and distant countries), language and cultural proximity, all affect the qualification mix of migrants and point to substantial heterogeneity among EU countries, with destination country dummies further capturing other differences such as other labour market features, immigration and integration policies, etc.

Furthermore, the lower share of tertiary educated migrants residing in the EU OECD countries (relative to non-EU OECD countries) is associated with a significantly lower share of highly educated recent migrants, which most likely also reflects substantially higher shares of low-skilled temporary migration into the EU OECD countries. On the positive side, however, the EU countries in general have experienced a slightly stronger increase in the share of tertiary-educated foreign-born than non-EU OECD countries in the last decade. In terms of student mobility, EU countries also seem to be more attractive and admit a higher share of foreign students.

Generally, it can also be observed that comparing the EU OECD countries with the four major non-EU receiving countries in the OECD – Australia, Canada, New Zealand and the US – more often yields significant differences, while comparisons of the EU with the US alone seldom lead to significant or sizable differences[89]. This result can be interpreted as indicating that those countries with modern, point-based migration systems (Australia, Canada and New Zealand) are more successful in attracting highly skilled migrants than the EU or the US.

3.5. Labour market situation of highly skilled migrants in the EU

Employment, unemployment and inactivity rates

There are also substantial differences in the labour market outcomes (as measured by employment, unemployment and activity rates) of foreign and native-born

89 For example, the major non-EU receiving countries not only have a significantly higher share of foreign-born residents in the population, but also a significantly better educational structure than the EU OECD countries. On the other hand, no significant differences can be found when comparing the US to the EU OECD countries.

Table 3.4: Regression results for the probability of unemployment, employment and inactivity

	Skill level									
	High			Medium			Low			Test for difference among skill groups[1)]
	marginal effect		std. error	marginal effect		std. error	marginal effect		std. error	
					Employment					
Female	–0.050	***	0.006	–0.140	***	0.006	–0.205	***	0.009	a,b
Age 25-44	0.263	***	0.010	0.348	***	0.007	0.460	***	0.008	a,b
Age 45+	0.043	***	0.009	0.081	***	0.008	0.079	***	0.010	b
Foreign-born	–0.093	***	0.006	–0.072	***	0.005	0.029	***	0.006	a,b
					Inactivity					
Female	0.045	***	0.005	0.134	***	0.007	0.221	***	0.010	a,b
Age 25-44	–0.231	***	0.010	–0.323	***	0.008	–0.474	***	0.009	a,b
Age 45+	0.001		0.009	–0.023	***	0.009	–0.023	**	0.012	b
Foreign-born	0.054	***	0.005	0.040	***	0.005	–0.054	***	0.007	a,b
					Unemployment					
Female	0.003	**	0.001	0.002		0.002	–0.004	***	0.001	
Age 25-44	–0.023	***	0.002	–0.018	***	0.002	0.007	***	0.002	a,b
Age 45+	–0.041	***	0.002	–0.048	***	0.002	–0.046	***	0.002	b
Foreign-born	0.030	***	0.002	0.027	***	0.002	0.012	***	0.001	a,b

Notes: The table reports marginal effects of a multinomial choice model, Base population aged 15+, excluding Germany and Ireland, excluding unknown highest completed education and unknown country of birth (see section 2 for details of data construction). Lowskilled = ISCED 0-2, medium-skilled = ISCED 3,4, high-skilled = ISCED 5,6 Results for receiving country dummy variables and year 2007 not reported *(**) (***) signifies significance at 10% (5%) (1%) level, std. error – heteroscedasticity robust standard error of the estimate. 1) column presents results of a test for the significance of coefficients across skill groups: a) indicates that the coefficient of the variable for the medium educated differs from that of the less educated, b) indicates that the coefficient of the variable for the highly educated differs from that of the less-educated. All tests are at a significance level of 5%.
Source: EU LFS.

EU-27 residents by skill groups. In general, the less skilled foreign-born in the EU-27 are characterised by higher employment rates, higher labour market participation and also higher unemployment rates than the less skilled natives. The high-skilled foreign-born have lower labour market participation rates, higher unemployment rates and lower employment rates[90]. In addition native-foreign unemployment, employment and inactivity rate differentials are more pronounced for the migrants from outside the EU than for migrants from other EU countries.

An empirical investigation based on (weighted) multinomial logit regression analysis using EU LFS data (see Table 3.4) suggests that (after controlling for country of residence, age and gender) the highly skilled foreign-born in the EU have a 9.3 percentage-point lower probability of being employed, a 3 percentage-points higher probability of being unemployed and a 5.4 percentage point higher probability of being inactive than comparable natives. This points to a substantial underutilisation of highly skilled foreign labour in the EU-27. The less-skilled foreign-born, by contrast, have a 2.9 percentage-point higher probability of being employed than comparable natives and face a 5.4 percentage point lower risk of inactivity but a 1.2 percentage-point higher risk of unemployment.

This underutilisation is greater for migrants born in more distant (i.e. non-EU) sending countries. This applies in particular to the probability of unemployment. Here only less- and medium-skilled migrants born in Northern America and Oceania have a lower risk of unemployment than migrants from the EU, while the unemployment risk for highly skilled migrants born in for instance the Near and Middle East is 7 percentage points higher than that of comparable high-skilled natives.

But also migrants born in the EU-15 and even more markedly, migrants from the new Member States have substantially different labour market outcomes than natives. For instance, high-skilled migrants born in the EU-15 have an employment probability that is 7.4 percentage points lower, an unemployment risk that is 1.1 percentage points higher and a 6.3 percentage-points higher probability of being inactive than natives of the same skill group (even after controlling for receiving region, gender and age effects). These results thus suggest that even within the EU-15 borders the transfer of skills across country borders is far from unproblematic.

90 It should be noted that immigration rules in the EU are (at least to some extent) demand-driven, and under the EU Blue Card directive a high-skilled third-country worker can only be admitted if s/he already has a job or binding job offer earning him or her a salary above the threshold defined in the Directive. Also, the recognition of qualifications is an admission requirement at least for regulated professions, cf. the EU Blue Card Directive 2009/50/EC.

Table 3.5: Regression results for the probability of unemployment, employment and inactivity among the foreign-born

	Skill level									
	High			Medium			Low			Test for difference among skill groups[1)]
	marginal effect		std. error	marginal effect		std. error	marginal effect		std. error	
					Employment					
Female	–0.120	***	0.008	–0.210	***	0.006	–0.271	***	0.008	a,b
Age 25-44	0.244	***	0.021	0.259	***	0.009	0.381	***	0.010	a,b
Age 45+	0.066	***	0.020	0.077	***	0.010	0.129	***	0.013	A
Duration<10 years	–0.097	***	0.010	–0.058	***	0.008	–0.018	*	0.009	a,b
					Unemployment					
Female	0.010	***	0.004	0.009	***	0.003	–0.008	**	0.003	a,b
Age 25-44	–0.019	**	0.010	–0.021	***	0.004	0.002		0.004	a,b
Age 45+	–0.033	***	0.009	–0.048	***	0.004	–0.045	***	0.006	A
Duration<10 years	0.017	***	0.005	0.014	***	0.004	0.008	*	0.004	a,b
					Inactive					
Female	0.110	***	0.007	0.202	***	0.006	0.280	**	0.009	
Age 25-44	–0.225	**	0.019	–0.238	***	0.009	–0.383	***	0.010	
Age 45+	–0.033	***	0.017	–0.029	***	0.009	–0.084	***	0.013	
Duration<10 years	0.081	***	0.009	0.044	***	0.007	0.009		0.010	

Notes: The table reports marginal effects of a multinomial logit model, Base foreign-born population aged 15+, excluding native-born population, excluding Germany and Ireland, excluding unknown highest completed education and unknown country of birth (see section 2 for details of data construction). Low-skilled = ISCED 0-2, medium-skilled = ISCED 3,4, high-skilled = ISCED 5,6 Results for receiving country dummy variables and year 2007 not reported (see below) *(**) (***) signifies significance at 10% (5%) (1%) level, std. error – heteroscedasticity robust standard error of the estimate, 1) column presents results of a test for the significance of coefficients across skill groups: a) indicates that the coefficient of the variable for the medium-educated differs from that of the less-educated, b) indicates that the coefficient of the variable for the highly educated differs from that of the less-educated. All tests are at a significance level of 5%.
Source: EU LFS.

In addition econometric evidence indicates that the highly skilled foreign-born profit more strongly from a longer duration of stay (and thus improved integration) in the receiving country than the less skilled (see Table 3.5). The employment probability of a highly skilled migrant who has resided in the country of residence for more than 10 years is 9.7 percentage points higher than that of a migrant who has resided in the country of residence for less than 10 years. For the highly-skilled the unemployment probability is 1.7 percentage points lower and the inactivity probability is 8.1 percentage points lower. For the less-skilled the differences are 1.8 percentage points for employment –0.8 and –0. 9 percentage points for unemployment and inactivity risks. They are thus substantially smaller. Thus, the highly skilled foreign-born, who stay in the country of residence for a longer period of time have significantly higher improvements in labour market performance than less skilled[91]. The highly skilled are thus particularly likely to profit from improved integration.

Finally, gender differences in unemployment, employment and inactivity probabilities among the foreign-born are significantly higher than for all residents (although they also decrease with increasing educational attainment). This thus draws attention to the fact that female migrants (of all skill groups) must also be considered as particularly disadvantaged with respect to labour market integration.

Over-qualification

Based on reference levels of the educational attainment necessary to fulfil the tasks required in a particular occupation, over-qualification can be defined by comparing the actual level of highest completed education of a person to that required in her/his occupation. According to this definition a person is overqualified if the actual level of educational attainment is higher than that required for the occupation and under-qualified if the actual level of educational attainment is lower than that required for the occupation. Thus, over- and under-qualification is defined in terms of a characteristic of the employee relative to the occupation he/she holds. High-skilled migrants face substantially higher risks of over-qualified employment in the EU-27 than medium-skilled migrants

91 Here, another important factor may play a role: foreign-born with a longer period of residence might (and most likely will) have received part or all of the education in the country of residence and hence their qualifications will more closely match with those of natives.

Table 3.6: Foreign-born share in total population and share of total foreign-born population by receiving country and skill group

	High-skilled		Medium-skilled	
	Foreign-born	Native-born	Foreign-born	Native-born
Receiving country EU-27	33	19.4	19.4	7.7
Receiving country EU-15	33.3	20.9	19.8	7.4
Austria	29.3	22	20.0	7.3
Belgium	27.4	21.4	14.3	9.3
Denmark	25.6	13.6	14.2	8.1
Spain	57.6	32.6	31.9	7.9
Finland	30.4	17.8	13.6	9.8
France	26.2	20.1	14.6	8.3
Greece	59.5	16.8	28.6	3.0
Italy	42.1	11.6	21.2	4.3
Netherlands	19.8	13.0	7.3	2-0
Luxembourg			13.7	5.6
Portugal	23.7	11.6	15.2	5.2
Sweden	27.1	11.6	9.5	5.5
UK	24.2	22.4	16.9	10.2
Receiving country NMS	27.3	13.8	14.3	8.3
Bulgaria		20.9		12.1
Cyprus	50.7	28.6	37.4	9.9
Czech Republic	14.3	5.8	8.6	4.9
Estonia	41.7	23.6	21	9.5
Hungary		10.4		5.4
Lithuania		22.0		12.8
Latvia	29.4	15.0	15.8	12.2
Malta				
Poland		15.1		8.4
Romania		9.1		9.7
Slovenia		7.3	9.7	4.8
Slovakia		9.3		8.8

Notes: Base employed aged 15+, excluding Germany and Ireland, excluding unknown highest completed education and unknown country of birth (see section 2 for details of data construction). Low-skilled = ISCED 0-2, medium-skilled = ISCED 3,4, high-skilled = ISCED 5,6. – = data provides too few observations to be reported.
Source: EU LFS.

(see Table 3.6). According to results from the EU LFS 19.4% of the native-born high-skilled employed in the EU-27 (excluding Germany and Ireland) were over-qualified, as against 33.0% of the high-skilled foreign-born. Both native and foreign-born highly skilled women have substantially higher rates of over-qualification (20.7% of native women and 34.9% of foreign-born women) than men (18.1% of natives and 31.2% of foreign-born).

For the medium-skilled, levels of over-qualification, by contrast, are substantially lower both for the foreign-born and for natives. On the average for the years 2006 and 2007 around 7.7% of the natives with an educational level equivalent to ISCED 3 or 4 were over-qualified for their occupation in the EU-27. Among the foreign-born the equivalent share was 19.4%. As with high-skilled workers, over-qualification among medium-skilled female workers is substantially higher than among males. While the over-qualification rate for native-born women in the EU-27 amounted to 8.4% in the EU-27 and was thus only 1.2 percentage points higher than that of men, for foreign-born medium-skilled women the gender gap amounted to 9.7 percentage points (men 15.2%, women 24.9%) (cf. Table 3.6a).

In addition econometric results from regressions similar to those in the previous section (see Table 3.7) show that:

(1) The probability of over-qualification is lower for migrants born in the EU-15 than for natives. The risk of over-qualified employment is 2.9 percentage points (for high-skilled) and 1.2 percentage points (for medium-skilled) lower than for a native, when the migrants were born in other EU-15 countries. Thus migrants born in the EU-15, provided they find work, seem to face few problems in transferring human capital across national borders.

Table 3.6a: Share of overqualified workers in total employment by gender, skill group and receiving country

	High-skilled				Medium-skiled			
	Foreign-born		Native-born		Foreign-born		Native-born	
	Male	Female	Male	Female	Male	Female	Male	Female
Receiving country EU-27	31.2	34.9	18.1	20.7	15.2	24.9	7.2	8.4
Receiving country EU-15	31.6	35.2	19.2	22.6	15.6	25.2	7.2	7.7
Austria	27.0	32.2	26.1	15.7	14.9	26.3	7.2	7.4
Belgium	23.7	31.7	18.5	24.2	13.6	15.2	8.3	10.7
Denmark	26.0	25.2	14.5	12.8	12.9	15.4	9.0	6.8
Spain	56.9	58.5	33.7	31.4	22.3	43.7	7.3	8.6
Finland	-	37.9	13.5	21.1	(11.8)	-	7.3	12.9
France	23.3	29.7	16.4	23.4	9.4	21.9	5.9	11.3
Greece	59.7	59.3	16.7	17.0	14.8	46.0	2.6	3.5
Italy	42.9	41.5	9.1	14.2	13.3	31.4	4.4	4.1
Luxembourg	(3.0)	(6.2)	-	-	(3.9)	11.8	2.2	(1.6)
Netherlands	18.3	21.4	11.5	14.8	12.1	15.4	6.3	4.9
Portugal	23.5	23.8	10.0	12.7	9.9	21.0	4.4	5.9
Sweden	30.1	24.5	12.3	11.1	8.6	10.5	4.9	6.3
UK	21.8	26.7	19.0	26.0	18.6	14.7	11.8	8.0
Receiving country NMS	24.5	30.0	13.8	13.8	9.2	20.3	7.2	9.8
Bulgaria	-	-	23.6	19.2	-	-	11.6	12.8
Cyprus	36.8	60.2	24.0	33.1	22.0	49.0	10.8	8.6
Czech Republic	14.3	14.4	5.7	6.0	5.5	13.1	3.9	6.2
Estonia	44.8	39.5	23.6	23.6	14.0	27.8	6.2	13.5
Hungary	-	(18.6)	10.1	10.7	-	-	4.1	7.1
Lithuania	-	-	27.7	18.0	-	-	11.3	14.5
Latvia	29.3	29.5	17.5	13.5	11.8	19.6	11.3	13.1
Malta	-	-	-	-	-	-	-	-
Poland	-	-	15.0	15.3	-	-	6.4	11.1
Romania	-	-	9.6	8.6	-	-	10.0	9.2
Slovenia	(10.8)	-	7.8	7.0	(6.0)	(16.0)	3.8	6.2
Slovakia	-	-	9.7	8.9	-	-	8.3	9.5

Notes: Base employed aged 15+, excluding Germany and Ireland, excluding unknown highest completed education and unknown country of birth (see section 2 for details of data construction). Low-skilled = ISCED 0-2, medium-skilled = ISCED 3,4, high-skilled = ISCED 5,6 Values in brackets have a low reliability. – = data provides too few observations to be reported.
Source: EU LFS.

(2) High-skilled migrants from the new Member States face a substantially (namely 29.6 percentage points) higher risk of being over-qualified than natives. Medium-skilled migrants from the NMS have an over-qualification risk 19.6 percentage points higher than that of natives. Migrants born in the NMS thus belong to the groups of migrants with the greatest difficulties in transferring human capital across borders.

(3) For most other sending country groups the over-qualification risk is 10 to 20 percentage points higher for highly skilled migrants than for highly skilled native workers and 3 to 7 percentage points higher for medium-skilled migrant workers.

(4) Comparing the magnitude of over-qualification between high- and medium-skilled foreign-born, highly skilled foreign-born have substantially larger problems in transferring human capital across border than medium-skilled workers.

Furthermore, results of further regressions (not reported here) suggest that the over-qualification risk reduces more substantially with increasing duration of residence for highly skilled than for medium-skilled foreign-born. Highly skilled foreign-born who have lived in a country for more than 10 years, experience a reduction in their over-qualification risk of approximately 15.4 percentage points. For medium-skilled migrants this effect is more modest. Finally, migrant workers face particularly higher over-qualification risks in agriculture and energy & construction.

3.6. Migration and productivity

Whether there is a relationship between migration and productivity is likely to depend on the attributes that migrants possess relative to native workers. In part, this may be determined by domestic immigration policy

Table 3.7: Regression results for the probability of over-qualified employment

	High-skilled		Medium-skilled	
	marginal effect	standard error	marginal effect	standard error
Female	0.064***	0.003	0.011***	0.001
Age 25-44	–0.155***	0.006	–0.041***	0.001
Age 45+	–0.174***	0.004	–0.050***	0.001
		Sending country		
Native-born	Reference category		Reference category	
EU-15	–0.029***	0.007	–0.012***	0.002
NMS	0.296***	0.017	0.192***	0.010
Other Europe	0.350***	0.015	0.148***	0.006
Turkey	0.188***	0.038	0.066***	0.012
North Africa	0.157***	0.021	0.051***	0.010
Other Africa	0.105***	0.014	0.043***	0.008
South & Central America	0.194***	0.019	0.177***	0.013
East Asia	0.103***	0.032	–0.001	0.009
Near and middle East	0.168***	0.021	0.025***	0.008
South and southeast Asia	0.123***	0.013	0.063***	0.008
US, Australia and Oceania	–0.079***	0.017	–0.040***	0.005
		Sector of employment		
Agriculture and Mining	Reference category		Reference category	
Manufacturing	–0.155***	0.003	–0.030***	0.001
Energy and Construction	–0.122***	0.004	–0.019***	0.001
Market services	–0.216***	0.005	–0.057***	0.001
Non market services	–0.363***	0.007	–0.052***	0.001

Notes: The table reports marginal effects of an ordered logit model, Base foreign-born employed aged 15+ excluding, excluding Germany and Ireland, excluding unknown highest completed education and unknown country of birth (see section 2 of the main report for details of data construction) medium-skilled = ISCED 3,4, high-skilled = ISCED 5,6. Results for receiving country dummy variables and year 2007 not reported (see below). *(**) (***) signifies significance at 10% (5%) (1%) level, standard error – heteroscedasticity robust standard error of the estimate.
Source: EU LFS.

– more selective policies enable governments to identify specific skills and professions that are required in the domestic labour market. This section estimates the impact of various aspects of migrant labour on productivity at industry level across EU countries, taking into account skills and interactions with technology and differentiating sources of migration. The paucity of empirical evidence should be noted in this regard, particularly with respect to differentiating labour types and their interaction with technology.

Using data from EU KLEMS[92] and the EU LFS, the contribution made by migrant labour to productivity growth in the EU is explored. The qualities that migrant workers bring are diverse, largely dependent on their home country. Here, an industry perspective is adopted. Data is available at the NACE (Rev. 1.1) sectoral breakdown for the period 1995-2004 as shown in Table 3.8.

First, a description of migration trends at sectoral levels is presented. Our analysis considers a division of migrant labour into those from the EU and those from the rest of the world (ROW). The EU here is defined as the EU-15 since the data covers the period prior to the 2004/2007 EU expansion. It is well documented that migrants tend to be concentrated in certain industries (cf. Mas et al., 2008). Taking a sectoral perspective, Figure 3.4 shows the extent to which, at aggregated EU level, sectors are dominated by skill types. Figure 3.4 reveals that, in terms of the proportion of total employment, construction, hotels and restaurants, business services (70 and 71t74) and private households are sectors with significant proportions of migrants. In these sectors, the proportion of low-skilled migrants accounts for at least half of total migrants, except in business services, where higher-skilled migrant workers are relatively important. Conversely, sectors where migrants play a relatively minor role are fishing, energy and public administration and defence.

The importance of low-skilled migrants in some sectors, such as construction, is not surprising, but it is perhaps

92 More information on this research data base can be found in Timmer et al. (2008) and the data is available from www.euklems.net.

Table 3.8: Sectors available in EU LFS

	Code	Description
1	A	Agriculture
2	B	Fishing
3	C	Mining
4	15t16	Food, drink and tobacco
5	17t19	Textiles and textile products, leather and footwear
6	21t22	Pulp, paper, paper products, printing and publishing
7	23	Coke, refined petroleum products and nuclear fuel
8	24	Chemicals and chemical products
9	25	Rubber and plastics
10	26	Other non-metallic mineral products
11	27t28	Basic metals and fabricated metal products
12	29	Machinery n.e.c.
13	30t33	Electrical and optical equipment
14	34t35	Transport equipment
15	36t37	Manufacturing nec; recycling
16	E	Energy/utilities
17	F	Construction
18	G	Wholesale and retail
19	H	Hotels and restaurants
20	60t63	Transport and storage
21	64	Communications
22	J	Financial intermediation
23	70	Real estate activities
24	71t74	Renting of machinery and equipment and other business activities
25	L	Public administration and defence
26	N	Health
27	O	Other social, personal and community
28	P	Private households

more surprising to see that low skills account for such a small proportion of migrant labour in some other sectors, such as agriculture. This may be taken as evidence of over-qualification in such sector, where work is exceptionally seasonal and likely to be short-term.

A sectoral breakdown of the EU LFS data thus shows that there is a great deal of variation in the concentration and the nature of the migrant labour force. It should also be noted that there is considerable heterogeneity among the EU countries. In addition, there has been a shift from low- to high-skilled migrants in the EU (see background study). By comparison, migration growth for the rest of the world displays a positive trend in almost all countries in all periods and in all skill groups.

As a first step, the measure of multi-factor productivity (MFP) provided in EU KLEMS for each country and each industry over time is obtained. Both MFP growth and MFP levels are used, and regressed on a number of additional explanatory variables that relate to the migrant workforce, as specified below:

$$(1a)\quad \Delta LnMFP_{cti} = \alpha + \beta_1 eu\_share_{cti} + \beta_2 row\_share_{cti} + C_{it} + I_{ct} + T_{ci} + e_{cit}$$

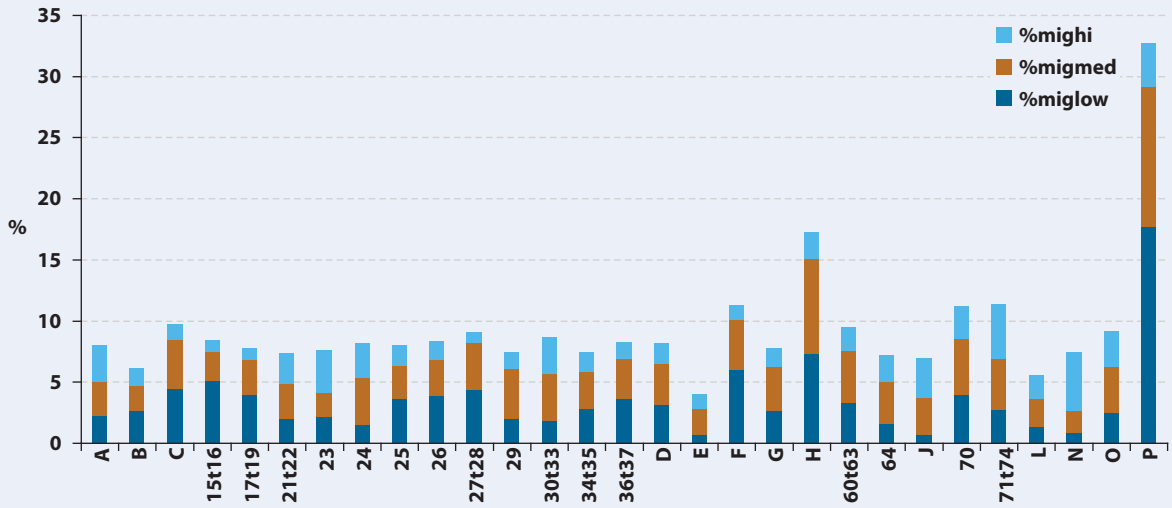
$$(1b)\quad LnMFP_{cti} = \alpha + \beta_1 eu\_share_{cti} + \beta_2 row\_share_{cti} + C_{it} + I_{ct} + T_{ci} + e_{cit}$$

where eu_share is the proportion of migrant workers in the workforce from EU countries and row_share is the rest of the world proportion for each country (c), industry (i) and year (t).

The aim is to see how far the proportion of migrants affects both productivity levels and growth. Equations 1a and 1b are estimated using standard-panel ordinary least squares (OLS), including industry, time and country dummies. A number of variants of the equation are considered, including time*country effects to take explicit account of business cycle effects, which are reported below.

As a refinement to the estimations above, a simple Cobb-Douglas production function is adopted, with value added as the dependent variable, capital differentiated in terms of its ICT and non-ICT components,

Figure 3.4: Migrant share in % of total employment by sector and skill group, 2004 ('EU total')



Source: EU LFS; EU total comprises 13 countries, Austria, Belgium, Denmark, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden, UK.

and hours worked as the labour input. In addition, the share of migrant labour differentiated by EU and ROW is included:

$$(2a)\quad \Delta LnVA_{c,t,i} = \alpha_1 + \beta_1 \Delta \ln hrs_{c,t,i} + \beta_2 \Delta \ln capit_{c,t,i} + \beta_3 \Delta \ln capnit_{c,t,i} + \beta_4 eu\_share_{c,t,i} + \beta_5 row\_share_{c,t,i} + C_{it} + I_{et} + T_{ei} + e_{cit}$$

$$(2b)\quad LnVA_{c,t,i} = \alpha_1 + \beta_1 \ln hrs_{c,t,i} + \beta_2 \ln capit_{c,t,i} + \beta_3 \ln capnit_{c,t,i} + \beta_4 eu\_share_{c,t,i} + \beta_5 row\_share_{c,t,i} + C_{it} + I_{et} + T_{ei} + e_{cit}$$

In order to take better account of the impact that migrants have on productivity, a measure needs to be incorporated to take explicit account of the skills that this subset of workers have. There are a number of ways in which this may be done. The share of high-skilled migrants is included in the specification in addition to the share in terms of numbers of migrant workers. These terms should enable us to capture both the volume and quality effects to some extent. However, a more efficient way of incorporating these two components would be to construct a labour quality measure (Timmer et al., 2008), because it would be interesting to disentangle the skills effect (high/low labour quality) from the labour-type effect (migrant/non-migrant).

Another refinement to the estimation is to incorporate a measure of the interaction between ICT and high-skilled migrant labour. This term is added to the estimated models in order to explore the extent to which migrant labour allows for better utilisation of these new technologies, since they may bring to the labour market additional knowledge and know-how not captured in the skills measure. Table 3.9 below outlines the variables included in the specifications and how they have been constructed.

In summary, the level estimates appear stronger than the growth estimates. Thus, the ratio of migrants to total employment is negatively related to sectors where productivity levels are higher, but are not significantly positively related to growth in productivity. When considering a simple share of migrant labour in total labour by industry, country and year, it is found that the impact is negative for levels of MFP and value added. In growth rate specification the impact is positive. Tables 3.10 and 3.11 outline some of the key findings in relation to the whole dataset.

It is important to distinguish between EU and ROW migrants, since the productivity effects of these two groups of migrant workers appear to operate in opposite directions, with the EU effect being negative. This is likely to be influenced by national immigration policies geared towards the selective recruitment of ROW workers. There are much fewer restrictions on EU nationals. The correlation between EU and ROW shares of migrants is positive though small (0.05), so should not bias the findings because of multicollinearity. The highest correlation between the various migrant variables included in the productivity specifications was between the share of high-skilled migrants (hi_share) and the interaction between this and the ICT and high-skilled share variable (ict_int) at 0.54. These terms are not included together in any one specification. It should be noted that the breakdown of migrants into ROW and EU is crude; ROW includes workers from technology-leading as well as

Table 3.9: Variables included in the econometric analysis

Name	Description	Calculation
va	Value added	From EU KLEMS
lnva	logged value added	Ln(va)
dlnva	logged value added growth	d.ln(va)
mfp	Multifactor productivity calculated in EU KLEMS – quality adjusted	From EU KLEMS
lnmfp	Logged mfp	Ln(mfp)
dlnmfp	Logged mfp growth	d.ln(mfp)
ict_ratio	Ratio of ICT capital to total capital (ICT+nonICT)	ict_ratio=capitlev/(capitlev+capnitlev)
ict_int	ICT ratio multiplied by the share of high-skilled migrants	ict_int=(hi_share*ict_ratio)/10
eu_share	Share of EU migrants in total employment	eu_share=(eu_hi+eu_med+eu_low)/totl_lfs
row_share	Share of ROW migrants in total employment	row_share=(row_hi+row_med+row_low)/totl_lfs
hi_share	Share of high skilled migrants in total migrant employment	Hi_share=(eu_hi+row_hi)/totl_mig
hi_share_m	Share of high skilled migrants as a proportion of share of high-skilled natives	Hi_skill_m=hi_share/(nat_hi/nat_totl)
hi_sh_nat	Share of high-skilled natives in total native employment	Hi_sh_nat=nat_hi/(totl_lfs-totl_mig)

Table 3.10: Multi-factor productivity and the impact of migrant workers, 1995-2004, EU countries, all sectors

Variables	LnMFP	LnMFP	LnMFP	dlnMFP	dlnMFP	dlnMFP
mig_share	-0.7719**			0.0979***		
	[0.3185]			[0.0345]		
hi_share	0.2422***	0.2319***		0.0034	0.0035	
	[0.0738]	[0.0731]		[0.0082]	[0.0082]	
Eu_share		-4.8824***	-4.2582***		0.1224*	0.1012
		[0.6428]	[0.6817]		[0.0706]	[0.0753]
row_share		0.7487**	0.1395		0.0891**	0.0890**
		[0.3775]	[0.4107]		[0.0411]	[0.0451]
lct_int			6.6211***			-0.0349
			[1.9925]			[0.2162]
Observations	2957	2957	2909	2697	2697	2654
R-squared	0.898	0.9	0.897	0.212	0.212	0.213
F	173.9	176.3	169.2	5.182	5.143	5.121
Rmse	0.381	0.378	0.374	0.0398	0.0398	0.0397

Source: EU KLEMS and EU LFS data, own calculations estimated on dataset excluding Luxembourg. Note that all models include time, industry, country and business cycle dummies; ***, **, * indicate 1%, 5% and 10% significance respectively.

technology laggard countries. Ideally, more disaggregated data should be available, allowing us to distinguish more specifically between nations.

A more disaggregated approach by sector also seems to tell us more about the nature of the relationship between migrants and productivity. Two sectoral disaggregations are considered, one separating manufacturing from services and another based on patterns of technological usage. The manufacturing and services split is particularly important since these are two distinct sectors that operate very differently. The share of manufacturing is generally falling in European economies, while the relative growth in services has been increasing. However, services are more difficult to measure since information on inputs and outputs is less quantifiable. It is therefore reasonable to assume that they are unlikely to operate under the same production function. When industries are grouped according to whether they use or produce ICT, there is little evidence that, in ICT – using

Table 3.11: Value added production function and the impact of migrant workers, 1995-2004, EU countries, all sectors

Variables	lnVA	lnVA	lnVA	dlnVA	dlnVA	dlnVA
Lnhrs	0.5198***	0.5194***	0.4571***	0.3309***	0.3311***	0.3302***
	[0.0267]	[0.0267]	[0.0263]	[0.0277]	[0.0277]	[0.0276]
Lnkit	-0.0350***	-0.0349***	-0.1071***	0.0435***	0.0437***	0.0432***
	[0.0118]	[0.0118]	[0.0129]	[0.0097]	[0.0097]	[0.0097]
Lnknit	0.3651***	0.3646***	0.4605***	0.1333***	0.1335***	0.1309***
	[0.0198]	[0.0199]	[0.0207]	[0.0300]	[0.0300]	[0.0300]
mig_share	-0.5504**			0.1293***		
	[0.2547]			[0.0329]		
hi_share	0.3904***	0.3900***		0.0082	0.0083	
	[0.0574]	[0.0574]		[0.0076]	[0.0076]	
Eu_share		-0.6853	-1.1060**		0.1470**	0.1334**
		[0.5113]	[0.4995]		[0.0661]	[0.0662]
row_share		-0.4894	-0.7684**		0.1215***	0.1154***
		[0.3240]	[0.3167]		[0.0416]	[0.0415]
Ict_int			23.3410***			0.3661*
			[1.7757]			[0.2029]
Observations	2987	2987	2987	2727	2727	2727
R-squared	0.935	0.935	0.938	0.332	0.332	0.332
F	278.9	276.9	289.9	9.447	9.375	9.398
Rmse	0.3	0.3	0.294	0.0376	0.0376	0.0376

Source: EU KLEMS and EU LFS data, own calculations estimated on dataset excluding Luxembourg. Note that all models include time, industry, country and business cycle dummies; ***, **, * indicate 1%, 5% and 10% significance respectively.

or producing – sectors the use of migrant labour has any significant impact on productivity in the MFP estimations or in the value added specifications.

Another interesting issue is how skilled migrant labour affects productivity, and also how such labour might interact with technology. The findings in Tables 3.10 and 3.11 suggest that there are strong positive relationships between productivity and high-skilled migrant workers and in the technology interaction. However, when looking at productivity growth the effects are much more muted and generally insignificant. This is most likely because productivity changes resulting from migrant labour operate over a much longer time frame than that measured in the growth equations, so the longer-run levels specification appears to be more able to capture the impacts. Refinements to measurement may help, and a number of possible changes to the variables and data have been explored to test how sensitive the findings are to specifications and the dimensions of the data (truncating time periods and reducing the number of countries included). Extensions to the work include adopting a more sophisticated production function, although the interpretation of the coefficients with these more flexible functional forms is less straightforward than with the Cobb-Douglas function. More sophisticated estimation techniques are also available and have been explored using the General Methods of Moments (GMM) estimation procedure. The findings from these estimates caution against placing too much emphasis on the OLS results, since the effects of migrant labour on productivity largely disappear. That said, there are reasons to suppose that GMM estimation procedures might be less suited to industry data than to microanalyses because of the dimensions of the data, which include a relatively small and diverse number of industries and not so many years. An alternative is the pooled mean group estimator (Pesaran, Shin and Smith, 1999), which has been used before (O'Mahony and Vecchi, 2005).

Policy conclusions

The impact of migration on productivity is an under-researched area, particularly in view of the increased mobility of labour in recent years. The findings in this section are mixed but are in line with other studies of the productivity impact of migrant labour (Mas et al. 2008; Paserman 2008). Some evidence is found of a significant effect of migrant labour at industry level across Europe, which differs for ROW and EU migrants, with the former displaying some evidence of a positive effect, while EU migration shows if anything a negative impact on productivity and its growth. However, this largely disappears when potential endogeneity within the production function estimates is taken into account. Thus, caution should be exercised when drawing firm policy recommendations from this exploratory research across such a diverse collection of experiences. With this in mind, however, there is some evidence to suggest that the more selective

Table 3.12: Descriptive results in %, 2005

	Share of high skilled workers			Share of migrants		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Austria	17.6	13.8	25.9	13.5	6.3	31.7
Belgium	38.4	30.8	50.9	12.1	3.2	37.0
Germany	25.7	18.5	38.8	14.1	3.2	24.5
Spain	32.2	21.9	47.8	11.4	4.0	21.4
Finland	31.5	22.4	37.3	3.6	1.3	9.6
France	25.3	16.3	41.6	9.0	2.7	31.5
Greece	19.9	13.2	29.4	6.2	2.6	12.3
Ireland	30.3	25.9	34.6	11.4	11.1	11.7
Italy	14.3	11.1	19.7	7.3	3.1	12.7
Netherlands	28.8	22.3	39.2	10.2	4.3	17.9
Portugal	13.5	9.1	22.8	7.9	3.9	14.5
Sweden	27.8	22.7	36.9	11.7	6.5	21.9
United Kingdom	29.2	20.6	49.6	7.8	2.7	43.2

Note: The means represent unweighted averages over regions.

immigration policies applying to rest of the world workers do yield a positive effect, in contrast with the indifferent findings in relation to EU migrants. There is some limited evidence that technology and the share of high-skilled migrants have a positive impact on productivity.

3.7. Effects of migration on regional GDP per capita and patenting

The relationship between (skilled) migration and economic performance at regional level is also studied. For this, data are combined from the European Labour Force Survey (EU LFS) and the Eurostat Regional data base. In particular the impact of migration on GDP per capita growth and patenting is investigated at the EU-15 NUTS 2-digit level over the period 2000-2006 using (dynamic) panel regression methods.

Some regional aspects of migration are summarized in Table 3.12, which shows the arithmetic average over regions of the share of high-skilled workers, and the share of migrants in total employed persons, together with the minimum and maximum for each of the respective indicators and each country. The first variable (share of high-skilled workers) indicates that there are quite large differences across countries. The shares range from a minimum of 13.5 percent in Portugal to a maximum of 38.4 percent in Belgium. This of course reflects specificities of the national educational systems (further note that these numbers are the arithmetic means over regions for each country). Even more important, however, is the range of high-skilled workers across regions. This range is lowest in Ireland and Italy with less than 10 percentage points, but goes up to about 25 percentage points in France and Spain and is even higher in the United Kingdom with almost 30 percentage points.

The next variable looked at is the share of migrants in total employed persons. The corresponding figures are reported in the next three columns of Table 3.12. Again, the arithmetic mean over regions for each country is reported. These average shares range from less than 4 per cent in Finland to about 14 per cent in Germany (not considering the case of Luxembourg). This partly reflects the country-specific patterns of migration already discussed above in more detail. Let us thus turn again to the distribution of these shares measured – for simplicity – by range, i.e. the difference between the maximum and the minimum as reported in Table 3.12. This range varies from little less than 10 percentage points in Finland, Greece and maybe Portugal (not considering the special case of Ireland) to more than 40 percent in the United Kingdom. Though these quite high numbers might be caused by data problems they nonetheless show that migrants within countries are highly concentrated in particular regions (at least in some countries). In many cases the highest migrant shares are observed in the capital cities or other larger urban areas. A closer examination shows that most regions exhibit migrant shares in the range between 0 and about 20 percent whereas only very few regions exhibit migrant shares larger than this. Second, between 2000 and 2005 the distribution shifted to the right, in particular for regions with migrant shares up to 20 per cent. This implies that higher migration shares can be observed in most regions.

In the econometric part, the effects of migration on regional GDP per capita growth and patents per inhabitant are studied. The following specification for regional growth is used:

$$\gamma_{it} = \beta_1 Gap_{i,t-1} + \beta_2 ShGFCF + \beta_3 ShSH_{it} + \beta_4 ShM_{it} + \beta_5 ShSHM_{it} + Dummies + u_{it},$$

where γ refers to regional GDP per capita growth by NUTS-2 region, taken from the Eurostat Regio database. GAP refers to the initial gap in GDP per capita defined as Gap=(GDP per capita/max{GDP per capita}) (where max{GDP per capita} denotes the region with highest GDP per capita in the particular year). ShGFCF is the share of gross fixed capital formation in total output, ShSH is the share of high-skilled workers (workers with ISCED levels 5 and 6), ShM is the share of migrants, and ShSHM is the share of high-skilled migrants. In another specification the difference between the shares of native high-skilled workers and migrant high-skilled workers is used, i.e. Diff=ShSH-ShSHM. The results from various specifications of a random effects model are reported in Table 3.13. Generally, the share of gross fixed capital formation and the number of patents (per million inhabitants; PTcap) turn out to be not significant in any of these specifications. Further, the gap lagged by one period is significant with the proper (negative) sign, i.e. a lowering of the gap also reduces the growth rate (catch-up growth). The share of migrants does not turn out to be significant in any case. More important, the variables of interest are significant and also show the expected sign in most cases. These are the share of high-skilled workers, and in particular the share of high-skilled migrants, or the difference, though these are only significant in specifications (1) and (2), respectively.

With respect to the size of the coefficients the results indicate that an increase in the share of high-skilled migrants (or increase in the difference) by one percentage point increases the growth rate by 0.03 percentage points. As the share of migrants and the share of high-skill migrants might be endogenous, an attempt is made to account for this using the lagged shares as instruments. The results of this exercise are qualitatively similar to those reported in Table 3.13. In particular, the share of high-skilled migrants remains significantly positive in the first two specifications.

In Table 3.14 the log of patents per million inhabitants is used as the dependent variable which is regressed on the lagged skill share, the share of migrants and the skill share of migrants or the difference variable. In the random effects specifications (1) and (2) the lagged skill share and the share of migrants are found to be highly significant and positive whereas the variables capturing high-skill migration are not significant. When allowing for a lagged dependent variable in specifications (3) and (4)[93], the share of migrants remains significantly positive. More important, the variables capturing high-skill migration are significant at the 10 percent level. However, it should be noted that the instruments used in this specification might not be appropriate[94].

93 For this we use a GMM-type estimator. Instruments in the differenced equation are the further lags of the dependent variable and first differences of the independent variables. In the level equations, the instrument used is the first lagged difference of the dependent variable.

94 The large values of the Sargan test indicating that the over-identifying restrictions are not valid.

Table 3.13: Econometric results I

	Dependent variable: Growth of GDP per capita			
	(1)	(2)	(3)	(4)
ln Gap_{t-1}	-0.035***	-0.034***	-0.048***	-0.048***
	0.001	0.001	0.001	0.001
$ShSH_t$	0.028	0.061***	0.046**	0.063***
	0.117	0.000	0.026	0.000
$ShGFCF_t$	-0.004	-0.004	-0.022	-0.021
	0.789	0.802	0.333	0.336
ShM_t	0.006	0.006	-0.004	-0.004
	0.658	0.642	0.783	0.804
$ShSHM_t$	0.033***		0.017	
	0.001		0.114	
$Diff_t$		0.028***		0.015
		0.002		0.146
$PTcap_t$			0.000	0.000
			0.995	0.992
Chi2	600.499	597.809	564.622	563.984
R2 within	0.252	0.251	0.275	0.275
R2 between	0.731	0.729	0.695	0.694
R2 overall	0.352	0.351	0.407	0.407
Obs.	1132	1132	846	846
No. of groups	194	194	187	187

z-values reported below coefficients; ***, **, * denote significance at 1, 5, and 10%, respectively. All regressions include country dummies, time dummies and a constant.

Table 3.14: Econometric results II

	Dependent variable: ln PTcap			
	Random effects		Arellano-Bover/Blundell-Bond GMM estimation	
	(1)	(2)	(3)	(4)
ln PTcap t-1			0.247***	0.251 ***
			0.000	0.000
ShSH t-1	1.688 ***	1.661 ***	1.311	1.283
	0.006	0.006	0.130	0.140
ShM t	2.043 ***	2.001 ***	1.766 ***	1.876 ***
	0.000	0.000	0.005	0.003
ShMSH t	-0.085		0.380	
	0.643		0.113	
Diff t		-0.146		0.457 *
		0.430		0.065
Chi2	633.678	634.646	179.279	179.173
R2 within	0.158	0.158		
R2 between	0.742	0.742		
R2 overall	0.712	0.712		
Obs.	850	850	832	832
Nr. of groups	187	187	184	184
Sargan			225.341	223.581

z-values reported below coefficients; ***, **, * denote significance at 1, 5, and 10%, respectively.
Specifications (1) and (2) include country dummies, time dummies and a constant; specifications (3) and (4) include time dummies and a constant.

The results suggest that an increase in the share of high-skilled workers by one percentage point will increase the patents per million inhabitants by a little less than 2 per cent. Similarly, a higher share of migrants will increase it by about 2 percentage points. With respect to the size of the coefficients, the results are in line with the findings by Hunt and Gauthier-Loiselle (2008), who perform similar regressions for the US. For this comparison one has to take into account that a yearly panel is estimated in the present analysis whereas in the paper mentioned the effects are estimated over 10-year periods. However, the results are not robust to alternative specifications or when trying to take into account potential endogeneity, heteroscedasticity of the error term, etc.

3.8. Conclusions

This study provides an overview of the extent and potential effects of high-skilled migration to the EU-27. First of all, it investigates how many high-skilled migrants live in the EU, where these migrants come from, and how the European Union is positioned in the international competition for talent. Second, it studies how high-skilled migrants fare in European labour markets. To this end, employment, unemployment and inactivity rates are analysed by skill groups as along with job-skill mismatch for natives and foreign-born workers in the EU. Finally, the issue of the effects of high-skilled migration on productivity and other measures of competitiveness is addressed at sectoral and regional levels.

It is found that – despite substantial heterogeneity among individual EU countries – high-skilled migrants are an important source of high-skilled labour in the EU-27. According to data from the European Labour Force Survey, 9.7% of the total tertiary-educated resident population (as opposed to 8.1% of total resident population) in the EU-27 is foreign-born. The share of the highly skilled among the resident population born outside the EU is 21.1%, while for intra-EU migrants it is 23% (as opposed to 17.9% for the native-born population). The foreign-born thus contribute more than proportionately to the share of the highly skilled in the EU. High-skilled migration is, however, also strongly concentrated on individual receiving countries. Around 94.2% of all highly skilled migrants in the EU-27 live in the EU-15. Only around 5.8% reside in the new Member States. The three largest receiving countries in the EU-27 (France, the UK and Spain) in all account for 57.5% of the total foreign-born population in the EU-15 (with Germany and Ireland excluded from the sample) and 63.6% of the highly skilled. The foreign-born share in the total resident population (aside from the obvious outlier of Luxemburg) is higher than 15% in Austria and Sweden but below 10% in Denmark, Greece, Italy and Portugal and even below 3% in Finland.

Immigration policy vis-à-vis high-skilled third country migrants: Increasing the skill selectivity of European migration policy

There is some evidence that – on average – EU OECD economies (EU) have a lower share of highly qualified migrants than the (arithmetic) average of the (high-

migration) non-EU OECD economies, and that the gap compared with the average of the major migration receiving countries (such as Australia, Canada, New Zealand) is larger for short-term than long-term migrants. The gap compared with the US, by contrast, was much smaller and – in many instances – not significant.

Although these international comparisons could not be conducted separately for migration flows inside the EU and from outside the EU, evidence from the European labour force survey suggests that the high-skilled share among migrants from outside the EU is lower than among migrants from within the EU, despite non-EU countries being a more important source of human capital for most EU-27 countries than migrants from within the EU.

Thus one possible policy initiative to improve the skill structure of migrants is to increasingly target highly skilled migrants in immigration laws, taking into account that only the entry and stay of highly skilled migrants from third countries (third-country nationals) can be actively steered by Member States according to their changing economic and labour market needs. The EU (e.g. Students Directive 2004/114/EC; Researchers Directive 2005/71/EC; EU Blue Card Directive 2009/50/EC) and most EU-27 countries have undertaken major steps to change immigration in this direction in recent years, which has resulted in an increasing share of high-skilled migrants settling in the EU. The European Pact on Immigration and Asylum, approved by the European Council in October 2008, calls explicitly for these efforts to be continued in the future "to increase the attractiveness of the European Union for highly qualified workers and take new measures to further facilitate the reception of students and researchers and their movement within the EU".

However, the results also suggest that this increasing selectivity of immigration regimes is offset by a relatively low qualification structure of short-term migrants in the EU. In particular, more recent migrants (in the EU for less than 10 years) from the main African, Asian and South American sending regions are less well qualified. Overall, the tertiary educated share among non-EU-born residents living in the EU-27 for less than 10 years is 20.5%, compared with 21.3% among the more established non-EU-born. For intra-EU migrants, by contrast, the share of the highly skilled among those residing abroad for less than 10 years is 25.9% (compared to 20.9% among migrants resident for more than 10 years).

Thus, the evidence also suggests that attempts to improve the qualification structure of migrants to the EU-27 are offset by an opposing tendency of increasing labour market demand for low-skilled workers that often enter the EU labour market as temporary or seasonal workers or illegal migrants. While international competition for migrants is focusing primarily on the high-skilled, comprehensive migration policies thus need to address future labour market needs across the full skill spectrum. Realistically, migration policy will thus also need to develop strategies towards less-skilled migrants. From the standpoint of competitiveness, however, highly skilled migration should be preferred over low-skilled migration.

Making the EU more attractive for high-skilled migrants

With respect to high-skilled migrants, increasing the selectivity of migration regimes alone will not suffice to attract more of them. To be fully effective, such measures have to be accompanied by increased efforts to make the European Union more attractive as a destination for highly skilled migrants. In this respect, the still fragmented nature of EU labour markets, which make both the recognition of qualifications as well as the transparent portability of entitlements to social security systems difficult even for intra-EU migrants, also act as an impediment to attracting high-skilled migrants from abroad. Thus, closer co-ordination of migration policies among the Member States with respect to highly skilled could help to increase the attractiveness of the European Union as a destination for high-skilled workers. Initiatives aiming at facilitating migrants to work within the entire EU and which focus on the highly skilled, such as the future "EU blue card" scheme (as of 2011), but also the creation of European networks with the aim of cross-linking national agencies and providing job exchange platforms are important first steps and good examples of the kinds of initiatives that could provide substantial returns, especially when the currently rather embryonic rules on intra-EU mobility are gradually further developed.

In addition, increasing the share of highly skilled migrants also has to go hand in hand with structural change in labour demand in the EU, since ultimately labour migration will only occur in sectors, occupations and regions where high-skilled labour is in high demand. Consequently, there is also a pressing need to develop migration and labour market policy for the integration and basic socio-economic rights of high-skilled migrants in co-ordination with industrial, technology and educational policies and the needs of employers dictated by structural change within the European Union.

Furthermore, results from previous literature suggest that – aside from financial considerations such as tax and social security arrangements, which may act as a deterrent to high-skilled migration – different subgroups among high-skilled migrants will be drawn to receiving countries for different reasons. Researchers for instance move abroad to keep up-to-date with the state of the art in their field, to get qualified feedback on the originality, relevance and quality of their research and as an additional source of inspiration. By contrast, political repression, social constraints, no (or only limited) access

to research funding, over-regulated bureaucracies as well as insecure conditions of employment or a generally low quality level of universities and other institutions of higher education and research deter migration by scientists and researchers. Especially for young researchers, this also holds true for rigid career advancement schemes tied to seniority instead of performance. For entrepreneurially-minded individuals, by contrast, the societal and administrative climate for innovation, business-start-ups and self-employment can play important roles (either as push or pull factors) in becoming a migrant. In this context also immigration related "soft factors", such as generous family reunification rules, may be of importance given that highly skilled persons have a tendency to marry or live together with a person having the same degree or level of education. Thus, increasing the share of highly skilled migrants, moving to the EU – aside from measures designed to make immigration laws more selective – may also involve a wide range of measures to increase the attractiveness of the EU-27 for high-skilled migrants, which may extend far into other policy fields, usually considered to be unrelated to migration policy.

Using the potentials of student mobility

One group of particular interest in this respect are students. The few results available in the literature on international student flows suggest that many EU countries have been relatively successful in attracting foreign students. This, however, seems to be mostly due to high student mobility within the EU (thus pointing to the success of programmes to enhance student mobility, such as the ERASMUS programme). With respect to student mobility from third countries and students studying in advanced research programmes, by contrast, many EU countries still seem to be lagging behind the major non-EU receiving countries. Thus, initiatives aiming to increase the attractiveness of European universities for students from third countries and for students intending to participate in advanced programmes (e.g. at Ph.D. level) could also be expected in the long run to increase high-skilled migration to the EU.

However, the success of such initiatives will also hinge on the possibility for these students to work in the receiving countries after completing their degree. In this respect success so far seems to have been rather limited, since the share of highly educated migrants working in EU countries is by and large not correlated with the number of foreign-born students studying in a country. Recently, however, a number of EU-27 countries have shifted to migration policies designed to encourage foreign-born students to remain and work in the receiving country at least for some time after they graduate and it is currently too early to evaluate how successful these measures are in increasing the skill content of migration to the EU.

Return migrants

Another group of particular interest are highly skilled emigrants from the EU who intend to return[95]. Here results from international comparisons suggest that a number of EU countries have a large share of highly educated migrants working abroad. However, the return intentions of these migrants are still an open question in international migration research. Despite this lack of research, from a policy perspective, ensuring frictionless return and encouraging models of repeat migration (i.e. brain circulation) also with non-EU partner countries are central policy concerns, which have received some attention in the recent migration debate. In particular, it is likely that return and repeat migration will become increasingly common among high-skilled migrants and that migration and labour market management systems will increasingly have to accommodate this group.

Improving the labour market integration of high-skilled third country migrants

While attracting more highly skilled migrants is an important challenge, an arguably even more important policy-relevant finding of this study is that high-skilled migrants in the EU face a number of challenges when entering the European labour market, which distinguish them from less skilled migrant groups. In particular high-skilled migrants – in contrast to less-skilled migrants – have lower labour market participation rates, higher unemployment rates and lower employment rates than comparable natives and face substantially higher risks of being employed in jobs that do not fit their skill profile.

Econometric evidence based on the EU LFS suggests that (after controlling for country of residence, age and gender) highly skilled migrants in the EU have a lower probability of being employed (by 9.3 percentage-point), a 3 percentage points higher probability of being unemployed and a 5.4 percentage point higher probability of being inactive than comparable natives. Less skilled foreign-born, by contrast, have a 2.9 percentage-point higher probability of being employed than comparable natives and face a 5.4 percentage-point lower risk of inactivity but a 1.2 percentage-point higher risk of unemployment. Thus (even after controlling for compositional effects) highly skilled – in contrast to less skilled – migrants in the EU-27 are substantially (by 9.3%) less likely to be employed than high-skilled natives. In addition according to results from the EU LFS 19.4% of the native-born highly-skilled, workers in the EU-27 (excluding Germany and Ireland) were over-qualified, as against 33.0% of the highly-skilled foreign-born. This thus points to a substantial underutiliza-

95 For example, a study for the United States concludes that high-skilled immigrants from China and India are returning to their home countries because of, among other factors, better career opportunities (see Wadhwa et al., 2009).

tion of highly-skilled foreign labour in the EU-27 due to non-employment and over-qualification.

These results thus suggest that aside from policies to attract more high-skilled migrants, there is also a need for increased efforts to integrate highly skilled migrants within the labour market. Here, aside from measures to improve foreign-language knowledge of migrants, the acceptance of professional qualifications, and training and action to fight discriminatory practices in the workplace, a number of EU-27 countries have recently adopted measures that increasingly acknowledge that improved integration requires a more broad-based approach, one backed by measures to improve the social, cultural and political integration of migrants. In such policies, national approaches are often also augmented by more regionally focused integration initiatives.

Aside from this, however, the results also point to a number of specific groups among the high-skilled that may require particular policy attention. This applies in particular to highly skilled foreign-born women. Virtually all results indicate that gender differences to the disadvantage of women with respect to employment, unemployment and inactivity as well as over-qualification rates are larger among the foreign-born than among natives. This points to the double disadvantage often faced by foreign-born women in integrating within the labour market of host societies.

A further target group for such measures, highlighted by the results, are more recent migrants. The results suggest that differences in activity, unemployment and employment as well as over-qualification rates between more recent migrants and established migrants are larger for the high-skilled foreign-born than among the low-skilled foreign-born. High-skilled migrants thus often have to accept a sizeable "transferability discount", which is documented by the high degree of over-qualification (but also by lower employment rates) found in the analysis. On the other hand low-skilled migrants find it easier to transfer their skills, which are lower in any case. Thus almost by definition high-skilled migrants are also more likely to profit from measures to ensure better labour market integration (for example by improving language proficiency and training in the host country), than the less skilled.

In addition the results indicate that highly skilled migrants from more distant destination countries also have greater problems in integrating within EU labour markets. It is thus to be expected that increased efforts to attract high-skilled migrants, which will almost by necessity also entail an increased share of migration from countries more remote from Europe (for instance Asian countries), will also have to be accompanied by increasing efforts to ensure their labour market integration.

Finally, a number of results in the literature (see Chiswick and Miller 2007, Bock-Schappelwein et al. 2009) also suggest that aside from labour market integration, the integration of foreign-born children within the school system of the receiving country requires close attention. Persons migrating in their late teens (i.e. at an age when compulsory education has ended) often end up with a substantially lower educational attainment than migrants migrating earlier or later in their lives.

Policies for high-skilled migrants within the EU

Finally, it should be noted that aside from highly skilled migrants from third countries, high-skilled migrants within the EU also often face a sizeable "transferability discount" on their human capital, which is reflected in higher rates of over-qualification and lower employment rates. This applies even to migrants migrating from one EU-15 country to another, but even more strongly to the more recent group of migrants from the new Member States to the EU-15, who are often faced with very high rates of over-qualification. According to the results high-skilled migrants from the NMS (even after controlling for differences in age and gender structure) face a 29.6 percentage points higher risk of being over-qualified than natives, and medium-skilled migrants from the NMS have an over-qualification risk that is 19.6 percentage points higher than that of natives.

While the policy instruments to reduce these substantial over-qualification rates among EU migrants clearly should follow similar lines as initiatives catering for third-country migrants (i.e. giving high priority to formal and informal transferability of qualification, language proficiency and training), the role of the European Commission in devising such policy instruments for intra-EU migrants and supervising their efficient implementation should seem to be particularly important.

Policies designed to exploit sectoral and regional allocation patterns of migrants

Our analysis regarding the impact of migration and, in particular, high-skilled migration on sectoral productivity and gross value added (levels and growth) is still preliminary (in the sense of endogeneity issues not being fully resolved), but yields a number of interesting results regarding the relationship between migration and productivity using sector-level data. Particularly interesting is the difference in the impact of the share of migrants in levels and growth specifications, as well as the importance of a break-down by different groups of migrants (from EU and RoW). There is also a relatively robust result for the positive impact of the share of high-skilled migrants and for an interactive effect between the high-skill migrant share and ICT technology. Furthermore, it is shown that

industry heterogeneity is important specifically with respect to a manufacturing versus services breakdown.

The results support the insights gained from other (country-specific) studies (see e.g. Paserman 2008). The allocation of migrants to jobs/firms/sectors is negatively related to productivity levels in these jobs/firms/sectors, but migration contributes positively to productivity growth. It is interesting to note that migrants that undergo more skill-screening (RoW migrants) do not show the negative allocation effect in the same way – in fact the effect is often positive – and that the share of high-skill migrants mostly yields positive level and growth effects. Taking these results at face value (i.e. forgetting about the still unresolved endogeneity issue), one can conclude that there is a positive relationship between migrant shares and productivity (and output) growth and that the level relationship between migration and productivity (which is an allocation effect of migrants across sectors) can be influenced through skill screening. However, one might also argue that migrants perform an important "greasing of the wheels" function (see Borjas, 2001) in that they also contribute to productivity growth in industries with lower productivity levels, which might be important in itself.

As regards the analysis of migrants and regional growth and regional technological development (proxied by patents per capita) a positive relationship is found between the share of high-skilled employed persons and high-skilled migrants and the growth rate of regional GDP per capita. Looking at patenting (per capita) as the dependent variable, a positive significant relationship with the share of migrants is also found. However, these results are not robust to changes in specifications to take potential endogeneity into account, so further work on this will be needed. There are various avenues available to deal with this issue (exploring particular instrumental variables), but the data-base has not allowed to make much progress so far. Nonetheless, the results obtained so far do point to a positive relationship between the share of high-skilled migrants and regional growth and between the share of migrants in a region and a region's patenting activity. The analysis of the dynamics of migrants' shares across regions revealed another interesting phenomenon: migrant shares (and this is also true for their shares among skilled workers) are increasing particularly in two types of regions: those where they have traditionally occupied a relatively low share – which amounts to a dispersion effect – and those where there was already a relatively high share – which is an agglomeration or network effect. The results for skilled migrant shares and regional growth (and for migrant shares and patenting) thus derive from a possible positive relationship in both types of regions. On the one hand, they might arise through an increased degree of "dispersion" which amounts again to a "greasing of the wheels" effect, and, on the other, might be due to an "agglomeration effect", taking account of possible complementarity or externality effects on the productivity of existing stocks of migrants or domestic workers. One possible way to disentangle these two effects would be to analyse the relationships separately for different groups of regions and test for complementarity effects explicitly. This will be explored in further research.

References

Ackers, L. (2005), "Moving People and Knowledge: Scientific Mobility in the European Union", *International Migration*, 43(5), 99-131.

Anderson, S., and M. Platzer (2006), "American Made: The Impact of Immigrant Entrepreneurs and Professionals on US Competitiveness", National Venture Capital Association.

Belot, M., and T. Hatton (2008), "Immigrant Selection in the OECD", CEPR Discussion Paper 6675, CEPR, London.

Benhabib, J., and M. Spiegel (2005), "Human Capital and Technology Diffusion", in: Aghion, P., and S. Durlauf (eds.), Handbook of Economic Growth, Amsterdam: Elsevier.

Bock-Schappelwein et al. (2009), "Die ökonomischen Wirkungen der Immigration in Österreich 1989-2007", WIFO, Vienna.

Borjas, G., J. Grogger, and G. Hanson (2008), "Imperfect Substitution between Immigrants and Natives: A Reappraisal", NBER Working Paper 13887, Cambridge, MA: National Bureau of Economic Research.

Borjas, G. (2001), "Does immigration grease the wheels of the labour market ?", Brooking Papers on Economic activity, 32, 69-134.

Brücker, H., and E. Jahn (2008), "Migration and the Wage Curve: A Structural Approach to Measure the Wage and Employment Effects of Migration", IZA Discussion Paper 3423, Bonn.

Chiswick, B. (2005), "High Skilled Immigration in the International Arena", IZA Discussion Paper 1782, Bonn.

Chismick, B., and P.W. Miller (2007), "The international transferability of human capital skills", IZA Discussion Paper 2670, Bonn.

Combes, P.-P., M. Lafourcade, and T. Mayer (2005), "The Trade-Creating Effects of Business and Social Networks: Evidence from France", *Journal of International Economics*, 66(1), 1-29.

D'Amuri, F., G. Ottaviano, and G. Peri, (2008), "The Labour Market Impact of Immigration in Western Germany in the 1990's", NBER Working Paper 13851, Cambridge, MA: National Bureau of Economic Research.

De Simone, G., and M. Manchin (2008), "Brain Drain with FDI Gain? Factor Mobility between Eastern and Western Europe", Manuscript, University College London.

Docquier, F., and E. Logigiani (2006), "Skilled Migration and Business Networks", Catholic University of Louvain Discussion Paper 2006-36.

European Commission (2007), "Green Paper: The European Research Area: New Perspectives", COM(2007) 161 final.

European Commission (2008), "Employment in Europe 2008".

Felbermayr, G., W. Geis, and W. Kohler (2008), "Restrictive Immigration Policy in Germany: Pains and Gains Foregone?", CESifo Working Paper 2316.

Girma, S., and Z. Yu (2002), "The Link between Immigration and Trade: Evidence from the United Kingdom", *Weltwirtschaftliches Archiv/Review of World Economics*, 138(1), 115-130.

Hunt, J. (2004), "Are Migrants More Skilled than Nonmigrants? Repeat, Return and Same employer Migrants", DIW Discussion Paper 422.

Hunt, J., and M. Gauthier-Loiselle (2008), "How Much does Immigration boost Innovation?", NBER Working Paper 14312, Cambridge, MA: National Bureau of Economic Research.

Javorcik, B.S., C. Ozden, M. Spatareanu, and C. Neagu (2006), "Migrant Networks and Foreign Direct Investment", The World Bank, Policy Research Working Paper Series 4046.

Kugler, M., and H. Rapoport (2005), "Skilled Emigration, Business Networks and Foreign Direct Investment", Economics Division, School of Social Sciences, University of Southampton, Discussion Paper Series In Economics And Econometrics.

Mas, M., M. Kangasniemi, C. Robinson, and L. Serrano (2008), "The Economic Impact of Migration – Productivity Analysis for Spain and the UK", EU KLEMS Working Paper Series, Working Paper No. 30.

Niebuhr, A. (2006), "Migration and Innovation: Does Cultural Diversity Matter for Regional R&D Activity?", IAB Discussion Paper No. 14/2006.

O´Mahony, M., and M. Vecchi (2005), "Quantifying the Impact of ICT Capital on Output Growth: A Heterogeneous Panel Approach", *Economica*, 72(288), 615-633.

OECD (2007), "SOPEMI Report – International Migration Outlook 2007", Organisation for Economic Co-operation and Development, Paris.

OECD (2008), "The Global Competition for Talent: Mobility of the Highly Skilled", Organisation for Economic Co-operation and Development, Paris.

Ottaviano, G., and G. Peri (2006), "Rethinking the Gains from Immigration: Theory and Evidence from the U.S.", NBER Working Paper 11672, Cambridge, MA: National Bureau of Economic Research.

Parsons, C. (2005), "Quantifying the Trade-Migration Nexus of the Enlarged EU: A Comedy of Errors or Much Ado about Nothing", Sussex Centre for Migration research, Sussex Migration Working Paper 27.

Paserman, D.M. (2008), "Do High Skilled Immigrants raise Productivity? Evidence from Israeli Manufacturing Firms, 1990-1999", IZA Discussion paper 3572.

Peri, G. (2005), "International Migrations: Some Comparisons and Lessons for the European Union", Mimeo, University of California, Davis.

Peri, G. (2007), "Higher Education, Innovation and Growth", in G. Brunello, P. Garibaldi and E. Wasmer (eds.), Education and Training in Europe, Oxford, Oxford University Press.

Pesaran, H., Y. Shin and R.P. Smith (1999), "Pooled Mean Group Estimation of Dynamic Heterogenous Panels", *Journal of the American Statistical Association*, 94(446), 621-634.

Quispe-Agnoli, M. and M. Zavodny (2002), "The Effect of Immigration on Output Mix, Capital and Productivity", Federal Reserve bank of Atlanta Economic Review, First Quarter, 1-11.

Timmer, M., M. O'Mahony and B. van Ark (2008), "The EU KLEMS Growth and Productivity Accounts: An Overview", University of Groningen and University of Birmingham.

Trembley, K. (2002), "Student Mobility Between and Towards OECD Countries: A Comparative Analysis", in: OECD, International Mobility of the Highly Skilled, Paris, Chapter 2, 39-67.

Vandenbussche, J., P. Aghion and C. Meghir (2006), "Growth, Distance to Frontier and the Composition of Human Capital", *Journal of Economic Growth*, 11(2), 97-127.

Wadhwa, V., A. Saxenian, B. Rissing, and G. Gereffi (2007), "America's New Immigrant Entrepreneurs", Duke University and University of California, Berkeley.

Wadhwa, V., A. Saxenian, R. Freeman, G. Gereffi, and A. Salkever (2009), "America's Loss is the World's Gain: America's New Immigrant Entrepreneurs, Part IV", Duke University and University of California, Berkeley.

CHAPTER 4
Training, education and productivity

4.1. Introduction

Remaining competitive in an increasingly globalised world requires that European nations maintain their comparative advantage in having a highly skilled labour force. Workers not only need to be skilled, but also have to adapt fast to change. On-the-job training and education are therefore important sources of long-term competitiveness and means of adjustment. Indeed, as part of its "Growth and Jobs Strategy", the EU intends to "adapt education and training systems in response to new competence requirements". The "New skills for new jobs" initiative aims to understand better how these objectives can be met. In the face of rapidly changing technology (for example, the changes brought about by information and communications technology), it is imperative that skills are appropriate and up to date. Providing basic skills is mostly the responsibility of the general education system, but changing education provision is often time-consuming. Firms or workers can instead make up for any skill shortfall by engaging in training. In times of crisis, training and education help mitigate the effects of the downturn. When people are maintained in jobs but activity is slowing down, in-house training can be an opportunity for re-training to facilitate mobility within the organisation. Training outside the firm can be a way to help workers move to other sectors or other organisations. Training is one way of improving the match between existing skills and the needs of the economy.

This chapter investigates the impact of training and education on productivity, referring in particular to a literature that emphasizes the need to reorganise production following the adoption of information and communication technology (ICT[96]). It examines training at the level of the economy as a whole and the variation across industries, focusing especially on manufacturing versus market service sectors. It also examines the characteristics of those who receive or do not receive training. It outlines the incentives that can be used to increase training uptake.

This chapter is organised as follows. It first reviews the literature on training, education, their links with the use of information technology and their impacts on productivity and earnings. Section 4.3 provides a descriptive overview of training in the EU using data from the EU Labour Force Survey (EU LFS[97]). It presents data by industry and country on the extent of training, who receives training, its duration and location, and fields of study. A sub-section also considers the training of migrants. Section 4.4 then analyses the impact of training and education on productivity and its links to ICT. This uses two complementary approaches – a growth accounting exercise that models training as intangible investments and an econometric analysis of the impact of training on productivity. Section 4.5 applies limited dependent variable regression methods to the EU LFS microdata on individuals to examine what factors characterise training recipients, including an analysis by field of training. Section 4.6 reviews the existing evidence on incentives to train, with a particular focus on older workers. Finally, section 4.7 concludes.

4.2. Training, education and productivity

The importance of education and training as drivers of firm performance has long been recognised in both human resource management and economics. Workplace learning and continuous improvement are considered essential for an organisation to remain competitive (Salas and Cannon-Bowers, 2001). When training does result in improvements in relevant knowledge and the acquisition of relevant skills, employee job performance should improve, provided that the skills learned in training transfer to the job (Baldwin & Ford 1988). According

96 ICT assets correspond to office and computer machinery, communication equipment, and software.

97 European Commission, Eurostat, European Union Labour Force Survey, quarterly data. Eurostat has no responsibility for the results and conclusions which are those of the researchers.

to Ostroff and Bowen (2000), employees' collective attitudes, behaviour, and human capital should influence organisational performance. In turn, organizational performance should lead to positive financial outcomes for the organisation (Becker and Huselid, 1998), mediating the relationship between human resource outcomes and financial performance. In general, research finds that workplace training promotes good working practices. For example, Krueger and Rouse (1998) find that training is positively associated with the incidence of job bids, upgrades, performance awards, and job attendance.

Training is all the more important for carrying out the reorganisations that come with the development of new technology. Countries may adopt and utilise technologies differently, depending on their skill endowments (Lewis 2005, Acemoglu 1998). Much research effort has been devoted to the issue of whether technical change is skill-biased (i.e. favours the more skilled workers) and to the impact of information and communications technology (ICT) on the demand for skilled labour (e.g. Bartel and Lichtenberg 1987, Autor, Katz and Krueger 1998, Machin and van Reenen 1998). Recent work shows that there is growth in both high-skilled occupations and low-skilled occupations, with declining employment in the middle of the distribution (Goos, Manning and Salomons, 2009). The implication is that there is a parallel increase in two opposite categories: high-paid on the one hand and in low-paid on the other hand. This is explained mainly by the fact that technologies are more pervasive and the use of non-routine tasks is also more spread. In a similar vein, research has highlighted that organisational changes and other forms of intangible investment such as workforce training are necessary to gain significant productivity benefits from using ICT (Bertschek and Kaiser 2004, Bresnahan, Brynjolfsson and Hitt 2002, Brynjolfsson, Hitt and Yang 2002, Black and Lynch 2001). Helpman and Rangel (1999) argue that technological changes may lead to an initial slow-down because the diffusion process requires more education or training. Thus the overall skills of the workforce have to be increased to ensure successful diffusion, whereby firms will have to replace their unskilled workers with those who are more skilled or have higher educational qualifications. The literature on technology and organisational capital suggests that an important element of organisational change is retraining of the workforce.

There are many studies that find a positive association between workplace training and productivity (Bartel 1994, Black and Lynch 1996, Conti 2005; Dearden et al. 2006, Vignoles et al. 2004, Zwick 2006). In one of the first papers on this issue, Bartel (1994) finds that there is a positive association between training and labour productivity in US manufacturing firms. Deardon et al. (2006) find that the impact of training is about twice as high on productivity as on wages, which they interpret as suggesting external benefits from training not captured by workers. Konings and Vanormelingen (2009) use panel data on Belgian private sector firms and confirm that the impact of training is higher on productivity than on wages (after having controlled for the potential endogeneity of training). The productivity premium of a trained worker is 23%, while the wage premium of training is 12%. The former is found to be strong and significant. This is slightly lower than Dearden. But their observations are at firm level and not at sectoral level. Therefore Konings and Vanormelingen do not capture spillovers. The work also differentiates the various industries and in the majority of sectors the impact on productivity higher than on wages.

In addition it is important to emphasise that training and education are important but not sufficient for productivity growth (Mayhew and Neely 2006). How much (if any) impact training has depends on the accompanying product and production strategies of the organization in which the training takes place. Ballot et al. (2006) use firm-level panel data to analyse the shares of firms and workers in returns on tangible (physical capital) and intangible assets[98] (training, R&D). They find that returns to firms from investing in physical capital are higher than the returns from investing in training and R&D.

Trainings are relevant if they are targeted. The literature also points to the need to distinguish the different types of training as much as possible, looking for instance at ICT training or training of different lengths. Mabey and Ramirez (2005) analyse the impact of varying training types on productivity and find the significance of the impact depends on the type of training. Lynch and Black (1998) find that the higher the proportion of off-the-job training the higher the productivity in manufacturing, whereas in non-manufacturing sectors training in computer skills will increase productivity. Plant productivity is found to be higher in businesses with more highly-educated workers or greater computer usage by non-managerial employees, while the impact of ICT adoption on productivity can only be realised if the appropriate work practice has actually been implemented (Black and Lynch 2001). Workers believe that their return on education and training will be high if firms adopt the new technology, so they will certainly invest more in their training. Moreover, firms will hire more skilled labour when adopting IT-related innovations (Bresnahan et al. 2002). Entrepreneurs will have more incentive to adopt new technology if the workforce's level of education is already high (Acemoglu 1997).

The willingness of firms to adopt ICT is subject to the relative benefits and costs involved (Hollenstein 2004). A firm will regard adoption as beneficial if it helps to lower production costs, improve efficiency and flexibility, and/or

98 "Section 4.4.1. Training as an intangible investment" clarifies the concept of intangible investment

increase product quality. Regarding the costs of adoption, the usual arguments involve: (1) direct costs of investment (Goodacre and Tonks, 1995); (2) ICT-related training and labour reshuffle costs (e.g. Leo, 2001); (3) management readjustment costs (e.g. Eder and Igbaria 2001).

There is no consensus on the impact of education on ICT adoption. Lee (2001) examines the impact of education on ICT adoption (PCs per 1000 people) using cross-section regressions for 80 countries in 1995 – 1998 and finds a significant relationship between education level and ICT adoption. He also finds that secondary and college-level education is important for adoption of ICT in a country. Furthermore, Gust and Marquez (2004) find that the level of human capital significantly influences ICT adoption (ICT expenditure as a percentage of GDP) for 13 industrial countries. In contrast, some research finds no evidence that education is associated with the diffusion of ICT (for example, see Hargittai 1999 for an investigation of the determinants of Internet connectivity (internet hosts per capita) in 18 OECD countries and Norris (2001) for Internet use in the EU-15 in 1999). Nevertheless, one should note that different dependent variables (ICT proxies) were used in the above papers and it may be natural to expect that estimates of the impact would vary.

Training can upgrade workers' skills and may thus be linked to faster adoption of ICT. Bresnahan et al. (2002) find worker skills are positively associated with ICT adoption. Hollenstein (2004) suggests that training will increase the absorptive capacity of firms and hence facilitate procedures' adoption.

There is ample evidence that training impacts on workers' earnings (see e.g. Booth 1991 and Blundell, Dearden and Meghir 1996 for the UK, and Lynch 1992 and Bartel and Sicherman 1999 for the US). A typical example is Dearden et al. 2006, who find that a 1% increase in training is associated with an increase in hourly wages of about 0.3%. Vignoles et al. (2004) find that male workers in mid-career (aged 33-42) experience the highest wage growth from training and that firms often train those workers who are more able in the first place. Training may have different impacts on workers based on their individual characteristics (e.g. age, gender and education level) and whether they work in the public or private sector. In the public sector, for example, women are found to have higher positive returns on job training than men, but returns are insignificant for young workers (Greenberg et al. 2003). Blundell et al. (1996) find that more educated people have higher chances of receiving training. It is also important to distinguish the source of funding for the training – firm-sponsored or self-sponsored? The different sponsors may have different interests in taking/providing training. Firms are more interested in investing in types of training that increase the worker productivity through skill improvement whereas workers want to see an increase in their wage rates after participating in training. In a perfect market, wage rates are equal to marginal productivity. However, imperfections in the labour market may lead to situations where workers may gain very little in terms of wage increases from the value added they create, (Ballot et al. 2006). In fact, it is now generally accepted that firms and workers jointly invest in training programmes (workers sometimes invest with reduced wages) – i.e. training is a joint decision.

Finally, macroeconomic conditions also affect the effectiveness of training. For example, training will be less effective if the unemployment rate is high – particularly for young people (Greenberg, 2003). Labour market imperfections (Acemoglu and Pischke (1999a)) also influence the level of training. In non-competitive labour markets, it is notably possible for firms to pay the workers below productivity, especially if the firm benefits from monopsony power. In that case, by increasing skills firms can also increase its profits. Compressed wage structure is justified by the fact that it is difficult for employees to find another job, but it may also be costly for companies to hire new suitable employees. Demographic trends also play a role. Numbers of studies put forward that health is increasingly important in the context of an ageing society. However, according to some authors there is no consensus on the fact that the performance of older workers is lower than younger ones. Furthermore, health is another component of human capital, besides education and training, which influences productivity. Healthier individuals, with a longer lifespan in front of them, would have greater incentives to invest in education or training as they would benefit from if for a longer time. And vice-versa, improvements in education also tend to lead to wealth improvements on average.

Having recapitulated the role of education and training as source of firms' and individuals' performance, it is essential to get a factual overview on the provision of training in the EU.

4.3. Workforce training in the EU

This section examines the prevalence of workforce training across EU countries and how training affects productivity. It uses EU LFS as the main data source, linked to data from EU KLEMS. It begins with an overview of training in the EU, considering both the quantity and quality of training provided and information on who receives training, also looking at the gender, age, skill and nationality dimensions. This is followed by estimates of the impacts of training on productivity using both growth accounting and industry panel regression analysis.

One should note that in the EU LFS, training refers to being provided with education or training during the previous four weeks. It includes both formal education being provided in the system of schools, colleges, uni-

Table 4.1: Proportion of the workforce receiving training in the past four weeks

	Total Economy		Manufacturing		Market Services	
	2003	2006	2003	2006	2003	2006
EU-26*	13.5	14.4	8.1	9.2	15.2	15.5
EU-15	15.3	16.2	9.8	10.9	16.7	17.1
NMS-11*	6.6	6.8	3.9	4.1	8.2	8.1

* Excluding Malta.
Source: EU LFS.

versities and other educational institutions and non formal provision outside these institutions.

4.3.1. Training in the EU: descriptive analysis

4.3.1.1. Proportions of the workforce receiving training

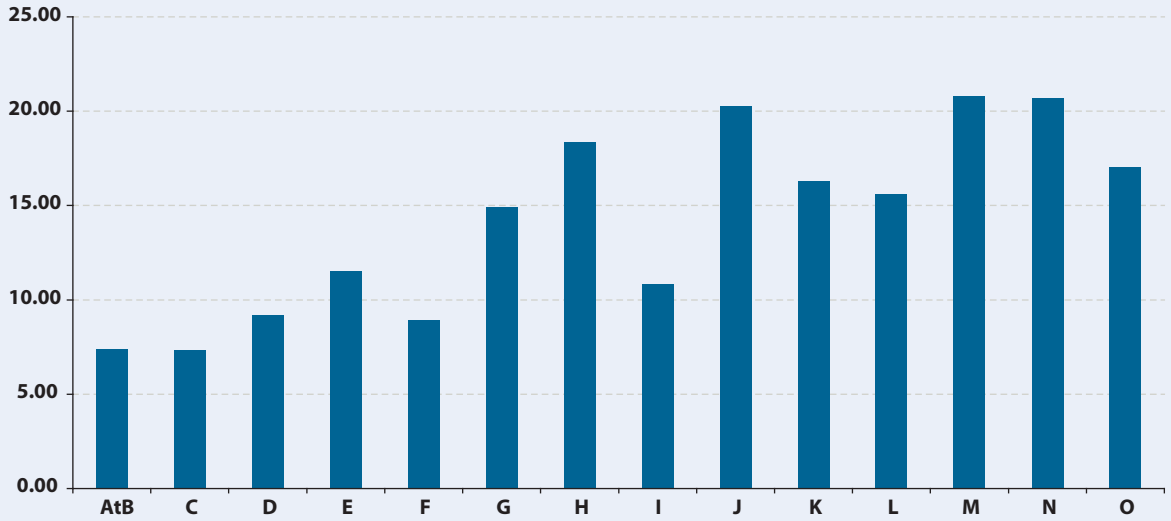
In 2006 in the EU as a whole approximately 14% of employees received some training in the four weeks prior to the quarterly survey. Training proportions are significantly higher in the EU-15 than in the new Member States and higher in market services than in manufacturing. There appears to be slightly higher growth between 2003 and 2006 in manufacturing than in market services. The figures for the EU as a whole hide large variation across countries (see Carmichael et al., 2009). The proportions are very high in the Scandinavian countries, the Netherlands and the UK, but are considerably lower in the large continental EU-15 countries: France, Germany, Spain and Italy. Some EU-15 countries (Portugal, Greece) have training rates as low as some of the smaller new Member States (NMS). Training proportions show a tendency to rise over time, which is especially apparent in countries for which long-run data are available.

Figure 4.1a shows the training proportions across industry groups in 2006 for the EU-26. It suggests that the training percentage is generally higher in service sectors than in production industries and is highest for financial services, education and health. The distribution across industries is similar in the EU-15 and the NMS, except perhaps in financial services where the NMS-11 proportion (excluding Malta) is closer to the EU-15 than for other sectors.

4.3.2. Characteristics of workers who receive training

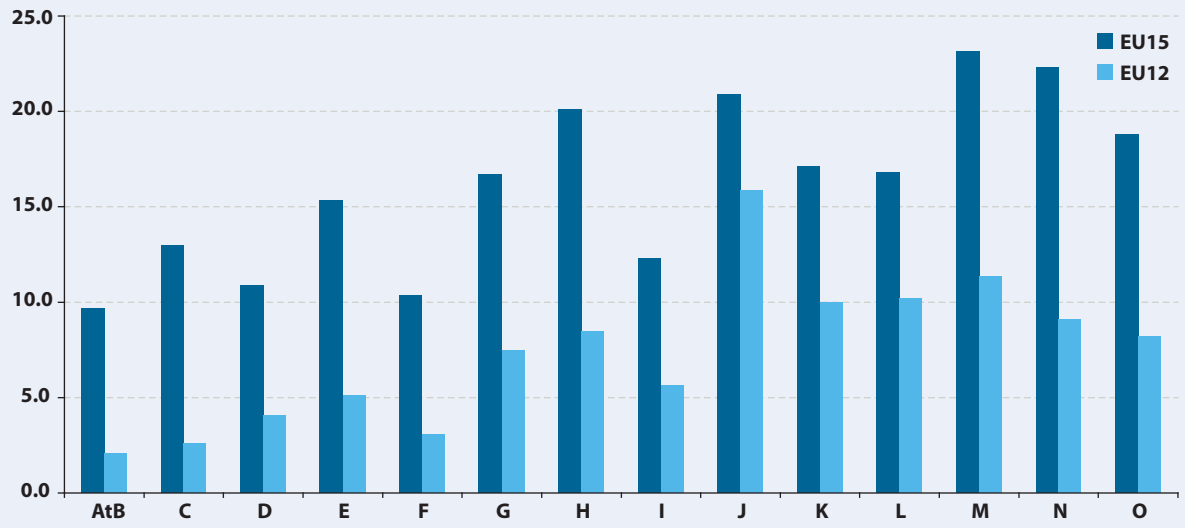
The characteristics of training recipients are considered in the following section. O'Mahony and Peng (2008),

Figure 4.1a: Training proportions by industry: EU-26*



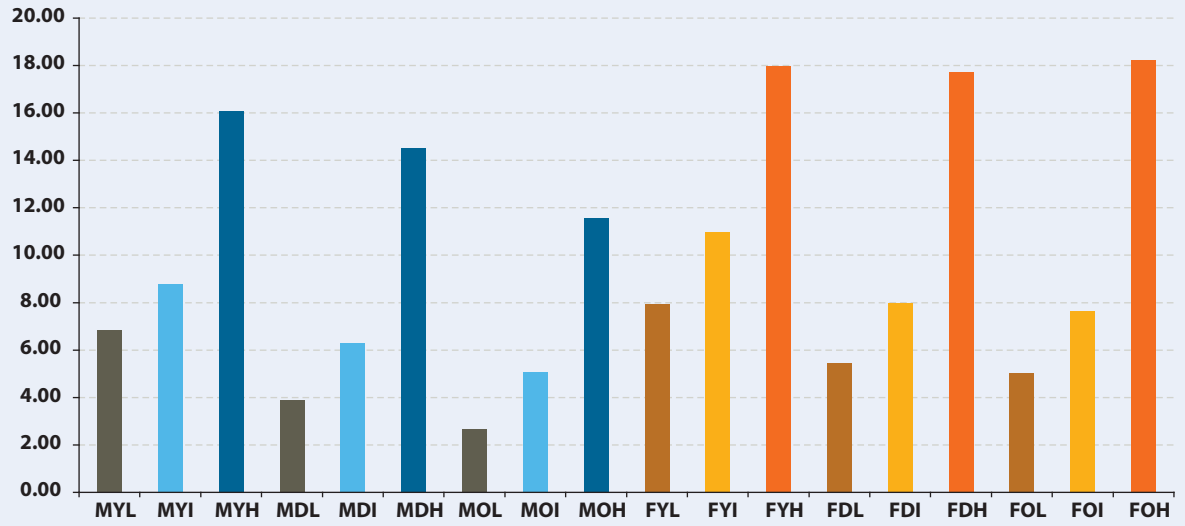
Notes: AtB = Agriculture, Forestry & Fishing; C= Mining; D = Manufacturing; E = Electricity, Gas & Water; F = Construction; G = Distribution; H = Hotels & Catering; I = Transport and Communications; J = Financial Services; K = Business Services; L = Public Administration; M = Education; N = Health and Social Services; and O = Other Personal Services.
* Excluding Malta
Source: EU LFS.

Figure 4.1b: Training proportions by industry: EU-15 and NMS-11*



Notes: AtB = Agriculture, Forestry & Fishing; C= Mining; D = Manufacturing; E = Electricity, Gas & Water; F = Construction; G = Distribution; H = Hotels & Catering; I = Transport and Communications; J = Financial Services; K = Business Services; L = Public Administration; M = Education; N = Health and Social Services; and O = Other Personal Services.
* Excluding Malta
Source: EU LFS.

Figure 4.2: Training proportions by worker characteristic EU-27



Notes: M=Males; F = Females; Y = aged 15-29; D=aged 30-49; O=aged 50+; L = low-skilled; I = intermediate-skilled; H= high-skilled.
Source: EU LFS.

using UK data, present evidence that the propensity to receive training decreases with age and increases with skill level, with males slightly less likely to receive training on average than females. Information for the EU as a whole for 2006 is summarized below, divided into 18 separate groups using the notation in the footnote to the table. Thus, for example, MOI is male, aged 50+ with intermediate level qualifications. The heights of the bars are greater on the right-hand side, indicating more females are trained than males and this is true for all age-skill combinations. The training proportion rises with skill level (from light to dark), and significantly so comparing those with university degrees or equivalent with other groups. The height of the bars also declines with age, comparing bars of the same colour, with the exception of the female high-skill group. There is a similar cross characteristic pattern in both the EU-15 and NMS-11 countries (excluding Malta), except that for

the high-skilled group in the NMS-11 (both males and females), those in the 30-49 age group are more likely to receive training than in the younger age group.

There are some differences across countries in this general pattern, with some showing far less variation across groups than others. Table 4.2 shows the coefficient of variation[99] for the training proportion across the 18 characteristic groups by EU country. In most countries the group with the lowest training intensity are low-skilled males aged 50+. In the Czech Republic and Slovenia the group least likely to be trained are low skilled females aged 50+, in Finland low-skilled young males and in the Netherlands low-skilled young females.

Table 4.2: Coefficient of variation in training proportions across 18 characteristic groups, 2006

AT	0.59	IT	0.75	CZ	0.99
BE	0.59	LU	0.47	EE	0.85
DE	0.78	NL	0.40	HU	0.88
DK	0.30	PT	0.63	LT	1.15
ES	0.55	SE	0.42	LV	0.87
FI	0.42	UK	0.35	PL	1.01
FR	0.40			RO	1.05
EL	0.89	BG	1.19	SI	0.70
IE	0.52	CY	0.76	SK	1.04

Source: Based on EU LFS data.

Similar patterns to those in Figure 4.2 are apparent for a breakdown by industry group, although the sample sizes tend to be very small for some industries. In both the EU-15 and the NMS-11 (excluding Malta), the decline in training with level of skill in manufacturing appears to be much steeper than for the economy as a whole, in particular for males.

4.3.3. Quality of training

This section considers a number of measures that yield information on the quality of training received. These include purpose of training, duration of training, whether training occurs during working hours and field of training.

These questions have only been asked since 2003 or 2004, depending on the country. Part of these EU LFS variables are optional only, so data availability is limited. The numbers presented below are hence all. The numbers presented below are all based on average values over the period 2003-2006. EU LFS respondents were asked if the purpose of training was mainly professional or mainly personal/social. In the EU as a whole 84% said the training was mainly professional. There was some small variation by type of worker – the most salient being that the low-skilled were more likely to say the training was for personal reasons (25%) as against only 14% for the highest skill group. The percentage of workers saying training was for professional reasons was similar across gender and across age groups. There were also some differences across country and industry, but in general the response rate on this question was quite low so these differences are unlikely to be significant.

A more revealing quality dimension is the average length of training, shown in Table 4.3. On average, workers who received training in the past four weeks were trained for about 12 hours or about 1.5 days in the EU as a whole. This is a significant length of time, suggesting a reasonable quality of training. There is some variation across countries with hours generally greater in the new Member States than in the EU-15. Comparison of the numbers in Tables 4.1 and 4.3 suggest an inverse relationship between length of training and percentage trained – indicating a possible trade-off between quantity and quality of training. The correlation between duration and proportions trained is significantly negative (-0.57, -0.64 and -0.49, for the EU-26, EU-15 and NMS-11, respectively).

Table 4.3: Average duration of training (hours), 2003-06

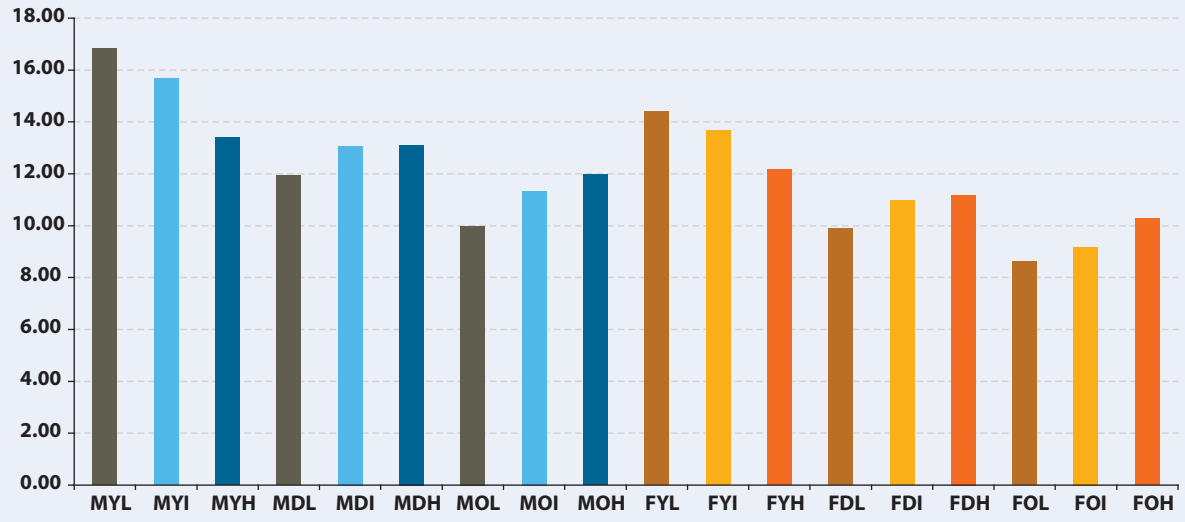
EU-26	**12.3**	FR	18.7	CY	13.9
EU-15	**12.0**	GR	22.5	CZ	11.7
NMS-11*	**15.6**	IE	13.1	EE	16.2
		IT	14.7	HU	24.1
AT	16.6	LU	16.2	LT	15.9
BE	14.8	NL	15.5	LV	16.2
DE	17.4	PT	19.6	PL	16.6
DK	15.7	SE	9.7	RO	19.8
ES	22.6	UK	12.0	SI	15.6
FI	11.5	BG	24.8	SK	15.4

* Excluding Malta
Source: EU LFS.

Figure 4.3 shows duration of training by worker characteristics. It suggests that females receive less training on average than males and that the duration of training falls marginally with skill level for the youngest age group, offsetting to some extent the reverse findings for proportions of workers trained with respect to these two dimensions. However, the duration of training falls with age, reinforcing the findings for this group in Figure 4.2 above, so both the quantity and quality of training appear to be lower for older age groups.

99 The coefficient of variation is a statistical measure of the spread of a sample (which has been normalised).

Figure 4.3: Duration of training by worker characteristics, EU-26, average 2003-06



Notes: M = Males; F = Females; Y = aged 15-29; D = aged 30-49; O = aged 50+; L = low-skilled; I = intermediate-skilled; H = high-skilled.
Source: Based on EU LFS data.

An important indicator of the commitment of firms to training, and of the cost to firms as used in the intangible investment calculations below, is the extent to which training occurs during normal working hours. The EU LFS asks respondents if their training occurred always or mostly during working hours. In the EU countries for which data were available, about 67% of respondents said training occurred wholly or mostly during working hours. Similar proportions were observed in manufacturing (70%), distribution (60%), financial and business services (72%) and health (68%), but were smaller in some sectors such as hotels (43%) and education (49%). The variation was greater across countries. In Finland, France and the UK more than 75% of training occurred during working hours. In Belgium, Ireland, Italy, the Netherlands and Poland, the proportion was about 50%, whereas in many new Member States and Greece the proportion was under 40%. However, it should be noted that this variable was not reported for many countries including Germany and Spain.

In terms of worker characteristics, all groups showed very similar proportions except low skilled young persons, who received about 50% of training outside normal working hours. This variable is the one most likely to be correlated with commitment by the firm, since the opportunity costs of lost production will be greater for those trained during working hours than for those who undertake training outside normal hours, even if the firm pays the direct costs of both. The opportunity costs in terms of production foregone are lowest for the young unskilled since they have the lowest relative earnings but they are also likely to be relatively mobile. The results suggest that the latter effect dominates.

The final quality dimension we examine is the field of training. The EU LFS divides this variable into 15 separate categories, which are given in Carmichael et al. 2009. As the response rate is also low for this question and the number of categories is large, the six groups described in Table 4.4 were aggregated. This shows that training directly related to computing is a small proportion of total training. However it should not be concluded that ICT is a minor element of training since many fields will involve some use of ICT. The table shows some differences between the EU-15 and the new Member States with language training and teacher training more prevalent in the latter and computer use and services training in the former. Science and engineering training is more common in manufacturing and social sciences, business and law in market services. Finally the summary data show only small differences by worker characteristics, although there is some indication that low-skilled older workers are more likely to be trained in computer use and less likely to receive training in science and engineering or social science, business and law.

4.3.4. Training of migrants

This section considers the training experience of migrants versus nationals. Given the transient nature of much migration it might be expected that migrants receive less training than other workers as firms are less likely to reap the benefits of training these workers. Table 4.5 shows the proportion of workers trained in 2006, cross-classified by migration status (national versus non-nationals) and skill level for the total of 17 EU countries for which data are available (EU-15 minus Greece and Ireland, plus the Czech Republic and Hungary).

Table 4.4: Training by field of study: shares of fields in total training

	EU-15	NMS-11*	EU-26	Manufacturing	Market services
General, arts and languages (000,200,222)	19.1	25.7	18.3	24.0	20.0
Social science, business and law (300)	22.2	20.5	23.8	19.0	32.6
Science and engineering (400,420,440,460,500)	9.7	11.5	9.7	20.5	8.8
Computing (481,482)	11.2	7.7	11.3	12.6	12.6
Health, veterinary, education (100,600,700)	20.0	21.2	20.6	5.7	7.2
Services (800)	16.9	12.3	16.3	18.3	18.7

* Excluding Malta
Source: EU LFS.

Looking first at the total economy, nationals are more likely to be trained than non-nationals although the difference is not large. Dividing by skill level shows that significant differences in training propensity by nationality are found only for the lowest skill group. Division by industry group highlights some interesting results. In manufacturing and market services the differences between nationals and non-nationals regarding the likelihood of receiving training is larger than for the total economy, with the largest differences again in the lowest skill group. In contrast in non-market services and especially health, non-nationals are more likely to receive training with the difference most pronounced for those with high skills. Carmichael et al. (2009) present data by country. This shows a wide variation. In Austria, France, Germany, Italy and Spain, non nationals are far less likely to receive training whereas in the UK and Denmark and the Czech Republic the training of non-nationals is significantly greater.

The EU LFS data as available for analysis do group respondents into EU nationals and others according to the EU composition of the reference period. Up to 2004, EU nationals were understood as citizens of EU-15 countries. Table 4.6 shows the proportion trained in 2004 dividing migrants into those working in an EU country who were nationals of another EU-15 country and migrants from all other countries. In total, migrants who were EU-15 nationals were marginally more likely to receive training than other migrants but this was primarily the case in manufacturing. In both market and non-market services, migrants from the rest of the world were more likely to receive training. This difference was most pronounced in the health sector and probably reflects recognition of medical qualifications among EU Member States and additional training requirements for those coming from outside the EU.

Table 4.6: Proportions of migrants receiving training: EU nationals and other, 2004

	EU-15 nationals	Rest of the world	Nationals
Total	13.5	12.3	15.6
Manufacturing	9.3	7.9	10.5
Market Services	13.4	14.6	16.5
Non-market Services	22.8	25.8	19.8
Health	*23.3*	*26.7*	*20.7*

Source: Based on EU LFS data.

Table 4.5: Training proportions by migrant status and skill, EU, 2006

	Total all workers	Total nationals	Nationals			Total non-nationals	Non-nationals		
			High skill	Medium skill	Low skill		High skill	Medium skill	Low skill
Total economy	15.5	15.7	21.2	14.2	12.7	12.5	20.1	13.6	7.2
Manufacturing	10.2	10.4	15.6	8.8	9.8	8.1	12.3	7.8	6.6
Market services	16.2	16.4	19.4	15.8	14.8	13.9	18.7	15.6	8.9
Non-market services	20.3	20.1	24.8	17.6	14.1	25.5	30.1	26.7	13.9
Health	*21.6*	*21.4*	*28.1*	*18.4*	*15.9*	*25.6*	*33.2*	*25.9*	*13.1*

Source: EU LFS.

4.4. Training, wages and productivity

This section analyses training as an intangible investment, using the information on proportions of workers trained and the duration of training to yield estimates of the values of these investments. It first sets out a description of the methodology employed – further details and sensitivity analysis are given in Carmichael et al. (2009). This is followed by a description of the importance of these intangible investments as shares of GDP. It then uses a growth accounting approach to assess the impact of intangible investments in training on output growth and compare with similar investments by individuals in general education. Another approach, an econometric one, brings new insight compared to the growth accounting approach as it allows to freely estimate the impact of training on productivity and earnings.

4.4.1. Training as an intangible investment

As noted in section 4.2, much of the recent literature on the productivity effects of new technologies emphasises the need to invest in organisational changes and other firm-specific changes in production processes in order to reap the benefits. These changes require firms to expend some resources, which collectively are termed intangible investments. The literature frequently referred to these intangible investments as the "missing input" – as intangibles are difficult to observe and measure by definition, their impact is mainly captured by the MFP component in analyses of sources of growth. The pioneering work by Corrado, Hulten and Sichel (2005, 2006) attempted to measure intangibles for the US, defining a number of categories, including software, scientific and non-scientific R&D, brand equity and firm-specific expenditure such as on-the-job training and managing organisational changes. Estimates by the above authors suggest that such investment accounts for about 11% of US GDP and have been growing rapidly. Similar studies for the UK (Giorgio Marrano and Haskel, 2006, Giorgio Marrano, Haskel and Wallis 2007), Finland (Jalava, Aulin-Amhavarra and Alanen, 2007), Canada (Baldwin et al. 2008), the Netherlands (van Rooijen-Horsten et al. 2008) and Japan (Fukao et al. 2007) also suggest that intangibles are sizeable, although most account for lower proportions of GDP than in the US.

This section analyses training as an intangible investment, using the information on proportions of workers trained and the duration of training. It first sets out a brief description of the methodology employed – further details and sensitivity analysis are given in Carmichael et al. (2009). This is followed by a description of the importance of this intangible investment as a share of outputs. Then growth accounting is used to estimate the impact of intangible investment in training on output growth.

Estimating intangible investments by firms requires a monetary valuation of the number of hours of training received by workers. Total hours trained is calculated by numbers of workers trained (proportion trained times employment) multiplied by average duration of training. These hours are then multiplied by the average hourly cost to firms. The latter requires an adjustment to account for any costs borne by the workers themselves. Hence intangible investments by firms in training in industry i, country j and time period t are calculated by:

$$TI = \frac{Nb\ of\ workers\ in\ training_{i,j,t}}{Total\ employment_{i,j,t}} * Total\ employment_{i,j,t} * \frac{Total\ nb\ of\ hours\ in\ training_{i,j,t}}{Nb\ of\ workers\ in\ training_{i,j,t}}$$

$$* Cost\ of\ an\ hour\ training_{i,j,t} * Proportion\ of\ training\ costs\ born\ by\ the\ firm_{i,j,t}$$

where TI = nominal expenditures on investments in training, the number of workers in training divided by total employment is the proportion of workers trained. The hours spent in training per worker correspond to the total number of hours in training divided by the number of workers in training. The other components of the decomposition of TI are the proportion of training costs borne by firms and the cost of an hour's training. The number of workers in training is estimated from the EU LFS data summarised in Table 4.1 above, total employment is employment from EU KLEMS and "Total nb of hours in training" is hours of training as summarised in Table 4.3. Since hours are reported for the previous four weeks, this is converted to an annual basis, allowing for time lost due to holidays and other forms of absence. Hourly costs will have two elements: the direct costs of training (costs of running courses or external fees) and the opportunity costs. The latter are estimated using the average labour compensation of employees taken from EU KLEMS. There is much less information available to estimate the direct cost. Here it is assumed that the ratio of total to opportunity costs is equal to two, which is based on UK survey data reported in Giorgio-Marrano and Haskel (2006). Finally, in a measure of intangible investments by firms it is important to exclude any cost borne by the workers themselves. Although there is no direct evidence on this it is assumed that it can be proxied by the extent to which training occurs during working hours. Training occurring outside usual hours arguably has zero opportunity cost for the firm, so the proportion of training costs borne by firms is estimated as the proportion of respondents who replied that training occurred entirely or mostly during working hours. Table 4.7 shows intangible investments as a share of value added.

Table 4.7: Intangible investments in training as a % of GDP, average 2003-06

	Total	Manufacturing	Market Services	Non-market services
EU-24*	**1.36**	**1.01**	**1.27**	**2.36**
EU-15	**1.50**	**1.15**	**1.39**	**2.54**
NMS-9*	**0.42**	**0.24**	**0.41**	**0.91**
UK	2.69	1.99	2.50	4.62
DK	2.60	2.08	2.40	4.24
NL	2.25	1.43	2.37	3.24
FI	2.22	1.59	2.14	4.01
SE	1.90	1.23	1.89	2.96
FR	1.77	1.59	1.62	2.55
DE	1.62	1.50	1.47	2.28
SI	1.30	0.66	1.48	2.32
ES	1.02	0.76	0.80	2.60
AT	0.87	0.77	0.77	1.46
BE	0.84	0.60	0.72	1.44
LU	0.82	0.60	0.84	1.18
LV	0.75	0.35	0.50	2.25
EE	0.69	0.27	0.61	2.06
PT	0.57	0.26	0.45	1.25
LT	0.51	0.25	0.51	1.41
PL	0.49	0.35	0.47	1.01
IE	0.47	0.16	0.42	1.04
CY	0.45	0.14	0.43	0.85
SK	0.36	0.13	0.42	0.82
IT	0.33	0.17	0.27	0.81
CZ	0.20	0.14	0.16	0.57
HU	0.20	0.06	0.20	0.42
GR	0.11	0.01	0.13	0.17

* Excluding Bulgaria, Malta and Romania

As industry value-added data are not available for Malta, Bulgaria and Romania, only 24 countries are included. In the EU-15, intangible investment in training represents 1.55% of GDP, more than three times the figure in the new Member States. The share is lower in manufacturing GDP than in the total economy, but the latter is heavily influenced by relatively high training propensities in non-market sectors such as health and education. The share of intangible training investments in GDP for 1-digit sectors is available in Carmichael et al. (2009). This indicates that training investments tend to be relatively high in financial services and business services but in many countries, it is also sizeable in wholesale and retail trade.

Table 4.7 also gives the results for individual countries, sorted from highest to lowest for the total economy. It shows that the UK is the country most willing to spend on training – the figure is a little higher than the share of 2.45% in 2004 estimated by Giorgio-Marrano and Haskel (2006), especially since their value-added figures include an upward adjustment to add many types of intangible investments to output. The figure for Finland is a little higher than that estimated by Jalava, Aulin-Amhavarra and Alanen, 2007, about 1.5% in 2005. In general intangible investment in training has a lower share of GDP in smaller countries and new Member States. However, the share is much smaller for Italy than for other large EU-15 countries, while the figure for Slovenia, a small new Member State, is comparable to Spain's. This is explained partly by the fact that the types of sectors that predominate in new Member States are less intensive in training. The cross-country pattern by broad sector is similar to that for the total economy, with some marginal differences in ranking – for example France ranks 4th in manufacturing but only 7th in non-market services.

In order to estimate the impact of this investment on productivity, it is necessary to transform workforce training into intangible capital. Numbers of steps are to be followed that require various assumptions: nominal series have to be derived, the nominal values are to be converted into real ones, the real investments are turned into capital stocks and capital assets are combined to estimate aggregate capital input. In the first phase one needs to convert investment values into volumes and construct capital stocks. Following the convention in the literature, introduced by Corrado, Hulten and Sichel (2005) and also used by Giorgio-Mar-

rano, Haskel and Wallis (2006), the perpetual inventory method to construct stocks, using geometric decay and a 40% depreciation rate is used. In addition this earlier literature is followed in using the GDP deflator to construct volume measures – see Carmichael et al. (2007a and 2007b) for further details. Table 4.8 shows growth in intangible training capital stocks and its contribution to value added growth. For comparison it also shows the percentage point contribution of labour composition to output growth where it is available in EU KLEMS. The labour composition effect corresponds to a change in the share of hours worked by low-skilled workers to high-skilled workers that leads to a growth of labour services which is larger than the growth in total hours worked. Labour services are labour inputs which take the heterogeneity of the labour force into account.

The results in Table 4.8 suggest that intangible capital growth from on-the-job training was very high in the period from 2001 in the EU-15 and also relatively high in the new Member States. To place this in perspective, the growth rate of real tangible physical capital in the EU-15 was only 2.5% per annum in the same period[100]. The contribution of intangible training capital in the EU-15 is only a little below the contribution from labour composition which in turn is mainly driven by up-skilling of the workforce through general education. In a number of countries, namely Denmark, Spain, Finland, France, the Netherlands, Sweden, Slovenia and the UK, these high growth rates translate into small but significant contributions to value added growth. For these countries, contributions from training are above those from labour composition in France and Denmark and around the same in Finland and the Netherlands. Interestingly, in many countries where labour composition changes are very high, e.g. Ireland, Portugal and Hungary, the contribution of intangible training capital is small.

Table 4.9 shows growth in intangible training capital and contributions to output growth by broad sector. Training capital is most important in non-market sectors – in the EU aggregates and all individual countries the contributions are greater in non-market services than in the total economies. The table also reveals that contributions are significantly higher in market services than in manufacturing in the EU and in all countries other than the Czech Republic. The growth rates of intangible training capital and contributions to value added in individual sectors are shown in Carmichael et al. (2009). These show that contributions are highest in the health sector as expected, with intangible training capital also important in financial services, business services and wholesale and retail trade.

Table 4.8: Intangible training capital and output growth, 2001-2005

	Growth in intangible training capital (% p.a.)	Contribution of intangible training capital to value added growth [1]	Contribution of Labour Composition to output growth [2]
EU-24	9.15	0.12	
EU-15	9.25	0.14	
EU-15ex [3]	9.48	0.15	0.19
NMS-9*	6.01	0.03	
AT	2.94	0.03	0.21
BE	6.68	0.06	0.16
DE	2.46	0.04	0.12
DK	5.84	0.15	0.15
ES	17.93	0.18	0.49
FI	8.67	0.19	0.26
FR	21.60	0.38	0.26
GR	20.30	0.02	
IE	8.41	0.04	0.63
IT	8.60	0.03	0.21
LU	14.06	0.12	
NL	17.91	0.40	0.48
PT	0.80	0.00	0.85
SE	5.08	0.10	0.33
UK	8.94	0.24	0.39
CY	17.16	0.08	
CZ	2.77	0.01	0.37
EE	5.14	0.04	
HU	9.07	0.02	0.93
LT	15.29	0.08	
LV	7.80	0.06	
PL	3.49	0.02	
SI	15.90	0.21	0.76
SK	8.31	0.03	

* Excluding Bulgaria, Malta and Romania
(1) Column 1 times share in value added.
(2) *Source:* EU KLEMS.
(3) Aggregate across EU-15 countries for which growth accounts are available in EU KLEMS.

The estimates above will be sensitive to the assumptions underlying equation for estimating investment in training and to the assumptions employed to capitalise these assets. These issues are discussed in more detail in Carmichael et al. (2009). An important sensitivity test is the impact of alternative depreciation rates – the results show a relatively small impact from changing the assumption for the depreciation rate.

100 This number, derived from EU KLEMS data, includes some intangible capital in the form of software; see O'Mahony and Timmer (2009) for more details of capital growth rates in the EU.

Table 4.9: Intangible Training capital and output growth, 2001-2005, by sector

	Growth in intangible training capital (% p.a.)			Contribution of intangible training capital to value added growth		
	Manufacturing	Market services	Non-market services	Manufacturing	Market services	Non-market services
EU-24	5.97	9.88	10.04	0.06	0.13	0.24
EU-15	6.03	9.97	10.13	0.07	0.14	0.26
NMS-9*	3.73	6.73	6.99	0.01	0.03	0.06
AT	2.67	3.51	6.01	0.02	0.03	0.09
BE	4.88	6.13	9.18	0.03	0.04	0.13
CY	14.03	12.89	23.00	0.02	0.06	0.20
CZ	4.54	0.99	3.92	0.01	0.00	0.02
DE	1.43	2.86	3.68	0.02	0.04	0.08
DK	2.24	6.37	6.60	0.05	0.15	0.28
EE	6.14	9.83	1.86	0.02	0.06	0.04
ES	17.90	17.17	17.89	0.14	0.14	0.47
FI	6.71	8.50	9.71	0.11	0.18	0.39
FR	23.57	23.39	19.30	0.37	0.38	0.49
GR	18.05	17.37	19.74	0.00	0.02	0.03
HU	5.38	8.28	10.53	0.00	0.02	0.04
IE	-0.80	8.06	10.16	0.00	0.03	0.11
IT	2.12	7.04	12.51	0.00	0.02	0.10
LT	16.74	20.69	11.30	0.04	0.11	0.16
LU	6.23	16.04	11.71	0.04	0.13	0.14
LV	2.79	8.06	7.28	0.01	0.04	0.16
NL	16.01	15.60	23.27	0.23	0.37	0.75
PL	0.95	4.55	5.02	0.00	0.02	0.05
PT	-5.96	-2.65	4.70	-0.02	-0.01	0.06
SE	2.65	5.22	5.77	0.03	0.10	0.17
SI	16.94	15.43	15.48	0.11	0.23	0.36
SK	4.42	7.67	8.56	0.01	0.03	0.07
UK	5.10	10.34	8.18	0.10	0.26	0.38

* Excluding Bulgaria, Malta and Romania

4.4.2. Training, wages and productivity: econometric analysis

An alternative to employing growth accounting is to use econometric methods to freely estimate the impact of training on labour productivity and to compare with impacts on multi factor productivity (MFP) and on earnings. In this section the specification employed by Hellerstein et al. (1999) to compare production function and wage equation estimation which was applied to the specific case of training by Deardon et al. (2006) are largely followed. Thus, the following log form equation for labour productivity (*lnlp*) is estimated:

$$\ln lp_{cit} = \alpha + \beta\, tr_{cit} + \gamma\, tr_{cit} \cdot \ln(capit/h)_{cit} + \mu \ln(capit/h)_{cit} + \lambda \ln(capnit/h)_{cit} + \text{labour type controls (interactions with } tr_{cit}) + \text{country, industry and time dummies}$$

where tr_{cit} is the proportion of workers receiving training in the industry i (i=1…9) of country c (c=1..17), in year t (t=1995…2005). Control variables include both ICT and non-ICT capital[101] per hour worked (*capit/h* and *capnit/h*), and workforce characteristics, namely, the proportions of male workers, workers aged 15-29, those aged between 30-49, the highly educated (*eduhprop*) and the medium-educated (*edumprop*) among total employees, and their interactions with training. In each OLS estimation country, industry and time dummies are used to control for the unobservable time-invariant effects and the business cycle.

The analysis in this section uses data for the 17 EU countries for which input, output and productivity data at industry level are available in the EU KLEMS database[102].

101 ICT capital corresponds to services flows from office and computer machinery, communication equipment, and software while non-ICT capital is based on services flows from machinery, transport equipment and non-residential buildings.

102 Austria, Belgium, Czech Republic, Denmark, Spain, Finland, France, Germany, Hungary, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Slovenia, Sweden and the United Kingdom.

This provides data on value added (VA), hours worked, labour compensation, a breakdown of capital into ICT- and non-ICT assets, and derived variables such as multi factor productivity (MFP) at industry level (O'Mahony and Timmer 2009). All these input, output and productivity variables are converted into the US dollar at 1997 values, using the volume index at industry level (also provided by EU KLEMS) and price ratios for outputs and inputs developed by Inklaar and Timmer (2008). Hence, all productivity and wage variables in regressions are comparable across countries and industries.

The panel data employed in this analysis cover nine industries, using the EU KLEMS industry division into Manufacturing (D), Electricity, gas and water supply (E), Construction (F), Trade (G), Hotels and restaurants (H), Transport, storage and communication (I), Financial intermediation (J), Real estate, renting and business activities (K), and Other community, social and personal services (O). Excluded are Agriculture, forestry and fishing (AtB) and Mining and quarrying (C) as the proportions trained in these sectors are small and variable, together with the public administration sectors such as Public administration and defence (L), Education (M) and Health and social work (N), in order to focus on the market economy.

Wage, labour and capital inputs variables are from EU KLEMS, while training and all workforce characteristics variables are from the EU LFS. The regressions are weighted by the average employee compensation share of each industry over the period 1995-2005, a standard approach in the literature to take account of industry heterogeneity.

Similar equations are estimated for multi factor productivity (*lnmfp*), which uses the standard growth accounting deducting the cost share weighted average inputs from output, and hourly wage rates (*lnw*). Labour productivity at industry level is measured as the value added per hour within the industry, while hourly wage rates at industry level are measured as labour compensation per hour within the industry. Labour and capital input variables are not included in the MFP equations as they are already accounted for in the measurement of that variable[103]. The availability of data on training varies by time period – see Carmichael et al. 2009 for details – so estimations are carried out on an unbalanced panel.

Two groups of regression results are presented. The baseline specification only considers the overall effect of training on productivity for all 17 European countries in the regression, while the more sophisticated specification involves allowing for the different education systems in European countries. Estimation was carried out using both the OLS within estimator and the Generalized Method of Moments (GMM), the latter to take account of the possibility that training and other explanatory variables in the regressions may be not strictly exogenous. The GMM approach is typically based on using lagged levels of the dependent variable as instruments for lagged first differences. However, it is very difficult to come up with the right instruments as the GMM results were not entirely satisfactory (see results of the GMM in Carmichael et al. 2009). Within OLS can corrects for certain selection and endogeneity effects that do not vary over time, hence a defendable route.

Results from the baseline specification are presented in Table 4.10 (within OLS). The first two columns in Table 4.10 use data on industry labour productivity regressed on industry training proportions (*tr*) and the ICT capital per hour interacted with training (*trlnicth*). When labour productivity is regressed on training alone the results were negative, but insignificant. The effect of training on its own is also negative in the MFP and wage equations. This is surprising given that authors such as Vignoles et al. (2004) and Dearden et al. (2006) find positive impacts. When training is interacted with ICT capital the results for labour productivity (1.217), MFP (0.404) and wage (0.273) were all positive and significant. The results in Table 4.10 suggest an important role for training when combined with ICT investments but suggests little or no benefits of training not linked to the new technology. The impact of training interacted with ICT is much higher in the labour productivity and MFP than in the wage equation consistent with the findings of Deardon et al. (2006). Therefore these results can support the idea of external benefits from training.

The within estimations also show significantly positive associations between education and productivity or wage. The proportions of workers with high (*eduhprop*) and medium education (*edumprop*) can significantly increase labour productivity and wage. And education also benefits labour productivity more than wage, while high education has a more significant effect than medium education. For instance, as the proportions of workers with high education increases by one percent, labour productivity increases by about 2.8 percent (see column 2) while wage increases by only 1.4 percent (see column 6). Moreover, as the proportions of workers with medium education increase by one percent, labour productivity increases by about 1.2 percent, and even less for wage (only about 0.36 percent). When high education proportions are interacted with the training proportion, the coefficients are negative for both labour productivity and wage, but positive for MFP. Hence, training appears to substitute for high education for both labour productivity and wage while complementing high education in MFP. Training and medium education seemingly have an opposite pattern to high education, but not all coefficients are significant.

103 See O'Mahony and Timmer (2009) for details of output, input and productivity measures at the industry level in the EU KLEMS database, and a discussion of issues in measuring productivity.

Table 4.10: Productivity, Wage and Training, Within OLS

	Lnlp		lnmfp		Lnw	
	(1)	(2)	(3)	(4)	(5)	(6)
tr	-1.617	-0.921	-2.061	-1.932	-1.762**	-1.606*
	1.901	*1.833*	*1.425*	*1.416*	*0.906*	*0.899*
tr*lnicth		1.217***		0.404***		0.273***
		0.121		*0.096*		*0.059*
lncapith	0.008	-0.159***			0.041***	0.004
	0.019	*0.025*			*0.009*	*0.012*
lncapnith	0.301***	0.292***			0.079***	0.077***
	0.031	*0.030*			*0.015*	*0.015*
tr*eduh	-4.117***	-7.509***	3.459***	3.097***	-2.221***	-2.981***
	0.980	*1.002*	*1.004*	*1.002*	*0.467*	*0.492*
eduhprop	1.966***	2.784***			1.234***	1.417***
	0.239	*0.244*			*0.114*	*0.120*
tr*edum	2.828**	1.065	-2.978**	-2.850**	0.801	0.406
	1.324	*1.288*	*1.233*	*1.225*	*0.631*	*0.632*
edumprop	0.670***	1.177***			0.248***	0.362***
	0.183	*0.184*			*0.087*	*0.090*
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1349	1349	1305	1305	1349	1349

Notes: Other age and gender control variables are examined but not presented in the table. Training interacted with age and gender show mixed results. See Carmichael et al. 2009. Standard errors are in italics. ***, ** and * denote significance at 1%, 5% and 10% levels, respectively.

To explore the training effect in different education systems, a more sophisticated specification is applied to this framework. The approach was to investigate the education and training systems characterising the various countries based on previous literature on the topic (drawing from the work of Estevez-Abe et al. (2001, Table 4.3, p. 170)) and on further interviews with researchers from the respective countries. In the "Vocational" group, vocational colleges or apprenticeships are predominant. In "Academic" countries, training is more company-based or vocational training is weak. "Mixed" types of training and education systems include both apprenticeship and vocational training. The Member States that recently joined the EU, the "new comers" are countries in transition. This last group of countries is not attached to any group as, due to the on-going changes, past experience may not be a good guide. Based on that, the education systems of the EU-15 countries are categorised into three groups: Vocational (Austria, Germany, Sweden and Finland), Academic (Italy, France, Ireland, the UK, Spain and Luxemburg) and Mixed (Belgium, Netherlands, Denmark and Portugal). Also included is a fourth group called New-comers (Hungary, Czech Republic and Slovenia)[104]. Dummy variables are created for four groups, which are interacted with training (and training interacted with ICT capital) variables. The vocational group is used as the baseline group. Since the vocational and academic groups include all big economies in the EU, they dominate the overall tendency in the estimation. The results of these regressions are shown in Carmichael et al. (2009). A summary of the coefficients on the training terms is given in Table 4.11. No group can be put forward as a better one. Nonetheless, the results highlight that certain forms of training and education system have more impact on productivity under certain conditions.

In Table 4.11, the training variable alone has no significant effect on labour productivity in the baseline vocational-oriented group and the academic-oriented countries, which is consistent with the findings in Table 4.10. These negative results may be biased by omitting the interaction with ICT capital. The effect of training alone is significantly positive in both mixed (3.412) and new member groups (4.833). Furthermore, when the training variable is interacted with ICT capital, the interaction has a significant positive effect on labour productivity in the vocational-oriented (1.447), academic-oriented (1.195) and the mixed countries (0.783), but is insignificant in new member countries. Thus, these results strengthen the findings in the baseline specification that the overall effect of training on labour productivity is not significant in those big economies while training interacted with ICT capital have positive effect on labour productivity.

The estimates for MFP and wages show a very similar pattern. In the next four columns, it is undeniable that the effect of training alone on MFP and wage is insig-

104 Estevez-Abe et al. (2001) do not categorise all countries for which data are available in this report. Based on discussions with researchers from these countries, Spain is classified in the academic group and Portugal in the mixed group.

Table 4.11: Training and Education Systems: Summary of Within OLS results

Training	Labour productivity	MFP	Wages
Vocational	0.808	-1.919	-0.779
Academic	-0.112	-1.984	-1.215
Mixed	3.412*	1.959	-0.085
New comers	4.833**	-3.251	1.824
Training interacted with ICT	Labour productivity	MFP	Wages
Vocational	1.447***	0.063	0.185***
Academic	1.195***	0.397***	0.407***
Mixed	0.783***	0.173	0.056
New comers	1.065	0.317	0.218

Notes: Full regression results are given in Carmichael et al. 2009. The coefficients presented here are the overall impacts for each group whereas the estimation in Carmichael et al. 2009 shows the incremental effects for groups 2-4 over the benchmark group 1. In order to gauge the importance of these cross group differences ***, ** and * denote significant difference relative to base (vocational) group at 1%, 5% and 10% levels, respectively.

nificant. However, the academic-oriented group shows significantly positive association with training interacted with ICT capital in MFP (0.397) and wage (0.407) estimation. Vocational-oriented countries also show a weaker, but still significantly positive effect of training interacted with ICT capital on wages (0.185), but is insignificant on MFP. Therefore, results from this sophisticated specification suggest an important role for training combined with ICT investments, especially for both vocational and academic-oriented groups, but little or no benefits of training not linked to the new technology.

Therefore, focusing on the results yields some interesting conclusions. Firstly, training alone has insignificant or even negative overall effect on labour productivity, MFP and wages. Positive effects of training alone on productivity are more evident for mixed and new member groups. Secondly, training combined with ICT capital has a significantly positive effect on productivity, MFP and wage. The academic-oriented group can benefit more from training combined with ICT capital than other groups. Finally, new Member States have no significant effects from training combined with ICT capital. It suggests that in new Member States the impact of training is not yet associated with the introduction of new technology.

4.4.3. Member States training and ICT

An alternative to looking at interactions between training and ICT in a production function is to consider the direct impact of training on the adoption and use of ICT. Cross-country, cross-industry and cross-firm analyses show how important the successful adoption of ICT is for the competitiveness of firms and the development of a country as a whole. In general, ICT is found to contribute positively to GDP growth (O'Mahony and Vecchi 2005; Oulton 2002) and firms' productivity (Matteucci et al., 2005 Gust and Marquez 2004). At the macro level, researchers have analysed the determinants for the adoption and diffusion of ICT, which include the overall educational level of the population, real per capita income, openness, industrial structure, geographical location and relative price of adoption across countries (for a detailed discussion, see Pohjola 2003). On the micro side, research is often concerned with quantifying the impact of determinants such as firm-level human capital (number or proportion of skilled labour), workplace organisation, benefits and costs of adoption, absorptive capacity induced mainly by training as well as initial human capital, competition and other firm-specific fixed effects (see Hollenstein 2003, for a survey of the literature). However, the industry or meso-level determinants of ICT adoption and diffusion are not so widely investigated due to lack of data in the past. Combining EU LFS and EU KLEMS data allows an examination of the direct link between ICT and training.

A series of industry level short-run demands for ICT is estimated using the following OLS (with fixed effects) specification, for industry i and country j:

$$(ICT/K)_{i,j,t} = TR_{i,j,t-1} + EDU_{i,j,t} + AGE_{i,j,t} + GENDER_{i,j,t} + X_{i,j,t-1} + \varphi_i + \gamma_j + \eta_t + \varepsilon_{ij\,t}$$

where ICT/K is the proportion of ICT capital, *TR* is the proportion of workers who have undertaken training during the last four weeks; *EDU* has three categories: proportions of workers with lower secondary, upper secondary and tertiary education; *AGE* comprises three categories: proportions of young (15-29), medium-aged (30-49) and older (50+) workers; *GENDER* is the proportion of male workers; *X* includes production function variables, namely log of value added, log of capital and log of employment. Industry (φ), country (γ) and year (η) dummies are included in the estimation and ε_{ijt} is the usual disturbance term.

Estimations using only the current level variables may be subject to the problem of endogeneity either because ICT investment or training decisions are made simultaneously by management. Therefore, lagged explanatory variables are used. More work is needed to deal with the simultaneity issue so the results should be interpreted with some caution. Carmichael et al. (2009) also report results when current values are used – these do not alter the conclusions. The regression results are presented in Table 4.12. The overall fit of the model is good with about 70% of the variation explained. As expected, the skill and human capital indicators are the strong predictors of ICT adoption. A one percentage point increase in the training proportion can predict about half a percentage point increase in ICT adoption. The contribution of educational attainment to ICT adoption increases substantially by education level. Age and gender profiles within an industry do not seem to have individual impacts, but there is some indication that ICT adoption is more prevalent in industries where the majority of the workers are young (aged 15 – 29). Value added is positively correlated with ICT adoption, a finding consistent with Bresnahan et al. (2002), possibly indicating that ICT adoption at industry level is related to greater success of firms within an entire industry. The level of capital investment shows no effect on ICT adoption, but the number of employees, usually an indicator of the size of an industry, has a significant negative impact on ICT adoption.

The cross-products introduced in the regression reveal that the impact of training and education is gender- and age-specific. In general, training males appears to be beneficial for ICT adoption. But the training of workers of different ages does not seem to matter, even though there is some indication that training older workers (aged 50+) is negatively correlated with ICT adoption. An interesting finding is that training provided to workers with a higher educational attainment contributes less to ICT adoption than the training provided to workers with low educational attainment. The possible reason is that the marginal benefit from training the less educated workers may be higher – they gain a greater amount of skill per training provided – than for their highly educated counterparts. Accordingly, firms which train less educated workers may increase the overall skill level of the workforce to a greater extent, which aids in the adoption of ICT.

As mentioned earlier, a higher proportion of male workers aged 50+ in a given industry is associated with a lower proportion of ICT capital. However, the most puzzling result is that a higher proportion of male workers with a higher educational attainment is also found to contribute less to ICT adoption. When these two impacts are seen together, it becomes obvious that the older male workers with a high educational attainment appear to be negatively associated with ICT adoption. O'Mahony and Peng (2008) find that ICT adoption adversely affects the wage share of high-skilled males aged 50+. They argue that faster skill depreciation, less training opportunities and less willingness to take-up training at old ages can partly explain this result. They find that older males tend to refuse training offers more frequently than younger males and females of the same age, particularly when they have higher degrees. This finding can be helpful in interpreting the puzzle. If older male workers tend to refuse more training offers, they will then be less likely to acquire modern skills, a precondition for the adoption of ICT. Firms with fewer employees with modern skills will tend to have less incentive to adopt new technology (Chander et al., 2004).

Table 4.12: ICT demand as a function of human capital (1995 – 2005) Dependent variable: ICT/K, (Number of observations = 2010)

	Coefficient	Std. Error
TRAINING	0.419***	2.72
EDU- (medium level)	0.180***	2.93
EDU- (high level)	0.143*	1.83
MALE	-0.062	-0.4
AGE- (30-49)	-0.025	-0.17
AGE- (50+)	0.355**	2.59
TRAINING * MALE	0.323***	3.43
TRAINING * AGE (30-49)	0.028	0.12
TRAINING * AGE (50+)	-0.325	-1.24
TRAINING * EDU (medium level)	-0.676***	-3.48
TRAINING * EDU (high level)	-0.315**	-2.06
MALE * AGE (30-49)	0.238	1.09
MALE * AGE (50+)	-0.384*	-1.84
MALE * EDU (medium level)	-0.260***	-3.77
MALE * EDU (high level)	-0.270**	-2.34
Adjusted R2 = 0.705		

Notes: Other control variables (value added, capital, employment) are examined but not presented in the table. ***, ** and * denote significance at 1%, 5% and 10% levels, respectively.

4.5. What affects on-the-job training

Having explored the impact of on-the-job training on productivity and wages this section focuses on what factors affect the decision of individual employees to train. There is a considerable previous literature looking at this question for a range of time periods and countries. One of the seminal papers for on-the-job training was provided by Mincer (1962), who uncovered some socio-economic patterns. These are that less on-the-job training is undertaken by women, black people, those with lower incomes and those with lower levels of education. Lynch (1992) uses the youth cohort of the US National Longitudinal Survey to explore the on-the-job training experiences of young employees. She finds that on-the-job training has a substantial impact on subsequent earnings. She also finds that females and non-white people experi-

ence a significantly lower incidence of on-the-job training. Similarly, using a 1994 survey of US employers, Lynch and Black (1998) find that employer-provided training is greater for employers with larger numbers of employees, for capital-intensive production and for employees with existing higher levels of educational attainment. Sussman (2002) focuses on various socio-economic characteristics that affect access to job-related training in Canada. Her main finding is that being too busy is the main constraint on employees undertaking additional training. Rubenson (2007) finds, using Canada's Adult Education and Training Surveys, that the strongest impact of on-the-job training is from the existing level of education of the employee. Other papers that address this issue include Krueger and Rouse (1998) and Wooden et al. (2001).

Vignoles et al. (2004) find that there is a great deal of selection by employers as to which employees are able to engage in on-the-job (lifelong) training. They use the individual-level panel data from the UK National Child Development Study (NCDS). Employers seem able to select those employees who benefit the most, in terms of their wage, from their training. This implicitly also means that those employees whose productivity can increase the most are selected for on-the-job training. The research aims to identify those demographic and economic characteristics that are, for a sample of EU countries, consistently associated with a higher probability of on-the-job training.

This question is addressed by carrying out an econometric analysis on individual-level employee data from the European Union Labour Force Surveys (EU LFS) for the years 2003 to 2007. The dependent variable is the indicator of on-the-job training, recording if the employee undertook any training in the previous four weeks. It is called EDUC4WN. The dependent variable is binary zero-one, so Probit regressions are used for the analysis and marginal (probability) effects are also reported to aid interpretation. The explanatory variables include as many demographic and economic characteristics as are important and are consistently available in the dataset. Country-specific Probit regressions are run for a representative sample of EU Member States: Austria, Belgium, Germany, Denmark, Spain, Finland, France, Italy, Netherlands, Sweden and the United Kingdom. The next sub-section reviews the EU LFS data, followed by a discussion of the economic and demographic characteristics that determine training take-up.

4.5.1. The EU Labour Force Survey data

The analysis is based on individual-level data from the EU LFS from 2003 to 2006 where only employees are selected. In this section some explanatory variables are presented along with the reasons why they are included in the regression – further details are available in Carmichael et al. (2009). For ease of exposition, the independent variables are divided into three broad categories: demographic, economic and temporal that are presented in Appendix (table 4.13 and 4.14).

The demographic characteristics relate to age, gender, marital status, education level, area of origin (relative to the urbanisation level), nationality (national or foreigner). The economic characteristics account for job tenure, number of hours worked, part-time work, work from home, looking for another job and the area in which the employee works.

The variables related to age are included in order to model the expected non-linear decline in training that occurs with age. The impact of being female on training may vary by country according to various other factors, such as the level of female participation in the labour market. Regarding urbanisation, the prior assumption is that more densely populated urban areas will have easier access to educational facilities for on-the-job training.

The job tenure variables are variables capturing the number of years an employee has been with the current employer. The probability of undertaking training is expected to increase with tenure but at a decreasing rate. It is worth noting that age is already controlled for in the Probit regressions. Temporary employees may have a higher probability of receiving training if this is self-financed but a lower probability of receiving firm-paid training. Unfortunately, the data do not show who paid for the training. Looking for another job may discourage training if it takes up too much time. Conversely, looking for another job may encourage training if it improves outside employment opportunities. The area in which the employee works is represented by the "International Standard Classifications of Occupations" which is detailed in Appendix in table 4.14. Ten binary variables (ISCO_0to9=0,1) capture one-digit categories for the European Union variant of ISCO-COM (88). With the exception of ISCO_0=1, which covers the military, the other categories can be interpreted as a rough measure of occupational status, with ISCO_1=1 the highest status and ISCO_9=1 having the lowest. These nine binary variables can also be viewed as a rough proxy for earnings, which are not available in the EU LFS datasets. The excluded control category in these regressions is the lowest status ISCO_9. No strong prior is available on the effect of these ISCO variables on the probability of training. It may be that higher status occupations are associated with more training opportunities. Conversely, those in the highest-status occupations may already have all the training required for the occupation and no further need to train. The existing literature suggests that the probability of on-the-job training should increase with the job status of the employee.

In addition some temporal dummy variables are also included. QUARTER_(1/2/3/4)=0,1 are binary variables recording the quarter corresponding to the survey reference week and are intended to capture if there is a seasonal cycle for undertaking on-the-job training. For example, QUARTER_3 may be a quarter when less on-the-job training is undertaken because employees are more likely to be on holiday. Conversely, it may be associated with a higher probability of training if employees see the holiday period as an opportunity to train. The year variables (from 2003 to 2007) are binary variables capturing the year of the interview reference week. The excluded control year is 2007, and the regression results indicate which other years have been excluded from the regression because of data unavailability.

4.5.2. Economic and demographic characteristics that determine training take-up

The analysis in this section employs a Probit estimation, details of which are given in Carmichael et al. 2009. Since EDUC4WN is a binary 0/1 variable, limited dependent variable regression rather than OLS is the appropriate statistical tool for the analysis. The estimated parameters are difficult to interpret directly, so the discussion below focuses on marginal effects which provide a measure of the change in the probability of the dependent variable due to changes in the independent variables. If the independent variables are binary, the marginal effects provide a measure for the probability of a change in these variables leading to a positive outcome for the dependent variable. For example, they indicate the change in the probability of being trained (EDUC4WN=1) for a woman as compared to a man (FEMALE=1). If the independent variables are continuous the marginal effects give the slope of these functions with respect to the probability, e.g. the estimated parameter on number of hours per week usually worked in a first job gives the change in the probability of being trained due to working an extra hour. Marginal effects can be calculated for any set of characteristics, but are most often, as here, based on the mean characteristics for the sample under analysis.

The marginal effects from country-specific Probit regressions are given in Appendix Table 4.15. The age dummies are significant in the Probit regressions for every country – the young have the highest probability of undertaking training and this probability declines, at a diminishing rate, with age. The effect of being female is mixed, associated with a lower probability of undertaking on-the-job training in Germany, Spain, France, Italy and the Netherlands, and associated with a higher probability of undertaking on-the-job training in Denmark, Finland, Sweden and the UK. These results are likely to reflect the degree of female labour market participation within each respective country. The results for marital status show no clear patterns although the parameter estimates for most countries are statistically significant but with different signs.

Having received high or medium education seems to have the effect of increasing the probability of undertaking on-the-job training when compared to having received low education for the vast majority of countries. This suggests that on-the-job training is a complement to existing educational attainment. One exception is Denmark where the results are mixed with having received medium education reducing the probability of undertaking more training and having received high education increasing this probability. The other notable exception is Germany with high and medium level of education being associated with a lower probability of undertaking on-the-job training, suggesting it may act as a substitute to compensate for lower previous educational attainment rather than as a complement.

A dense urban environment is associated in most cases with a higher probability of undertaking on-the-job training in most countries. This result seems reasonable if dense urban areas have easier geographic access to adult educational facilities. However, this pattern is not universally true, as in the cases of Spain, Sweden and the United Kingdom.

Being a foreign national is almost universally associated with a significantly reduced probability of undertaking on-the-job training. It is easy to envisage situations where nationals of the home country have better access to on-the-job training facilities. The three exceptions to this general result are Denmark, the Netherlands and the United Kingdom. In these three countries being a foreign national is actually associated with a higher probability of undertaking on-the-job training. This situation could possibly come about if Denmark, the Netherlands and the United Kingdom attract a large number of non-EU nationals who simultaneously undertake both paid work and studies, which may be explained by the existence of a large number of non-EU students in higher education. As noted above, it can also reflect the high usage of foreign workers in the health sectors in some countries, most notably the UK.

The results for the parameter estimates on tenure in the job indicate for most countries a concave function with respect to on-the-job training. It means that the probability of on-the-job training increases with the length of tenure but at a decreasing rate. This, obviously, suggests that the longer an employee has been in a job, the higher the probability of undertaking on-the-job training. It is worth noting that the effect of age was controlled for by the included age variables.

Longer usual hours of work are associated in every country with a reduced probability of undertaking on-the-job training, while the significant positive parameter esti-

mates for part-time work (except for Sweden) indicate part-time employees have a higher probability of undertaking on-the-job training. Being a temporary employee is in every country associated with a higher probability of undertaking on-the-job training. This result is evident if the temporary employment is perceived as a transitional job in expectation of obtaining better employment once the on-the-job training is successfully completed.

The impact of looking for another job varies largely by country. In some cases it is not significant, but in others it can have a significant positive or negative impact on having undertaken on-the-job training in the previous four weeks. Evidently, in some countries looking for another job is a complement to on-the-job training, while in others these two activities are substitutes.

Working from home has the almost universally strong effect of increasing the probability of undertaking on-the-job training. The flexible working practices associated with being able to work from home may be correlated with increased training opportunities. However, the results also suggest that those employees who usually work from home actually have fewer on-the-job training opportunities that those who only sometimes work from home.

The ISCO dummies capture the "status" of the occupation and are highly correlated with earnings and/or wealth. ISCO_9 (elementary occupations) is the excluded category and is the one associated with the lowest earnings. The probability of on-the-job training increases consistently from ISCO_8 to ISCO_2 (professionals). For ISCO_1 (legislators, senior officials and managers) the probability of on-the-job training is slightly lower than for ISCO_2. The parameter for ISCO_0 varies from country to country regressions, indicating different impacts on training for different national armed forces.

Finally, no systematic patterns emerge with respect to the QUARTER dummies, other than QUARTER_3 (July to September) being typically associated with a lower probability of on-the-job training.

The analysis presented was extended to take account of different systems of education provision by comparing Austria and Germany to France and the UK. In Austria and Germany the general education systems place high emphasis on vocational training whereas in France and the UK general education is recognised as being largely academic in nature. Without any prior pre-conceptions, it is investigated whether the vocational versus academic nature of education affects the probability of undertaking on-the-job training. The results of this extension are presented in Carmichael et al. (2009) and are just summarised here.

First adding a "Vocational" dummy, with the value 1 for Austria or Germany, has the effect of reducing the probability of undertaking on-the-job training. Specifically, all other things being equal, a worker in a country with a vocationally-oriented education system has on average a 3.92 percent lower probability of undertaking on-the-job training. Including interactions between the vocational dummy and other variables also yields some interesting conclusions. For example, being female in a country with a vocational education system is associated with a much lower probability of undertaking on-the-job training. Individuals in countries with vocational education systems tend to undertake more education the younger they are while those in countries with academic educational systems undertake more education the older they are. For those with an existing higher or medium level of education the probability of undertaking additional on-the-job training is actually lower in vocationally oriented countries. Against this the results for the occupational dummies suggest that in countries with vocational education systems the positive association between job status and on-the-job training is magnified.

This interesting result showing lower probabilities of training in more vocationally oriented countries could come about if much of what is taught in general vocational training in countries such as Austria and Germany needs to be learned on the job in countries where the school curriculum focuses on more academic subjects. However it could also be consistent with other explanations such as lower willingness by workers to undertake training or a proxy for different types of labour market institutions.

4.5.3. Determinants of the field of training

The analysis was further developed to explore the determinants of training participation by type or field of training. In this analysis the relationships between training field and other variables are examined in more detail: (i) educational systems (whether a country is more vocationally or more academically orientated); (ii) age; (iii) education and; (iv) gender. The sample for this part of the research was restricted to those who had attended informal training courses within the last four weeks. The research methodology involved multinomial logit estimations (see Carmichael et al. 2009 for details of the method) for which the categorical dependent variable, field of training, was constructed as follows:

Outcome 0: General: General programmes and arts; the base outcome
Outcome 1: Social Science: Social science, business and law
Outcome 2: Science: Science and engineering
Outcome 3: Computing: Computer science and use
Outcome 4: Health: Health (including agriculture and veterinary) and education
Outcome 5: Services

The data set comprises annual series (2004-2006) for the UK, France, Austria and Germany. Regressions were run including a dummy variable representing the vocation system (for Germany and Austria) and including interactions terms with this dummy variable. The independent variables included in the estimations closely mirror those in the training participation estimations, e.g. variables indicating individual characteristics (e.g. age and marital status) and controls for job- specific characteristics (e.g. tenure, temporary, part time and occupational dummies). In addition, industry-sector dummy variables for current economic activity were also included. Therefore, the sector of industry in which a company training its employees is operating is controlled for.

The results of the multinominal regressions are reported in Carmichael et al. (2009). The main conclusions that emerged are as follows. The odds ratios associated with the vocational dummy variable are consistently less than one and significant. This implies that relative to general training the odds of an individual undertaking training in any of the other fields is significantly less in the more vocationally oriented countries (Germany and Austria) compared with the more academically orientated countries (the UK and France). These differences are most pronounced for training in social sciences and are also large for science and computing. The difference is less in relation to training in health and even smaller in relation to services. These results appear to be consistent with the notion that vocational training at school level can substitute for specific skills required in the workplace.

Some interesting results also emerge regarding the demographic variables. The results indicate that the relationship between age and training participation depends to some extent on the type of training being undertaken since the impact of age varies according to training field. For example, the odds of training in social science, science and services (relative to general training) are less than 1 for all age groups over 42 (indicating that older workers are less likely to be involved in these fields of training relative to general training). However, the relative odds of training in computing and health appear to be higher for some older people below 60. The results indicate that, compared with general training, males are significantly more likely than females to undertake any kind of specialised training.

Looking at education variables, for social science and science training, educational attainment has no significant effect (at the 5% level or above) on participation relative to the base category. However, having attained a higher level of education lowers the relative odds of participating in computer-related training and having attained either an intermediate or higher level of education lowers the relative odds of participating in services training (even after controlling for industry sector). In contrast, the odds of undertaking health-related training (relative to general training) are higher for those who have attained a higher level of education.

In summary the results indicate that participation in training is conditioned by type of field of training, since, for trainees, participation in alternative training fields is not random. For example, while the overall relationship between age and training participation is clearly negative, among trainees, workers over 44 are more likely to participate in general training and training in health and computing. In contrast, younger trainees are more likely to be involved in services training although they are also more likely to be involved in general training. Female trainees are more likely than males to be involved in general training while male trainees are more likely to be involved in any kind of training other than either general training or training in health. More educated trainees are most likely to be involved in health and social science training and least likely to be involved in training in computing and services. Regardless of age, gender or educational attainment, trainees in more academically oriented countries are more likely to be engaged in non-general training than trainees in more vocationally oriented countries and the latter are more likely to be involved in general and services training than any other kind of training.

This analysis helps policy makers identify which characteristics affect the probability of undertaking on-the-job training. One must, however, be cautious in automatically assuming that more on-the-job training is to be recommended. There is the much more subtle question as to the effectiveness of on-the-job training on the efficiency of the workforce. Until the EU LFS microdata provide a measure of labour efficiency, such as the wage, this remains a challenging question to address directly.

4.6. Incentives and disincentives to train for older and less-skilled workers

This section explores reasons for lower training rates among older and less skilled workers. It sets out theoretical perspectives for incentives in terms of the costs and benefits of training and then relates these theoretical ideas to empirical evidence on barriers to training.

4.6.1. Theoretical considerations: the costs and benefits of training

According to human capital theory (Becker 1964; Mincer 1962, 1974), the decision to invest in human capital is based on cost-benefit considerations for both employers and employees, which determine their decisions on whether to offer or undertake training. For workers, the main benefits from participating in training are likely to be increased chances of promotion, greater opportuni-

ties for career development, more choice in employment and higher earnings. The latter in particular will depend on the type of job or occupation to which the training relates; higher potential earners will have more incentive for training. For unemployed workers who participate in training, the expected gains may also derive from enhanced employability. The costs of training for the individual will vary according to a number of factors, including whether or not training takes place on the job or not, whether the employer pays the direct costs of training, the duration of the training, how arduous or how difficult the training is and how much effort is involved. If training is not fully incorporated within time at work, individuals may also incur forgone or lower earnings and loss of leisure time. The net benefits of training will therefore vary according to the type of training being considered, the employment to which it is relevant, the characteristics of the individual concerned, and the duration of time over which the benefits of training can be earned and therefore compensate for costs incurred.

For employers, the benefits from training derive from expected increases in productivity leading to higher profits. Employers accrue training costs in the form of course fees, payments to instructors, supervision costs and foregone output while an employee participates in training. As these costs will vary to some extent depending on the characteristics of trainees, employers will tend to provide more training opportunities for those workers for whom they perceive the costs of training to be lower and the long-term benefits higher due to increases in productivity.

Human capital theory predicts that the extent of any net benefits from job-related training (for either or both employees and employers) will critically depend on the likely length of tenure of the employee, the return to training in terms of higher wages, and the effectiveness of training. The first two factors potentially have a negative impact on the incentives of older people to undertake training while the third also has implications for low-skilled workers of any age if their status is attributable to lower ability. Acemoglu and Pischke (1999b) offer a model where investment in general training from companies is relevant under certain circumstances. Firms have higher return to training if employees do not leave the company. They mention that high turnover countries or industries have lower training. In many European countries, it is the employer who pays for the general training.

In relation to length of tenure, the earlier any training is undertaken the greater the likely return to both trainee and employer. This is because the period during which the gains from higher productivity and the consequent flow of higher, discounted earnings are received will be longer. Since older employees have fewer years of employment to recoup any training costs (for themselves or their employer), human capital theory predicts that older workers will not only be less motivated to accept any offers of training that come their way but will also be less likely to be offered training in the first place. Against this, there is a general perception that older workers exhibit greater employment stability than younger employees, so that expected years with the firm will be synonymous with years to retirement. Also, where depreciation rates for investment in training are very high, the impact of age will be relatively minor.

Since there is a positive relationship between age and earnings (due to career progression and seniority), any forgone earnings costs associated with training will increase with age. This will act as a further disincentive for older people to train since it reduces the rate of return on such investments. However, for older workers in low-skilled jobs where there is little or no reward for seniority, age will be less of a factor in determining willingness to accept offers of training. Nevertheless, the direct costs of any training not financed by employers or the government will be higher (relative to income and wealth) for the generally less well-off, lower-skilled workers (of any age). Therefore, training costs are more likely to impact negatively on the training incentives of lower-skilled workers. However, while these costs may be similar for all low-skilled workers, the net effect on the motivation to train will be greater for older workers since, as discussed above, they have less time in which to recoup such costs.

In relation to the effectiveness of training, human capital theory predicts that lower levels of ability lead to lower productivity in the workplace and therefore that a worker with a higher ability will command a higher wage. It follows that any given human capital investment, or more specifically training, is associated with a higher rate of return (in terms of both higher productivity and higher earnings) the more able the worker. Thus if learning ability declines with age, training effectiveness, in terms of the potential gains to the employer from higher productivity and consequently higher earnings for the trainee, would be lower for older workers (as well as lower-ability workers). This would lead to both lower offers of training for older workers and less incentive for them to accept any offers that came their way. Furthermore, lower learning ability will also raise the costs of training, in terms of effort and time, for the trainee and therefore have an additional negative impact on their motivation to train. However, while it is commonly assumed that learning ability deteriorates with age, the evidence on this point is very mixed (see Wooden et al. 2001; and Waldman and Avolio 1986).

The above arguments indicate that the lower training rates observed among older people as well as less-skilled people, as outlined in section 2.1 above, are consistent with the predictions of human capital theory,

also implying that decisions to reject an offer of training may be entirely rational. Nevertheless, lower training rates will impact negatively on employability in the medium to long-term, particularly if an older person becomes unemployed, since the value of human capital depreciates. For example, Groot (1999) has estimated that the value of skill depreciates at rates of between 11 per cent and 17 per cent annually. In addition, some beliefs regarding the relationship between the costs and benefits of training and age may be based on incorrect or stereotypical and ageist attitudes to older workers. Specifically, ageist perceptions may reinforce employers' disinclination to invest in training for older workers (Lundberg and Marshallsay 2007; Cabinet Office 2000; McKay and Middleton 1998; Thompson 1990). This could therefore partly explain the lower incidence of training among older workers. In such cases, however, the decisions made by both employers and employees in relation to training would not necessarily be correct ones. This point is developed further below.

4.6.2. Empirical evidence: barriers to training

A number of studies from a range of countries have reported evidence for lower training participation rates among older and less skilled workers being related to barriers to training. These may either reduce an individual's incentive to take up training offers or an employer's incentives to offer training to particular groups. As such, barriers to training are factors that either restrict opportunities for training or, if training is available, raise the perceived costs of training or reduce the benefits of training, making it more likely that an offer of training is rejected. Three main types of barriers to participation in job-related training can be identified in the literature (Sussman, 2002):

- *Situational barriers:* barriers associated with a person's situation in life at a given time e.g. being too busy at work, financial constraints, family responsibilities or lack of child care, language, health problems, lack of relevant education, or insufficient ability

- *Institutional barriers :* barriers associated with established practices that exclude or discourage participation in training e.g. high training fees, entrance requirements, limited course offerings, inconvenient times or locations, ageist attitudes of employers

- *Dispositional/or psychological barriers:* barriers attributable to negative options and attitudes towards learning or negative perceptions of oneself as a learner

All three types of barriers to training raise the perceived or actual costs associated with training. Situational and dispositional barriers are perhaps more likely to explain why a particular individual (or group of individuals) has relatively low incentives to train and therefore is more likely to reject an offer of training. Institutional barriers are most likely to explain why a person or group of individuals is not offered training by employers. However, none of these categories are mutually exclusive as they can overlap or act together to reinforce each other, e.g. if the location is not convenient, the costs of the training are likely to be higher.

The degree to which barriers to training impact on actual training outcomes has been explored by Sussman (2002), who reviews evidence from the 1998 and 1994 Adult Education and Training Surveys (AETS), supplements to the respective Canadian Labour Force Surveys. Respondents were asked if there was any training or education they needed to take for job-related or career reasons *but did not.* If the answer to this question was yes, then they were asked to identify all the barriers to training they faced. The main barriers identified by those who did perceive an unmet need for training were: 1. too busy at work (situational); 2. training too expensive (situational/institutional); 3. inconvenience of time and location if training was available (institutional); 4. unavailability of a course or training programme (institutional); 5. lack of employer support (institutional); 6. family responsibilities (situational). Sussman (2002) found that among those who reported unmet needs for training the two main reasons given were being too busy at work and expense, but also important were lack of an offer of training, the inconvenience of location or time if training was offered, lack of employer support and family responsibilities (especially for women). Insufficient qualifications or prerequisites and health reasons were only important for a small minority. Among those who perceived unmet needs for training but who *had* taken some job-related training, the main barriers to more training were also being too busy at work, inconvenient time or location and the unavailability of a course. For those who had taken training, finance was not an important issue.

Cully et al. (2000) report on data from the Australian surveys of Training and Education Experience (ATEE) which interviewed only employed respondents. In these data three types of training are examined; in-house, external and unstructured. This study additionally identifies fear of training as a dispositional or psychological barrier to participation in training which is particularly demotivating for older people.

Chapman et al. (2003) suggest that the expense of training (particularly in the context of credit constraints among the unemployed) is an important barrier to training for older people in Australia. They found that 50-60 year olds were less likely than younger cohorts to have participated in self-financed training although they were no less likely to have had taken part in assisted training. They also cite lack of employer support as a further disincentive for training among older people. Similarly,

Lundberg and Marshallsay (2007), who report on evidence from survey-based studies on the perspectives of older workers (aged over 45) in three industry sectors: finance, care work for the aged in the health sector and construction. They report that about 20% of respondents thought that that their employer had negative attitudes supporting training for older workers (specifically beyond retirement age).

Wooden et al. (2001) and Cully et al. (2000) both report on ATEE data and show that the likelihood of training was much lower among older employees. The main reasons cited by the authors for the lower training participation of older workers were fewer training offers, differential learning ability and the attitudes of the older workers themselves. Fewer offers of training are made to older workers either because they are perceived to be more costly to train or because of less specific, negative and potentially ageist attitudes of employers towards older workers. Wooden et al. (2001) and Culley et al. (2000) found that the probability of undertaking training was positively related to educational attainment. Since older workers generally have lower levels of educational attainment, these authors both suggest that this is likely to be an important explanation for lower training rates among older workers. Culley et al. (2000) use regression analysis to explore this relationship and find that much of the differences in age and participation in training are unexplained by the data, attributing this to unobservable characteristics of older workers and age discrimination.

The attitudes of older workers themselves can constitute a dispositional or psychological barrier to training if, for instance, they result in a fear of training or a lack of a perceived need for training. Cully et al. (2000) argue that fear of training is associated with lack of confidence in the ability to succeed on a training programme. Among older workers, fear of training can be attributed to negative self-perceptions related to expectations of low training performance or low ability, unfamiliarity with the training environment, or fear of being unable to compete with younger and possibly more educated trainees. Fear of training raises the psychological costs of training and consequently lowers motivation to train.

Lack of perceived need is potentially a major reason for low motivation for training among older people. From the human capital perspective, a lack of a perceived need for training suggests that the perceived benefits from training are either low (relative to the costs) or non-existent. Sussman (2002) found that while a majority of all respondents in the AETS Canadian data had not participated in any training, a majority of these did not perceive a need for training, which may suggest a lack of motivation. Older people in particular were less likely to report unmet needs for training than women, those with less than a high school education, part-time workers and workers in agriculture and other primary industries and construction. These were also found to report fewer barriers to training. Similarly, Cully et al. (2000) found that among the respondents to the ATEE surveys, *no need for training* was more likely to be cited by older workers. Similar findings are also reported in US research by Guthrie and Schwoerer (1996) and Lundberg and Marshallsay (2007). A perceived lack of need for training would be consistent with beliefs that there would be insufficient reward from participating in training either because the individual has already accumulated sufficient skills and experience or because training will do little to enhance future promotion prospects or employability. As such, training utility will be conditioned by age because, as discussed above, the longer-term benefits of training are reduced by looming retirement.

There is some evidence that older workers do not perceive a lack of need for training in itself, but rather a lack of need for the type of training that is currently on offer. This possibility is explored further by Lundberg and Marshallsay (2007) who found that a majority of respondents in their sample thought that training in computing skills would be the most useful in enabling them to continue work after retirement. As stressed by Lundberg and Marshallsay (2007) reiterating the recommendations of Pillay et al. (2003) and Sheen (2000), "there is a need to understand how workers perceive their work" in order to adopt practices that will result in "increased productivity" as well as "long-term career benefits". Qualitative studies are well suited to such a task.

Wooden et al. (2001) conducted focus groups with employed and unemployed people over 45 as well as with human resources managers. The main barriers identified were attitudinal, specifically resistance to change and fear of ICT. However, ageist attitudes of managers (particularly younger managers) rather than trainers were identified as obstacles by this group. For example, older workers thought that managers perceived older workers as being incapable of change or as a threat because of their willingness to challenge managers' decisions. The research by Carmichael et al. (2007a and 2007b) was based on a small-scale, in-depth study with 56 people between 50 and 68 in the North West of England. Among this sample there was a general appreciation of the value of training and a majority of respondents said that they had undertaken some job-related training since leaving full-time education; some more vocational than others, some more intensive than others and some quite limited. Nearly half of the respondents had been involved in training related to computing/IT. Some of this training was perceived to be inadequate but in several cases it had lead to career changes. Carmichael et al. (2009) identify five main barriers to training in addition to lack of opportunity. Two of these were dispositional: lack of motivation associated with the lack of perceived need for training and resistance to training and the acquisition of new skills. Lack of a perceived

need for training was noted above as an important determinant of lower training rates among older workers. Among the sample, lack of a perceived need or lack of motivation was sometimes attributable to the inappropriateness of the training in question or to looming retirement. Resistance to training was possibly symptomatic of a more general resistance to change (also noted by Wooden et al. 2001). Additional barriers identified in this research were the expense of training, lack of time for training and prior and negative experiences of training (e.g. due to the general unpleasantness, difficulty, inadequacies or ineffectiveness of training), with the latter acting as a disincentive for undertaking further training. In addition, this research identifies three possible incentives for training. First of all, self-motivation was identified as an important driver of learning and training. Secondly, employer attitudes were seen as a critical determinant of whether or not an employee undertook training. Lastly, while negative experiences of training could act as a disincentive to train, pleasant, enjoyable experiences could have the opposite effect.

4.7. Conclusions

Access to the microdata underlying the EU Labour Force Survey (EU LFS) has allowed for the first time a comprehensive examination of various aspects of employee training in the EU. These include its impact on productivity and earnings, links with ICT adoption and use, and determinants of who is trained and the fields of training. Modelling training activities as intangible investment by firms gave the possibility to compare the extent of this investments across countries while econometric analysis permits an evaluation of the links with ICT. Detailed analysis of the factors affecting who receives training is possible given the very large samples available. The main conclusions that emerge from this analysis are as follows:

In a small number of countries, intangible capital from investing in training is a significant contributor to output growth, and in some the impact of training is on a par with contributions from upskilling through the general education system. In other countries, however, the contribution of this type of investment is relatively small. The econometric analysis suggests that training has most impact when combined with investment in ICT, in particular in countries with a more "academic" general education system. This is consistent with recent literature emphasising the role of organisational change and associated retraining of the workforce in diffusing new technology. Training also appears to have a direct impact on the adoption and use of ICT although the impact is gender-, age- and skill-specific. An interesting finding is that training workers with a higher educational attainment contributes less to ICT adoption than training for the workers with low educational attainment.

A number of factors affect who is likely to receive training, confirming earlier analysis for the UK in O'Mahony and Peng (2008) that lower-skilled and older workers are less likely than other workers to receive training. The analysis also highlights that training increases with job tenure, thus implying that labour market systems that promote long-term relationships between firms and workers might have positive impacts on human capital accumulation, a point frequently emphasised by the ILO (see e.g. Storm and Naastepad 2007).

The analysis of the fields of training also yields some interesting findings in respect of worker characteristics. While the overall relationship between age and training participation is clearly negative, among trainees, workers over 44 are more likely to participate in general training and training in health and computing. Males are more likely to be trained in specific rather than general areas and more educated trainees are most likely to be involved in health and social science training and least likely to be involved in training in computing and services. Regardless of age, gender or educational attainment, trainees in countries with more vocationally oriented education systems are more likely to be engaged in general and services training than trainees in more academically oriented countries.

A number of implications follow for dealing with the barriers to training outlined in section 4.5. For example, lack of confidence, fear of training or resistance to training could be addressed by adopting particular training methods that are suited to specific groups of workers. Training providers need to ensure that prospective trainees can realistically expect tangible benefits from that training which translate into incentives to train e.g. by making the purpose of training clear and closely linking training to specific employment opportunities. But the lack of a perceived need for training is more difficult to address. Wooden et al. (2001) suggest that this could require a rise in the retirement age and more emphasis on a "throughout-career" requirement for accreditation.

Finally, the likely impact of the financial crisis on training is worth highlighting. Here, it is important to distinguish immediate effects from more long-term considerations. In the short run credit constraints are likely to inhibit firms from spending on activities such as training which are not central to their core activities. Against this, to the extent that firms hoard labour in recessions, the underutilisation of labour may provide an opportunity to undertake training. As firms are both more likely to hoard highly skilled workers and, as seen above, more likely to provide training to these workers, this might counterbalance the credit-tightening effects. Which predominates is an empirical matter on which there is little evidence to date. In this respect, in many of the large EU Member States for which data are available, training proportions increased in the previous recession period,

2000-2002, suggesting some labour hoarding impact. However this rise was small and not ubiquitous so it is probable that the credit-rationing effect dominates.

In the longer term the impact of the financial crisis on training is intrinsically linked with its effect on propensities to innovate and adopt new technologies. Lack of access to credit might seriously delay these activities. There is a large literature that suggests positive impacts of financial development on growth through financial intermediaries producing better information and improving resource allocation (see Levine 2005 for a review) and a growing one on the negative effects of financial crises (see e.g. Kroszner, Laeven and Klingebiel, 2007). Here again there are likely to be two counterbalancing effects. Firms dependent on external finance are less likely to invest and introduce new technologies when they are credit constrained and so are also less likely to undertake complementary activities such as on the job training.

However, in the very long run the crisis will probably change the nature of financial business models, which could stimulate innovation. One cause of the financial crisis, as discussed in Barrell and Davis (2008), was that low interest rates following the 2001 recession led financial market institutions to seek out alternative activities that yielded a higher rate of return. This in turn led to the financial innovations that ex post increased risk and have had such disastrous consequences. In the future financial institutions may look elsewhere in the search for higher returns and might well find these through financing innovation in the real economy. Whether these potential positive impacts materialize is a matter for future research. In the meantime, the most likely scenario is that the crisis will have a negative impact on intangible investments such as training for some time yet.

References

Acemoglu, D. (1997), "Training and Innovation in an Imperfect Labour Market", *Review of Economic Studies*, 64(3): pp. 445-464.

Acemoglu, D. (1998), "Why do new technologies complement skills? Directed technical change and wage inequality", *Quarterly Journal of Economics* 113 (4): pp. 1055-1089.

Acemoglu, D., and J.S. Pischke (1999a), "Beyond Becker: Training in Imperfect Labour Markets", *Economic Journal*, Royal Economic Society, vol. 109(453), pages F112-42, February.

Acemoglu, D., and J.S. Pischke (1999b), "The Structure of Wages and Investment in General Training", *Journal of Political Economy*, University of Chicago Press, vol. 107(3), pages 539-572, June.

Arellano, M., and S. Bond (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, 58 (2): pp. 277-97.

Autor, D.H., L.F. Katz, and A.B. Krueger (1998), "Computing Inequality: Have Computers Changed the Labour Market?", *Quarterly Journal of Labour Economics*, 113 (4): pp. 1169-1213.

Baldwin, T.T., and J.K. Ford (1988), "Transfer of Training: A Review and Directions for Future Research", *Personnel Psychology*, 41(1): pp. 63-105.

Baldwin, J., W. Gu, A. Lafrance, and R. Macdonald (2008), "Intangible capital in Canada: R&D, Innovation, Brand and Mining, Oil and Gas Exploration expenditures", paper presented to the 2008 IARIW conference, Slovenia, Statistics Canada.

Ballot, G., F. Fakhfakh, and E. Taymaz (2006), "Who Benefits from Training and R&D, The Firm or the Workers?", *British Journal of Industrial Relations*, 44 (3): pp. 473-495.

Barro, R., and J.W. Lee (1994), "Sources of Economic Growth (with commentary)", *Carnegie-Rochester Conference Series on Public Policy*, 40: pp. 1-57.

Bartel, A.P., and F. Lichtenberg (1987), "The Comparative Advantage of Educated Workers in Implementing New Technologies", *Review of Economics and Statistics*, 69: pp. 1-11.

Bartel, A.P. (1994), "Productivity Gains from the Implementation of Employee Training Programmes", *Industrial Relations*, 33: pp. 411-425.

Bartel, A.P., and N. Sicherman (1999), "Technological Change and Wages: An Interindustry Analysis", *Journal of Political Economy*, 107(2): pp. 285-325.

Becker, G. (1964), "Human Capital: A Theoretical and Empirical Analysis, With Special Reference To Education", New York: Columbia University Press.

Becker, B.E., and M.A. Huselid (1998), "High Performance Work Systems and Firm Performance", *Research in Personnel and Human Resources Management*, 16: pp. 53-101.

Bertschek, I., and U. Kaiser (2004), "Productivity effects of organisational change: Microeconometric evidence", *Management Science*, 50(3): pp. 394-404.

Black, S.E., and L.M. Lynch (1996), "Human capital investments and productivity", *American Economic Review*, 86(2): pp. 263-267.

Black, S.E., and L.M. Lynch (2001), "How to Compete: The Impact of Workplace Practices and Information Technology on Productivity", *The Review of Economics and Statistics*, 83(3): pp. 434-445.

Blundell, R., L. Dearden, and C. Meghir. (1996), "The Determinants of Work Related Training in Britain", London: Institute of Fiscal Studies.

Booth, A. (1991), "Job-Related Formal Training: Who Receives It and What Is It Worth?", *Oxford Bulletin of Economics and Statistics*, 53: pp. 281-294.

Bresnahan, T.F., E. Brynjolfsson, and L.M. Hitt (2002), "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence", *Quarterly Journal of Economics*, 117 (1): pp. 339-376.

Brynjolfsson, B., L. Hitt, and S. Yang (2002), "Intangible Assets: Computers and Organisational Capital", *Brookings paper on Economic Activity*, (1): pp. 137-181.

Cabinet Office (2000), "Winning the Generation Game: Improving Opportunities for people aged 50-65 in Work and Community Activity", A Performance and Innovation Unit Report.

Carmichael, F. (2007a), "Older workers in the North West", Report for the European Social Fund, People, Work and Organisations Research Centre, University of Salford.

Carmichael, F. (2007b), "Older men in the North West labour market", Report for the European Social Fund, People, Work and Organisations Research Centre, University of Salford.

Carmichael, F. M. Ercolani, L. Kang, Y. Maimaiti, M. O'Mahony, F. Peng and C. Robinson (2009), "Education, Training and Productivity", Report for the European Commission, University of Birmingham.

Caselli, F., G. Esquivel, and F. Lefort (1996), "Reopening the Convergence Debate: A New Look at Cross Country Growth Empirics", *Journal of Economic Growth*, 1 (3): pp. 363-89.

Chander, P., and S.M. Thangavelu (2004), "Technology Adoption, Education and Immigration Policy", *Journal of Development Economic*s, 75: pp. 79-94.

Chapman, B., T. F. Crossley, and T. Kim (2003), "Credit constraints and training after job loss", Discussion Paper 466, Centre for Economic Policy Research, Australian National University.

Conti, G. (2005), "Training, productivity and wages in Italy", *Labour Economics*, 12(4): 557-576.

Corrado, C., C. Hulten, and D. Sichel (2005), "Intangible Capital and Economic Growth", Measuring capital and technology: an expanded framework in Corrado, C., C. Hulten, and D. Sichel eds, Measuring Capital in the New Economy, Studies in Income and Wealth Vol. 65, Chicago*, The University of Chicago Press.*

Corrado, C., C. Hulten, and D. Sichel (2006), "Intangible Capital and Economic Growth", NBER Working Paper 11948.

Cully, M., A. VandenHeuvel, M. Wooden, and R. Curtain (2000), "Participation in, and barrier to, training: The experience of older adults", *Australasian Journal of Ageing,* 19(4): pp. 172-179.

Dearden, L., H. Reed, and J. van Reenen (2006), "The Impact of Training on Productivity and Wages: Evidence from British Panel Data", *Oxford Bulletin of Economics and Statistics*, 68(4): pp. 397-421.

Eder, L.B., and M. Igbaria (2001), "Determinants of intranet diffusion and infusion", *OMEGA – The Int. Journal of Management Science*, 29: pp. 233-242.

Estevez-Abe M., T. Iversen, and D. Soskice (2001), "Social Protection and the Formation of Skills: A Reinterpretation of the Welfare State", in P. A. Hall et D. Soskice (eds.), Varieties of Capitalism. The Institutional Foundations of Comparative Advantage (pp. 145-183), *Oxford University Press,* Oxford.

European Commission (2008), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "New Skills for New Jobs Anticipating and matching labour market and skills needs".

Fukao, K., H. Sumio, M. Tsutomu, and T. Konomi (2007), "Intangible Investment in Japan: Measurement and Contribution to Economic Growth", Discussion papers 07034, Research Institute of Economy, Trade and Industry (RIETI).

Giorgio-Marrano, M., and J. Haskel (2006), "How much does the UK invest in intangible assets", Dept of Economics, working paper No. 578, Queen Mary University of London.

Giorgio-Marrano, M., J. Haskel, and G. Wallis (2007), "What happened to the knowledge economy? ICT, intangible investment and Britain's productivity record revisited", Dept of Economics, working paper No. 603, Queen Mary University of London.

Goodacre, A., and I. Tonks (1995), "Finance and technological change", in Stoneman, P. (Ed.), *Handbook of the economics of Innovation and Technological Change*. Blackwell, Oxford, pp. 298-341.

Goos M., A. Manning, and A. Salomons (2009), "Job Polarization in Europe", American Economic Review: Papers & Proceedings 2009, 99:2, 58-63.

Greenberg, D., H. Michalopoulos, and P.K. Robins (2003), "A Meta Analysis of Government-Sponsored Training Programs", *Industrial and Labour Relations Review*, 57(1): 31-53.

Groot, W. (1998), "Empirical estimates of the rate of depreciation of education", *Applied Economic Letters,* 5: 535-8.

Gust, C., and J. Marquez (2004), "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices", *Labour Economics*, 11(1): pp. 33-58.

Guthrie, J.P., and C.E. Schwoerer (1996), "Older dogs and new tricks: career stage and self-assessed need for training", *Public Personnel Management*, 25: pp. 59-72.

Hargittai, E. (1999), "Weaving the western web: explaining differences in Internet connectivity among OECD countries", Telecommunications Policy, 23: pp. 701-718.

Hellerstein, J.K, D. Neumark, and K.R. Troske (1999), "Wages, productivity, and worker characteristics: evidence from plant level production functions and wage functions", *Journal of Labor Economics,* 17(3): pp. 409-446.

Helpman, E., and A. Rangel (1999), "Adjusting to a New Technology: Experience and Training", *Journal of Economic Growth*, 4: 359-383.

Hollenstein, H. (2004), "Determinants of the adoption of ICT, An empirical analysis based on firm-level data for the Swiss business sector", *Structural Change and Economic Dynamics*, 15: pp. 315-342.

Jalava, J., P. Aulin-Amhavarra, and A. Alanen (2007), "Intangible capital in the Finnish Business sector, 1975-2005", ETLA – The Research Institute of the Finnish Economy, discussion paper no. 1103.

Konings J., and S. Vanormelingen (2009), "The Impact of Training on Productivity and Wages: Firm Level Evidence", LICOS Discussion Paper Series Discussion Paper 244/2009.

Kroszner, R., L. Laeven, and D. Klingebiel (2007), "Banking crises, financial development and growth", *Journal of Financial Economics,* 84, 187-228.

Krueger, A., and C. Rouse (1998), "The effect of workplace education on earnings, turnover and job performance", *Journal of Labor Economics*, 16(1): pp. 61-94.

Lee, J.W. (2001), "Education for technology readiness: prospects for developing countries", *Journal of Human Development*, 2: pp. 115-151.

Leo, H. (2001), "European skills shortage in ICT and policy responses", WIFO working papers No. 163, Vienna.

Lewis, E. (2005), "Immigration, skill mix and the choice of technique", Centre for Economic Studies, US Census Bureau Working Paper No. 05-04.

Lundberg, D., and Z. Marshallsay (2007), "Older workers' perspectives on training and retention of older workers", National Vocational Education and Training Research and Evaluation Program Report, Adelaide: National Centre for Vocational Education Research.

Lynch, L.M. (1992), "Private Sector Training and the Earnings of Young Workers", *American Economic Review*, 82 (3): pp. 299-312.

Lynch, L.M., and S.E. Black (1998), "Beyond the Incidence of Employer-Provided Training", *Industrial and Labour Relations Review*, 52(1): pp. 64-81.

Machin, S., and J. Van Reenen (1998), "Technology and changes in skill structure: evidence from seven OECD countries", *Quarterly Journal of Economics,* 113 (4): pp. 1215-44.

Mabey, C., and M. Ramirez (2005), "Does management development improve organizational productivity", *International Journal of Human Resource Management*, 16: 1067-1082.

Matteucci, N., M. O'Mahony, C.A. Robinson, and T. Zwick (2005), "Productivity, Workplace Performance and ICT: Industry and Firm Level Evidence for Europe and the US", *Scottish Journal of Political Economy,* 52(3): pp. 359-386.

Mayhew, K., and A. Neely (2006), "Improving Productivity – Opening the Black Box", *Oxford Review of Economic Policy*, 22(4): pp. 445-456.

McKay, S., and S. Middleton (1998), "Characteristics of Older Workers: Secondary Analysis of the Family and Working Lives Survey", DfEE No. 45, London.

Mincer, J. (1962), "On the job training: Costs, returns and some implications", *Journal of Political Economy*, 70(5): part 2 pp. 50-79.

Mincer, J. (1974), "Schooling, experience and Earnings", New York: National Bureau of Economic Research.

Nickell, S. (1981), "Biases in Dynamic Models with Fixed Effects", *Econometrica*, 49 (6): pp. 1417-1426.

Norris, P. (2001), "Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide", *Cambridge University Bridge*, New York.

O'Mahony, M., and Peng, F. (2008), "Skill Bias, Age and Organisational Change", EU KLEMS working paper, No. 36, http://www.EU KLEMS.net

O'Mahony, M., and M.P. Timmer (2009), "eOutput, Input and Productivity Measures at the Industry Level: the EU KLEMS Database", *Economic Journal*, forthcoming, June.

O'Mahony, M., and M. Vecchi (2005), "Quantifying the Impact of ICT Capital on Output Growth: A Heterogenous Dynamic Panel Approcah", *Economica*, 72: pp. 615-633.

Ostroff, C., and D.E. Bowen (2000), "Moving HR to a higher level: HR practices and organizational effectiveness", in: K.J. Klein and S.W. Kozlowski, Eds, *Multilevel theory, research, and methods in organizations*, Jossey-Bass, San Francisco, CA, pp. 211-266.

Oulton, N. (2002), "ICT and Productivity Growth in the United Kingdom", *Oxford Review of Economic Policy*, 18: pp. 363-379.

Pillay, H., G. Boulton-Lewis, L. Wils, and C. Lankshear (2003), "Conceptions of work and learning at work: Impressions from older workers", Studies in Continuing Education, 25 (1): pp. 95-111.

Pohjola, M. (2003), "The adoption and diffusion of ICT across countries: Patterns and Determinants", in Jones, D., C. (Ed) *The New Economy Handbook,* Academic Press, Elsevier.

Rubenson, K. (2007), "Determinants of formal and informal Canadian adult learning: insights from the Adult Education and Training Survey", Human Resources and Social Development Canada, TD/TNC 92.775,. Accessed at http://www.hrdc.gc.ca/en/publications_resources/ January 2009-01-18.

Salas, E., and Cannon-Bowers, J., A. (2001), "The science of training: A decade of progress", *Annual Review of Psychology*, 52: pp. 471-499.

Sheen, V. (2000), "The ageing population and work in the 21st century", Development Conference, Washington, DC.

Stiroh, K. (2002), "Are ICT spillovers driving the New Economy?", *Review of Income and Wealth*, 48: pp. 35-58.

Storm, S., and C. Naastepad (2007), "Why labour market regulation may payoff: worker motivation, co-ordination and productivity growth", ILO, Economic and Labour market working paper 2007/4.

Sussman, D. (2002), "Barriers to job-related training", *Perspectives*, *Statistics Canada Catalogue*, 75-001-XIE, Ottawa, 5-12.

Thompson, A. (1991), "Last in the Queue? Corporate Employment Policies and the Older Worker", University of Sussex, Institute of Manpower Studies Report, No. 209, Brighton.

van Rooijen-Horsten, M., D. van den Bergen, and M. Tanriseven (2008), "Intangible capital in the Netherlands: A benchmark", Statistics Netherlands, Discussion paper No. 08001.

Vignoles, A., F. Galindo-Rueda, and L. Feinstein (2004), "The labour market impact of adult education and training: A cohort analysis", *Scottish Journal of Political Economy*, 51(2): pp. 266-280.

Waldman, D.A., and B.J. Avolio (1986), "A meta-analysis of age differences in job performance", *Journal of Psychology,* 71: pp. 33-38.

Wooden, M., A. VandenHeuvel, M. Cully, and R. Curtain (2001), "Barriers to training for older workers and possible policy solutions", Flinders National Institute of Labour Studies, University of South Australia. Accessed at http://www.dest.gov.au/archive/iae/documents/olderworkers/olderworekrsv4.pdf January 2009.

Zwick, T. (2006), "The Impact of Training Intensity on Establishment Productivity", *Industrial Relations*, 45(1): pp. 26-46.

Appendix

Table 4.13: Independent variables: demographic characteristics

Variable	Description
AGE	Ten 5 yearly age bands
FEMALE	Female employee
MARITAL_MARRIED	Marital status: married
MARITAL_W_S_D	Marital status: widowed, separated or divorced
MARITAL_SINGLE	Marital status: single
EDUCATION_L	Education low : ISCED 0 (no formal), 1 (primary), 2 (lower secondary), 3c (<2years)
EDUCATION_M	Education mid : ISCED 3abc (upper secondary), 4 (post secondary)
EDUCATION_H	Education high: ISCED 5ab (1st stage secondary), 6 (2nd stage secondary)
URBAN_DENSE	Densely-populated area
URBAN_INTERM	Intermediately-populated area
URBAN_THIN	Thinly-populated area
NATIONAL_HOME	Nationality of home country
NATIONAL_FOREIGN	National of foreign country

Table 4.14: Independent variables: economic characteristics

Variable	Description
TENURE	Number of years with current employer
TENURESQ	TENURE squared
HWUSUAL	Number of hours per week usually worked in first job
PARTTIME	Part-time employee
TEMPORARY	Temporary employee
LOOKOJ	Looking for another job
HOMEWK_USUALLY	Usually works from home
HOMEWK_SOMETIMES	Sometimes works from home
HOMEWK_NEVER	Never works from home
ISCO_0	0: Armed forces
ISCO_1	1: Legislators, senior officials and managers
ISCO_2	2: Professionals
ISCO_3	3: Technicians and associate professionals
ISCO_4	4: Clerks
ISCO_5	5: Service employees and shop and market sales employees
ISCO_6	6: Skilled agricultural and fishery employees
ISCO_7	7: Craft and related trades employees
ISCO_8	8: Plant and machine operators and assemblers
ISCO_9	9: Elementary occupations. This is the excluded/control category in the regressions

Note: For the variable TENURE, the minimum is 1 and the maximum 52, for TENURESQ the minimum is 1 and the maximum is 2704, for HWUSUAL the minimum is 1 and the maximum is 80.

Table 4.15: Marginal effects estimates – Independent variables: EDUC4WN (on-the-job training indicator)

	(1)	(2)	(3)	(4)	(5)	(6)
Country:	Austria	Belgium	Germany	Denmark	Spain	Finland
FEMALE	-0.0136***	-0.0110***	-0.0151***	0.0352***	-0.00592***	0.0251***
	(-8.76)	(-5.89)	(-15.8)	(11.8)	(-3.97)	(7.05)
AGE_17	0.531***	0.361***	0.630***	0.541***	0.195***	0.512***
	(89.9)	(24.6)	(116)	(85.4)	(22.8)	(55.8)
AGE_22	0.115***	0.0333***	0.215***	0.265***	0.0819***	0.234***
	(29.8)	(6.89)	(57.9)	(34.2)	(18.1)	(26.2)
AGE_27	0.0538***	0.0106***	0.0813***	0.107***	0.0349***	0.0829***
	(16.8)	(2.95)	(33.0)	(16.7)	(10.3)	(11.1)
AGE_32	0.0193***	0.000437	0.0228***	0.0153***	0.00919***	0.0282***
	(7.25)	(0.14)	(12.2)	(2.91)	(3.21)	(4.13)
AGE_37	0.00468**	-0.00597**	0.00801***	-0.00751	0.00760***	0.000990
	(1.98)	(-2.08)	(4.90)	(-1.53)	(2.80)	(0.16)
AGE_47	-0.00593**	-0.00744**	-0.00853***	-0.0110**	-0.00690***	-0.00991
	(-2.49)	(-2.56)	(-5.31)	(-2.23)	(-2.59)	(-1.63)
AGE_52	-0.0262***	-0.0154***	-0.0192***	-0.0246***	-0.0250***	-0.0273***
	(-10.2)	(-4.93)	(-11.6)	(-4.92)	(-8.95)	(-4.42)
AGE_57	-0.0625***	-0.0319***	-0.0383***	-0.0549***	-0.0430***	-0.0716***
	(-22.5)	(-9.27)	(-22.1)	(-10.8)	(-14.6)	(-11.3)
AGE_62	-0.0891***	-0.0412***	-0.0564***	-0.0895***	-0.0528***	-0.113***
	(-20.4)	(-7.64)	(-27.5)	(-14.2)	(-14.9)	(-13.7)
MARITAL_W_S_D	-0.00843***	-0.00473	-0.00707***	0.00954*	-0.00256	-0.000990
	(-3.18)	(-1.49)	(-4.08)	(1.73)	(-0.78)	(-0.16)
MARITAL_SINGLE	-0.0222***	-0.0110***	-0.0286***	-0.00679*	-0.0259***	0.00973**
	(-12.4)	(-5.08)	(-24.3)	(-1.92)	(-13.9)	(2.33)
EDUCATION_HIGH	0.0425***	0.0534***	-0.000614	0.0499***	0.0777***	0.0483***
	(13.6)	(16.8)	(-0.37)	(10.2)	(32.2)	(8.11)
EDUCATION_MED.	-0.00812***	0.0246***	-0.0389***	0.0181***	0.0743***	0.0408***
	(-3.77)	(9.19)	(-26.8)	(4.55)	(29.8)	(8.13)
URBAN_INTERM	-0.0136***	-0.00836***	-0.0114***	-0.0290***	0.00222	-0.0137***
	(-8.32)	(-4.98)	(-12.5)	(-9.26)	(1.32)	(-3.02)
URBAN_THIN	-0.0292***	-0.0266***	-0.0101***	-0.0349***	-0.00268*	-0.0392***
	(-19.3)	(-10.1)	(-9.22)	(-10.7)	(-1.68)	(-10.7)
NATIONAL_FOREIG.	-0.0384***	0.0171***	-0.0268***	-0.0311***	-0.0258***	-0.0294**
	(-16.0)	(5.32)	(-16.4)	(-3.99)	(-8.70)	(-2.14)
TENURE	0.00129***	-0.000366	0.00229***	0.00443***	0.000614**	0.00148**
	(5.10)	(-1.11)	(13.9)	(9.06)	(2.04)	(2.36)
TENURESQ	0.00000616	0.0000153	-0.0000309***	-0.0000911***	-0.00000597	-0.00000198
	(0.84)	(1.63)	(-6.80)	(-6.35)	(-0.70)	(-0.11)
HWUSUAL	-0.000970***	0.000889***	-0.00181***	-0.00514***	-0.00239***	-0.00340***
	(-10.4)	(7.49)	(-23.8)	(-24.3)	(-18.1)	(-12.0)
PARTTIME	0.0347***	0.0357***	-0.00331*	-0.00463	0.0212***	0.0143**
	(12.4)	(11.7)	(-1.72)	(-1.00)	(5.55)	(2.03)
TEMPORARY	0.220***	0.0525***	0.183***	0.0953***	0.0264***	0.0648***
	(58.4)	(14.0)	(78.3)	(19.2)	(14.0)	(12.8)
LOOKOJ	0.00407	0.0125***	-0.0380***	-0.0427***	0.0430***	0.0141**
	(1.00)	(3.41)	(-23.9)	(-8.99)	(12.8)	(2.44)
HOMEWRK_USUAL.	0.0985***	0.0516***	0.0290***	0.0734***	0.0622***	0.0556***
	(28.0)	(11.6)	(9.31)	(11.2)	(7.41)	(7.78)
HOMEWRK_SOMET.	0.0846***	0.0576***	0.0473***	0.0705***	0.0335***	0.0835***
	(33.3)	(15.1)	(25.4)	(17.4)	(4.96)	(11.5)
ISCO_0	0.177***	0.0935***	-0.00564	0.157***	0.0850***	0.150***
	(11.1)	(6.63)	(-1.10)	(6.74)	(7.79)	(5.47)
ISCO_1	0.174***	0.107***	0.160***	0.143***	0.111***	0.205***
	(31.1)	(14.8)	(29.2)	(16.7)	(14.0)	(20.6)

	(1)	(2)	(3)	(4)	(5)	(6)
Country:	Austria	Belgium	Germany	Denmark	Spain	Finland
ISCO_2	0.216***	0.0924***	0.160***	0.148***	0.109***	0.189***
	(39.2)	(16.5)	(38.5)	(21.1)	(24.2)	(23.0)
ISCO_3	0.178***	0.0818***	0.143***	0.134***	0.0731***	0.150***
	(46.6)	(14.1)	(41.7)	(22.6)	(18.4)	(19.8)
ISCO_4	0.137***	0.0615***	0.125***	0.0957***	0.0619***	0.0956***
	(34.7)	(12.2)	(33.9)	(14.5)	(16.0)	(11.1)
ISCO_5	0.123***	0.0515***	0.0969***	0.0806***	0.0515***	0.0553***
	(31.4)	(9.68)	(27.4)	(13.7)	(15.8)	(7.92)
ISCO_6	0.0592***	0.00449	0.0440***	0.0314**	0.0466***	0.0204
	(6.57)	(0.37)	(7.05)	(2.19)	(4.63)	(1.42)
ISCO_7	0.0753***	0.0156***	0.0574***	0.0427***	0.00150	-0.0315***
	(19.3)	(3.12)	(18.1)	(6.35)	(0.50)	(-4.26)
ISCO_8	0.0474***	0.00371	0.0241***	-0.0230***	0.0141***	-0.0411***
	(10.6)	(0.74)	(7.08)	(-3.18)	(3.87)	(-5.22)
QUARTER_2	0.00726***	0.000385	0.00214	-0.0153***	-0.00499*	0.0154
	(3.82)	(0.16)	(1.25)	(-4.14)	(-1.92)	(1.48)
QUARTER_3	-0.0518***	-0.0548***	-0.0193***	-0.109***	-0.0470***	-0.0913***
	(-29.9)	(-28.6)	(-12.4)	(-29.9)	(-24.2)	(-9.87)
QUARTER_4	0.00978***	-0.00338	0.00415**	0.0284***	0.00108	0.0351***
	(5.12)	(-1.48)	(2.45)	(7.42)	(0.42)	(3.17)
YEAR_2006	0.00344**	0.00240	-0.00543**	0.00917***	-0.00727***	-0.0144*
	(2.06)	(1.11)	(-2.01)	(2.70)	(-3.99)	(-1.76)
YEAR_2005	0.00128	0.0157***	0.000872	-0.0107***	-0.0790***	-0.0143*
	(0.77)	(7.00)	(0.42)	(-3.17)	(-40.1)	(-1.76)
YEAR_2004	-0.0129***	0.0197***	-0.00251	-0.0440***	-0.0703***	-0.00728
	(-4.29)	(5.04)	(-1.05)	(-7.65)	(-34.8)	(-0.89)
YEAR_2003	-0.0596***	0.0103***	-0.0214***	-0.112***		-0.0857***
	(-25.0)	(2.66)	(-9.67)	(-20.9)		(-11.4)
Observations' number	278230	124061	445534	111689	173556	74209
PseudoR2	0.218	0.093	0.324	0.128	0.170	0.116

t statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.16: Marginal effect estimates. Dependent variable: EDUC4WN (on-the-job training indicator)

	(7)	(8)	(9)	(10)	(11)
Country:	France	Italy	Netherlands	Sweden	United Kingdom
FEMALE	-0.00275*	-0.000184	-0.0280***	0.0703***	0.0508***
	(-1.95)	(-0.25)	(-16.4)	(50.1)	(20.3)
AGE_17	0.564***	0.208***	0.541***	0.332***	0.422***
	(64.1)	(33.7)	(94.6)	(55.1)	(70.2)
AGE_22	0.136***	0.0579***	0.177***	0.124***	0.0950***
	(28.1)	(22.7)	(41.3)	(33.1)	(16.9)
AGE_27	0.0497***	0.0195***	0.0555***	0.0587***	0.0212***
	(15.0)	(11.2)	(17.9)	(19.4)	(4.44)
AGE_32	0.0272***	0.00429***	0.0151***	0.00372	-0.00223
	(9.78)	(3.17)	(5.89)	(1.48)	(-0.53)
AGE_37	0.00967***	0.00126	0.00434*	-0.00848***	0.00303
	(3.89)	(1.04)	(1.82)	(-3.60)	(0.76)
AGE_47	-0.00786***	-0.00325***	-0.0136***	-0.0114***	-0.00848**
	(-3.37)	(-2.72)	(-5.71)	(-4.73)	(-2.09)
AGE_52	-0.0219***	-0.0140***	-0.0384***	-0.0223***	-0.0280***
	(-9.20)	(-11.5)	(-15.7)	(-9.21)	(-6.67)
AGE_57	-0.0484***	-0.0281***	-0.0816***	-0.0462***	-0.0578***
	(-20.4)	(-22.3)	(-32.7)	(-19.3)	(-13.4)
AGE_62	-0.0664***	-0.0356***	-0.126***	-0.0795***	-0.106***
	(-16.7)	(-19.8)	(-36.0)	(-31.6)	(-19.8)
MARITAL_W_S_D	0.0102***	0.00112	0.0138***	-0.00112	0.00221
	(3.78)	(0.71)	(4.54)	(-0.48)	(0.54)
MARITAL_SINGLE	-0.00204	-0.0141***	-0.0282***	0.00221	-0.0258***
	(-1.30)	(-15.1)	(-15.7)	(1.42)	(-8.47)
EDUCATION_HIGH	0.0458***	0.0862***	0.0597***	0.108***	0.138***
	(19.4)	(41.2)	(24.0)	(38.6)	(38.4)
EDUCATION_MED.	0.0237***	0.0443***	0.0484***	0.0425***	0.0799***
	(13.5)	(46.0)	(25.2)	(20.0)	(27.7)
URBAN_INTERM	-0.000781	-0.00606***	-0.0127***	0.00750***	-0.00202
	(-0.57)	(-8.21)	(-9.19)	(3.59)	(-0.74)
URBAN_THIN	-0.0121***	-0.00726***	-0.00555	-0.000166	-0.0132***
	(-6.55)	(-8.59)	(-1.38)	(-0.10)	(-4.53)
NATIONAL_FOREIG.	-0.0151***	-0.0187***	0.0197***	-0.0154***	0.0437***
	(-4.87)	(-10.9)	(4.14)	(-4.65)	(8.70)
TENURE	0.00315***	0.00113***	-0.00355***	0.00281***	-0.00165***
	(12.0)	(7.84)	(-13.0)	(12.5)	(-3.90)
TENURESQ	-0.0000489***	-0.0000143***	0.0000734***	-0.0000447***	0.0000442***
	(-6.82)	(-3.47)	(9.36)	(-7.57)	(3.44)
HWUSUAL	-0.000112	-0.000634***	-0.00188***	-0.00552***	-0.00152***
	(-1.32)	(-13.0)	(-13.6)	(-44.4)	(-10.7)
PARTTIME	0.0221***	0.0182***	0.00475*	-0.0408***	0.0333***
	(9.64)	(13.0)	(1.92)	(-18.9)	(8.12)
TEMPORARY	0.0852***	0.0209***	0.0261***	0.00979***	0.0340***
	(32.6)	(17.4)	(10.1)	(4.69)	(7.03)
LOOKOJ	-0.00710**	0.00316**	0.00533*	0.0122***	0.0224***
	(-2.47)	(2.22)	(1.91)	(5.03)	(5.11)
HOMEWRK_USUAL.	0.00605**	0.0587***	-0.0208***	0.0291***	0.0116
	(2.42)	(14.2)	(-3.29)	(5.29)	(1.16)
HOMEWRK_SOMET.	0.0226***	0.0270***		0.0469***	0.0922***
	(8.35)	(6.10)		(15.8)	(30.1)
ISCO_0	0.0656***	0.0578***	0.189***	0.108***	0.242***
	(8.56)	(12.0)	(17.0)	(8.01)	(12.1)
ISCO_1	0.117***	0.119***	0.116***	0.114***	0.0777***
	(19.7)	(24.0)	(23.9)	(23.0)	(14.9)

	(7)	(8)	(9)	(10)	(11)
Country:	France	Italy	Netherlands	Sweden	United Kingdom
ISCO_2	0.115***	0.0937***	0.141***	0.105***	0.139***
	(23.6)	(28.4)	(32.0)	(27.6)	(24.7)
ISCO_3	0.0991***	0.0727***	0.126***	0.0839***	0.145***
	(25.1)	(32.2)	(30.8)	(24.2)	(27.2)
ISCO_4	0.0595***	0.0376***	0.0671***	0.0458***	0.0829***
	(15.5)	(17.2)	(16.4)	(12.6)	(17.0)
ISCO_5	0.0538***	0.0455***	0.0659***	0.0421***	0.119***
	(14.3)	(19.9)	(15.9)	(13.0)	(24.8)
ISCO_6	0.00443	-0.00853*	0.0234***	-0.0142**	0.0301
	(0.67)	(-1.75)	(3.15)	(-2.05)	(1.64)
ISCO_7	0.0305***	-0.0112***	0.0418***	-0.0108***	0.0418***
	(8.02)	(-6.71)	(9.89)	(-3.01)	(6.87)
ISCO_8	0.0197***	-0.00966***	0.0150***	-0.0258***	0.000741
	(5.25)	(-5.25)	(3.41)	(-7.65)	(0.12)
QUARTER_2	0.00176	-0.000286	-0.00300	-0.0413***	-0.0377***
	(0.90)	(-0.32)	(-1.45)	(-22.1)	(-13.7)
QUARTER_3	-0.0364***	-0.0239***	-0.0474***	-0.109***	
	(-21.0)	(-29.0)	(-24.5)	(-65.1)	
QUARTER_4	0.00862***	0.00483***	0.00148	-0.00519***	
	(4.31)	(5.28)	(0.71)	(-2.75)	
YEAR_2006	-0.000222	-0.00136*	-0.0169***	-0.00300*	0.0592***
	(-0.087)	(-1.71)	(-6.69)	(-1.93)	(17.8)
YEAR_2005	-0.00743***	-0.00347***	-0.000127	-0.000399	0.0641***
	(-3.78)	(-4.37)	(-0.062)	(-0.23)	(18.3)
YEAR_2004	-0.00637**		0.00802***	0.188***	0.133***
	(-2.46)		(2.74)	(57.9)	(36.4)
YEAR_2003	-0.0105***		0.0143***	0.168***	0.00820**
	(-4.12)		(4.68)	(52.9)	(2.47)
Observations' number	231346	529218	352370	418708	173585
PseudoR2	0.119	0.114	0.083	0.096	0.106

t statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CHAPTER 5
ICT, regulation and productivity

5.1. Introduction

Since the mid-1990s considerable attention has focused on the productivity effects associated with the adoption of Information and Communications Technologies (ICT). During a period in which US productivity growth exceeded that of most European countries, the impact of assets incorporating the latest technologies, such as ICTs, has proved to be significant in explaining these differences (O'Mahony and van Ark 2003)[105].

A number of possible drivers have been put forward to explain the constraints the EU faces compared with the US, which are preventing large-scale exploitation of ICT technology or, for example, the lack of complementary assets such as suitable skills (O'Mahony et al, 2008) and appropriate management systems (Basu et al. 2003). Others identify the slower pace of adjustment to a new industrial structure as a key driver in the disparity between the US and EU, highlighting the inhibitive institutional and regulatory environment as the chief cause in preventing a reallocation of productive resources (van Ark 2006).

Regulation can have both positive and negative effects on productivity (BERR, 2008). For example, regulation can have a positive effect on productivity and economic welfare by supporting competitive markets and protecting intellectual property or by correcting for some forms of market failure. However, the extent to which productivity gains for individual firms translate into aggregate productivity gains is regarded as depending largely on features such as the degree of competition in an economy (BERR, 2008). Regulations can distort firm and market behaviour, and they do not always result in a more efficient or desirable allocation of resources. While recognising the essential role that certain types of regulation can have on the functioning of markets, this study focuses on the detrimental impact that anti-competitive regulation can have on ICT investment and productivity growth.

The negative impacts of regulation can be direct or indirect (Crafts 2006). Direct negative effects are associated with resources being diverted away from the creation of productive output. In relation to these effects, the aim of administrative reforms is to *"eliminate those no longer needed, streamline and simplify those that are needed and improve the transparency of the application" (1997 OECD Regulatory Reform).* Indirect effects involve regulations that create entry barriers, impose rigidities in the labour market and affect wider incentives to innovate or accumulate human capital.

The 1997 OECD Regulatory Reform Report stresses the need to undertake economic reforms aimed to *"increase economic efficiency by reducing barriers to competition and innovation, often through de-regulation and use of efficiency-promoting regulation and by improving regulatory frameworks for market functioning and prudential oversight"*. Economic reforms have been central to the European Union's Single Market Programme, as it was thought that economic gains would result from intensification of competition in markets, lowering of trade barriers, and economies of scale brought about by expansion of the market (Nicodeme and Sauner-Leroy 2007). More recently, economic reforms have been central to the Lisbon Strategy launched in 2000, where one of the aims is to use product market reforms to increase productivity in the EU.

The purpose of the study

The purpose of this study is twofold: firstly, to explore the extent to which restrictions imposed by regulations of both product and labour markets have affected the uptake of ICT investments and, secondly, to investigate whether excessive regulation may also have hindered the effective conversion of these investments into productivity gains. The aim of this study is to provide a comprehen-

105 For a summary of main results, see recent i2010 Benchmarking Reports at and the economic note respectively:
http://ec.europa.eu/information_society/eeurope/i2010/key_documents/index_en.htm
http://ec.europa.eu/information_society/eeurope/i2010/docs/high_level_group/note_on_economic_impact_of_ict.pdf

sive account of how ICT affects productivity and the role that regulation characteristics may play in this process.

The analyses in this chapter will draw attention to both product and labour market regulations, acknowledging the importance of promoting competitiveness in both product and factor markets. The Lisbon Agenda emphasises the importance of freeing labour and product markets from uncompetitive restrictions, in order to increase employment and productivity growth in the European Union and to sustain long-term growth.

Additionally, this chapter contains analyses of how regulation can affect investment and productivity in particular industries. Many European countries have seen little improvement in productivity performance in recent years, despite the new opportunities offered by globalisation and new technologies – especially the information and communication technologies (ICT). The analyses of the impact of anti-competitive regulation in several industries will shed further light on the question of why Europe has not been able to reap the benefits of developments in ICT technologies to the same extent as the US. These analyses aim to contribute to the understanding of the factors affecting multifactor productivity growth in the long run, which is an issue that continues to challenge academics and policy makers. It is essential to increase understanding of whether barriers to competition significantly affect the adoption and dissemination of ICT technologies, which have been regarded as one of the motors of economic growth over the last decade.

5.2. Literature review

5.2.1. Theoretical background

In neoclassical theory, firms are seen as profit maximizing agents that make their input and output decisions in response to price signals under the assumptions of perfectly competitive markets and constant returns to scale. Technological progress is exogenous in these kinds of models. Within this framework, the argument in favour of policy interventions is to correct for some types of market failure, externalities, spillovers or public goods that prevent an efficient allocation of resources, such as barriers to entry in natural monopolies or screening procedures for start-ups. However, in practice, distortions in the way markets are regulated can result in inefficiencies, such as an excessive administrative burden for start-ups.

The literature highlights three channels by which reforms that improve the functioning of the markets can affect productivity, both directly and indirectly: through impacting on allocative efficiency, productive efficiency and dynamic efficiency (Nicodeme and Sauner-Leroy (2007); Griffith and Harrison (2004)).

Allocative efficiency arises from reallocation of resources between surviving firms and through the entry and exit of firms. Certain product market regulations may reduce the number of firms and provide firms with market power, or they may introduce barriers to entrepreneurship, making it difficult to set up new firms and create new jobs. These types of regulations often take the form of screening procedures and affect small and medium-sized enterprises, especially those which have been identified as key drivers of competition, growth and job creation. Regulations which limit entry may also have a negative impact on the adoption of existing technologies by reducing competitive pressures, technology spillovers or the entry of new highly innovative firms.

Productive efficiency is related to improvements in the utilisation of factors of production by firms. This type of efficiency is related to reallocation of resources and the introduction of new or better production processes within the firm, such as organisational change. Related to this type of efficiency is the principal-agent literature with asymmetric information, according to which competitive firms have incentives to reduce slack in managers and workers. Despite the fact that the impact of managerial slack is difficult to evaluate empirically, there is some evidence to indicate that the productivity of individual firms is higher in more competitive environments (Nickell, 1996).

Dynamic efficiency refers to the incentives to innovate, which is a crucial determinant of competitiveness and long-run growth. The idea that an increase in competition is positively related to innovation challenges Schumpeterian models that suggest a positive association between innovation and market power. In reality, the effects of product market competition on innovation can be diverse, depending on factors such as the technological characteristics of the industries, or the distance of a country from the technological frontier. Recently, the idea that the relationship between intensity of competition and innovation may be non-linear has been favoured (Aghion et al. 2005).

According to Aghion et al. (2005), in sectors where levels of competition are low, pre-innovation rents can be reduced by competition, thereby encouraging innovative investments to "escape competition". However, in sectors with high levels of competition, product market competition will mainly affect post-innovation rents, and therefore an increase in competition is likely to discourage innovation. In reality, many innovations are made by firms with dominant market positions, as they have stronger incentives to invest in the latest technologies. For example, in an analysis of British manufacturing firms, Blundell et al. (1999) found that a monopolist's large size resulted in higher levels of investment in research and development. Although different theoretical models identify different incentives to innovate associated with

an increase in competition, at an empirical level there is a consensus that, at least in the long run, some degree of product market competition is beneficial for innovation.

One of the channels by which regulation can affect productivity indirectly is capital investment. Regulations influence the costs that existing firms face when expanding their capital stock, and may divert resources from productive uses such as capital accumulation. However, de-regulation initiatives, such as privatisation of public enterprises which may have been heavy investors, may reduce overall investment. In principle, the effects that regulatory reform in product markets can have on overall capital formation are uncertain. Theoretical models, however, offer no clear explanation of how institutional and policy settings may be affecting the adoption and dissemination of ICT in particular. The decision to invest in innovative activities can be heavily influenced by the environment in which they operate, where uncertainty may be a determining factor (BERR, 2008).

Bartelsman et al. (2004) argue that barriers to the reallocation of capital and labour inputs may have a significantly negative impact on the successful adoption and dissemination of innovative technologies like ICT.

Labour market institutions may affect the incentives of an economy to invest, mainly via firing and hiring rules and the industrial relations regime (Bassanini and Ernst, 2002). In theory, the effects that regulations in the labour market have on incentives to invest in productivity-enhancing innovative activities are ambiguous, and most of the empirical evidence is inconclusive.

Theory also formulates a hypothesis regarding the complementarity of product and market regulations. Inefficient product market regulations can generate economic rents that also contribute to additional labour market rigidities (Nicoletti et al, 2000). In countries where product markets are highly regulated, workers tend to be highly protected, but the ability of workers to appropriate rents from firms is thought to depend on a number of other institutional factors, such as the degree of unionisation and the level of collective wage bargaining. Minimum wages and generosity of unemployment insurance can play a role through their impact on wage structure and workers' bargaining power (Acemoglu and Shimmer, 1999). Blanchard and Giavazzi (2003) demonstrate that product market deregulation, by decreasing total rents, reduces the incentives for workers to appropriate a proportion of these rents and is likely to facilitate labour market deregulation.

Given the existence of trade-offs between static and dynamic efficiency, as well as the wide heterogeneity in the array of regulatory interventions, evidence of economic outcomes is quite disparate in the literature, usually highlighting a number of ambiguities in the magnitude and direction of the effects. The next section reviews empirical findings on these issues.

5.2.2. Empirical evidence

This section contains a review of relevant studies which have analysed the relationship between the stringency of regulation and productivity and ICT investments. The review focuses on studies which have analysed the influence that deregulation in product markets can have in fostering investment and productivity growth. In particular, cross-country empirical research conducted with policy indicators developed by the OECD are of interest. Additionally, existing evidence on the microeconomic impacts of labour market institutions and regulations will be reviewed.

With regard to productivity performance, Nicoletti and Scarpetta (2003) find evidence of a negative relationship between total factor productivity growth and three economy-wide measures of regulation, with the highest correlation for the indicators of administrative burdens, which represent a uniform barrier to entry for business in most industries. They also find evidence that regulatory reform in terms of privatisation and entry liberalisation in certain services sector have had a positive influence on total factor productivity growth for a number of OECD countries. More recently, Inklaar et al. (2008) have found that liberalisation of entry in markets has been beneficial for productivity growth in telecommunications, but not in other services industries.

With regard to investment, Griffith and Harrison (2004) conclude that regulatory reform which stimulates competition in a market is likely to increase factor demand. However, this is only observed for the services sectors. On industry-specific regulations, Alesina et al. (2005) find evidence that liberalisation, particularly on barriers to entry, is likely to spur investment in network industries. Other papers have investigated the effects of regulation on FDI (Nicoletti et al. 2003) and the presence of foreign affiliates (Conway et al. 2006).

Using firm-level data for the Czech Republic, Arnold et al. (2007) find links for improved productivity in manufacturing sectors from non-manufacturing regulatory reform, particularly with regard to reforms of trade regulations. Loayza et al. (2004) stress the importance of considering the time dimension in any analysis, showing that both product market and trade reforms have significant positive effects on growth, even though these may take some time to materialise.

Most empirical research so far has looked at the impact of regulation on productivity growth, on investment or innovation outcomes, but has focused less on the links between regulation, ICT investments and productivity.

Gust and Marquez (2004) argue that IT expenditures may be an important factor in explaining cross-country differences in productivity growth in the 1990s. They suggest that regulatory barriers, particularly employment protection legislation and several administrative burdens on businesses, have hindered the adoption of ICT outside the US. Focusing on the comparison between the US and the UK, they point out that lower competitive pressures in the UK may have lowered incentives to cut costs through ICT or any other kind of investment.

Nicoletti and Scarpetta (2003) provide additional evidence to suggest that countries and industries experiencing slow changes to their regulatory environment are suffering from technology gaps in their ICT industries in particular. Recently, Arnold et al. (2008) have argued that the differences in the timing of the technological boom in ICT technologies and the regulatory reform process in Europe were key factors in hindering the effective accumulation of ICT capital, in particular in services industries, where deregulation has been much slower to take place.

Moreover, other studies show that the detrimental effect of anti-competitive regulation on productivity during the 1990s was especially large in those sectors producing or using ICT intensively (Conway et al. 2006). This is attributed to the fact that regulatory barriers for diffusion tend to be higher in these sectors than in the rest of the economy. When there are rapid improvements in productivity, the positive effects of pro-competition regulations are amplified, which increases the dispersion of productivity levels across countries with different regulatory regimes. Gains from market reform should therefore be higher in ICT-intensive sectors, where product market reform is found to have a direct impact on labour productivity growth.

The impact of employment protection legislation has been investigated recently by Bassanini et al. (2009), using aggregate data on the stringency of the dismissal regulations and industry data on productivity. Their findings indicate that mandatory dismissal regulations have a detrimental effect on productivity in those industries where layoff restrictions are more likely to be binding.

In summary, there is a wealth of evidence in the literature that regulatory reform is likely to improve competition and productivity at the market level, as well as innovation and investment at the firm level. These are the main channels through which productivity is likely to be affected by regulation. One should bear in mind that regulation is multifaceted and affects different sectors differently. It is also important to consider the starting point in terms of the level of regulation in any given country or industry, since this appears to be an important determinant in terms of the effect that reforms are likely to have. As Alesina et al. (2005) point out, "*small changes in a heavy regulated environment are not likely to produce much of an effect*" (p. 792). The lack of time series data on regulation has traditionally been highlighted in the literature as a limitation. The increasing availability of such data in conjunction with harmonised data on output and inputs provided by EU KLEMS makes it possible to undertake the type of analysis that follows.

5.3. Regulations and ICT investments

The empirical analysis begins by considering the effect that the various dimensions of product and labour market regulations can have on aggregate capital formation, focusing on the ICT investment of the aggregate economies. This analysis is complemented by industry-level data in order to further investigate the potential harmful effect of anti-competitive regulation on ICT investments.

The importance of ICT for economic growth has been highlighted in the literature. Work carried out at the OECD suggests that investments in ICTs are positively correlated with uptake and dissemination of innovation. In particular, the use of ICT is closely linked to the ability of firms to innovate (OECD, 2004).

5.3.1. Impact of regulations on aggregate investments

As reviewed in the previous section, regulation is a broad concept and encompasses many dimensions in which citizens and businesses operate. Most of the empirical analyses of regulation and performance focus either on specific industries where regulation is heaviest or on firm-level studies. Investigation of the effects for overall economies has been generally overlooked (OECD, 1997), and the influence of different types of regulations is typically limited by a lack of data.

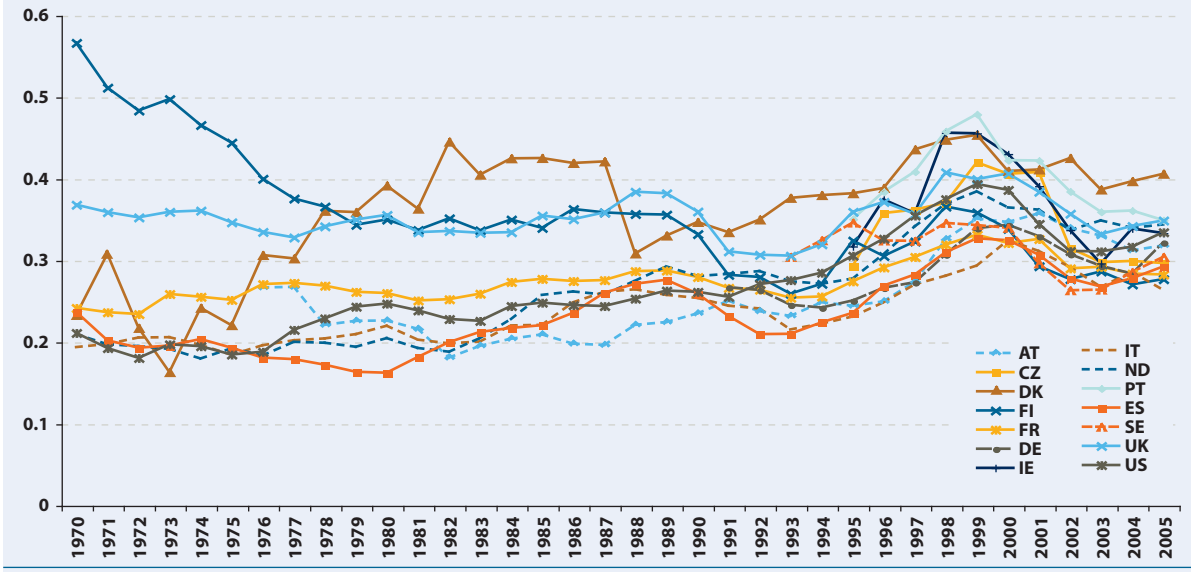
This section examines the influences that several features of the product and labour markets have on ICT investment performance at national level. It provides an insight into how individual regulations may promote or restrict resources spent on innovative technologies, and makes it possible to assess whether a high degree of State control of business enterprises is good or bad for investment, as well as establishing the extent to which legal and administrative burdens and barriers to international trade and investments are deterring capital formation.

The EU KLEMS Productivity Accounts database for the years 1990-2005 is used for this purpose[106] [107]. This data-

106 In the empirical exercise it has been assumed that the value taken by the OECD indicators in 1998 applies also to the period 1990-2000, and that the value taken by the indicator in 2003 applies to the period 2000-2005; this approximation enables the regulation to be matched with economic data, which is available on an annual basis. A similar approach has been used previously in the empirical literature (Nicoletti and Scarpetta, 2003). Whilst a new release of data has been recently published by the OECD for the year 2008, this cannot be fully incorporated into the model due to the lack of EU KLEMS data for the same years.

107 http://www.EU KLEMS.net.

Figure 5.1: ICT investment rates across countries, 1970-2005



Source: EU KLEMS database.

base contains harmonised data on output, inputs and productivity for European countries and the US. It is supplemented by the OECD Product Market Regulation indicators database for the years 1998 and 2003, and by the OECD-CEP database on labour institutions for the period 1960-2004.

The OECD Product Market Regulation Indicators (OECD PMR)[108], which embrace the whole economy, are cardinal measures that increase in relation to the degree of restriction they impose on market mechanisms. Most of these restrictions relate to barriers to market access, which are inherently anti-competitive, and to government interference with market mechanisms in areas such as price controls.

The OECD PMR indicators are available for OECD countries for the years 1998, 2003 and 2008, and cover an extensive range of regulatory areas within both the economic and administrative environments. At the most disaggregated level, 16 detailed indicators of regulation are provided (Low-Level Indicators), which are further classified into three broad regulatory domains: State control over business enterprise; Barriers to entrepreneurship; and Barriers to trade and investment (Medium-Level Indicators). At the top level, the indicators summarise the degree of strictness of the overall regulatory environment (High-Level Indicators). The aggregate measures of regulation are likely to impose strong restrictions on the way individual regulations can affect productivity growth. Therefore, this study investigates which specific regulations have the greatest effects by using the indicators at different levels of disaggregation.

The properties of the OECD PMR indicators are desirable for cross-country comparisons of regulatory structures and for analyses of the effects of differences in regulation on performance. They are policy-focused and not based on opinion surveys or market outcomes; this makes them a useful tool for empirical research linking policy and performance[109].

Additionally, the OECD-CEP labour market institutions (CEP LMR) dataset is used. This dataset provides relevant indicators in the various areas of the labour market, such as employment protection legislation, trade union, wage bargaining and minimum wage or active labour market policies.

Descriptive analyses

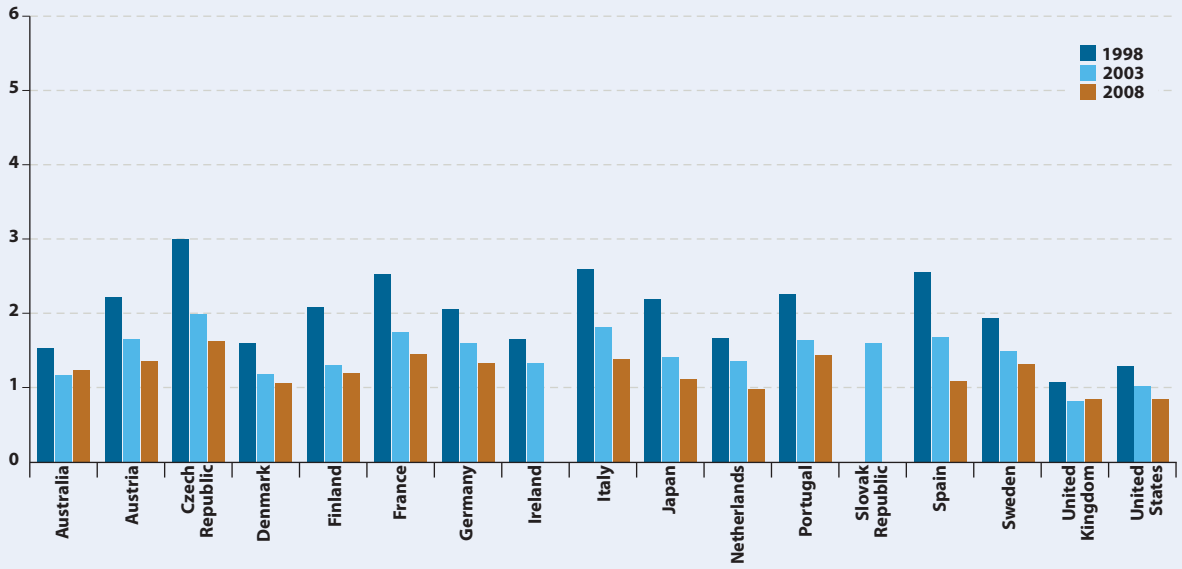
Graphic exploration of investment rates[110] shows that, up to the mid-1990s, ICT investment rates showed considerable disparities between from countries. From that point onwards, the ICT investment rates across countries have followed a similar trend, increasing between 1995 and 2000, decreasing between 2000 and 2003, and increasing again for the period 2004-2005. Despite the similarities in the trend of investment over the past few years, there are still major differences in investment

108 See Appendix for a description of sources and descriptive statistics.

109 See Wolfl et al. (2009) for a more thorough description of this source.

110 Investment rates are defined as gross fixed capital formation over stocks of capital.

Figure 5.2: OECD PMR, 1998, 2003 and 2008



Source: OECD International Regulation Database.

levels. The countries with higher than average ICT investment rates in the period 1995-2000 – measured as gross ICT capital formation over stock of ICT capital – are Denmark, Ireland, Australia, United States, United Kingdom and Portugal. The countries with lower ICT investment rates are Spain, Austria, Italy and Germany. Of the new Member States in the EU, the Czech Republic shows a high investment rate (0.37), which is above the average for all countries in the reference period, while Slovenia has an investment rate below the average. In the subperiod 2000-2005, ICT investment rates were generally lower in the EU countries and the US.

The descriptive analysis of the OECD PMR summary indicators points to a general trend towards lower regulation (see Figure 5.2). However, it also reveals a great deal of variety in the extent of regulation across the countries covered by the study. This is true for both the initial values of the dataset in 1998 and the most recent update to the data in 2008, which suggests that there is more room for further deregulatory measures in some countries than in others. The countries that are the most liberal in terms of the functioning of their product markets are the United States, Australia and some European countries, such as the United Kingdom, Ireland and Denmark. At the other end of the scale, the countries which have more restrictions on their operation in the product markets include continental European countries such as Italy, France and Spain, and some new Member States such as the Czech Republic. This cross-country variation will help us to investigate the extent to which deregulation may promote investment and affect performance[111].

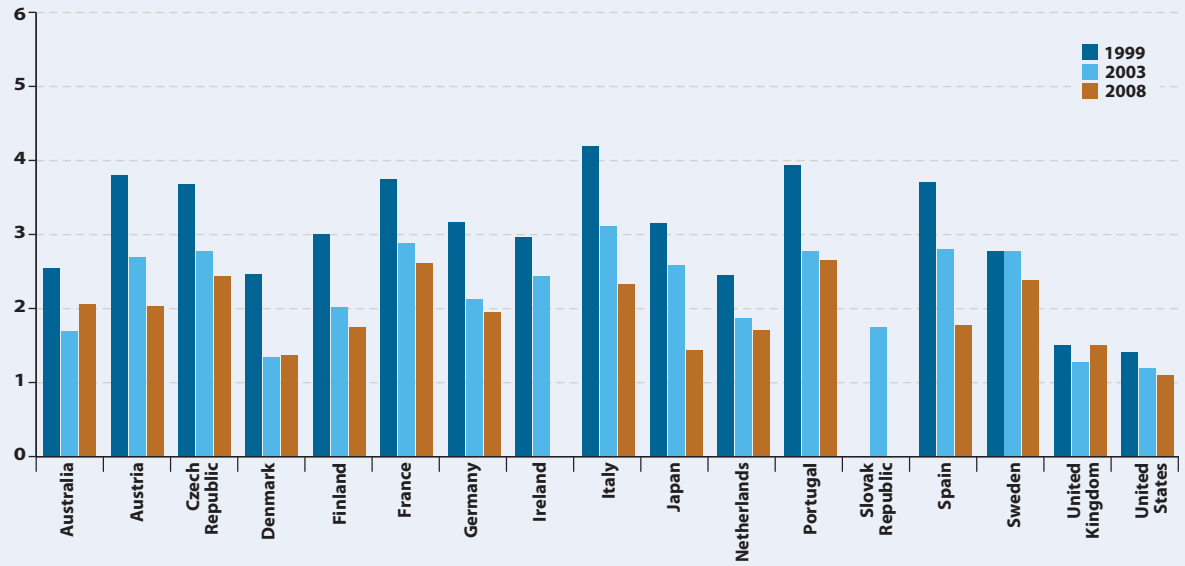
The OECD PMR indicators mask a considerable variation in the way countries have implemented reforms in several dimensions of the business environment. The levels of state control are lower in those countries which present lower restrictions in the product markets overall (Figure 5.3). Although there has been a general tendency towards a decrease in participation by the State in economic activity, the level in many European countries remains high.

Figure 5.4 shows a high variation as regards the indicators for "Administrative barriers to start-up". EU countries such as Ireland, Denmark and the United Kingdom show lower levels of administrative burdens for start-ups than does the United States. At the other end of the scale, the countries with the highest levels include Czech Republic, Austria, Spain and Italy, with the last two having reduced the level of regulatory burden dramatically during the period under review.

A third important aspect of the product markets is forward-oriented, and refers to the extent to which barriers to trade and investment with other countries represent significant restrictions to economic activity. Figure 5.5 shows that the lowest barriers are found in countries such as the United Kingdom, Ireland, Denmark and Sweden. Compared to these, the barriers to trade and invest-

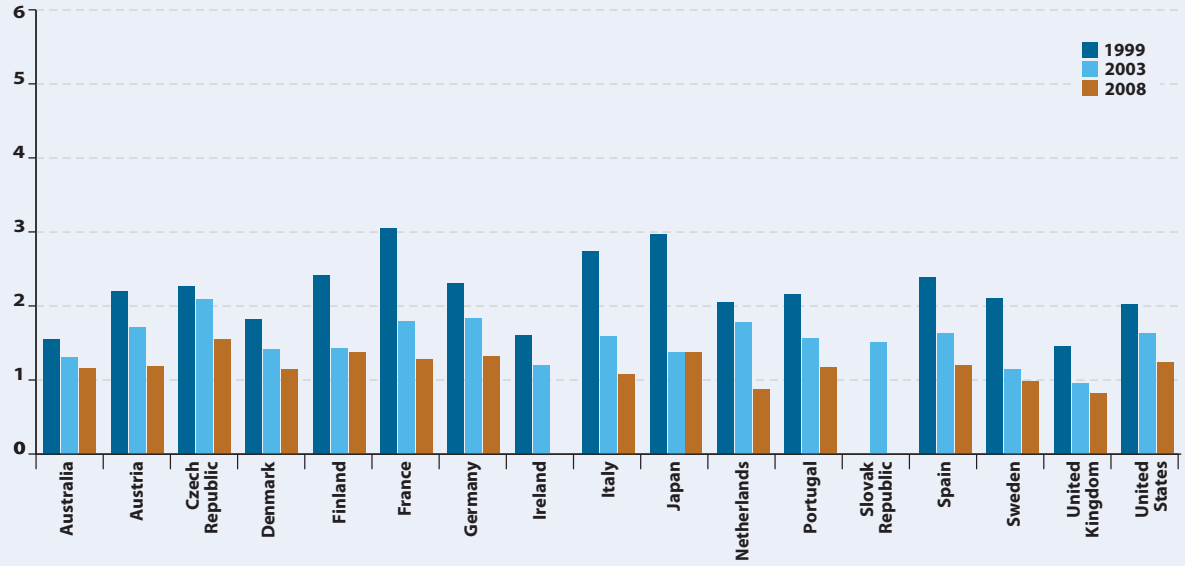
111 The term "performance" refers to how a country, industry or firm fares with regard to different economic outcomes.

Figure 5.3: OECD PMR, Degree of State control, 1999, 2003 and 2008



Source: OECD International Regulation Database.

Figure 5.4: OECD PMR, Administrative barriers on start-ups, 1999, 2003 and 2008

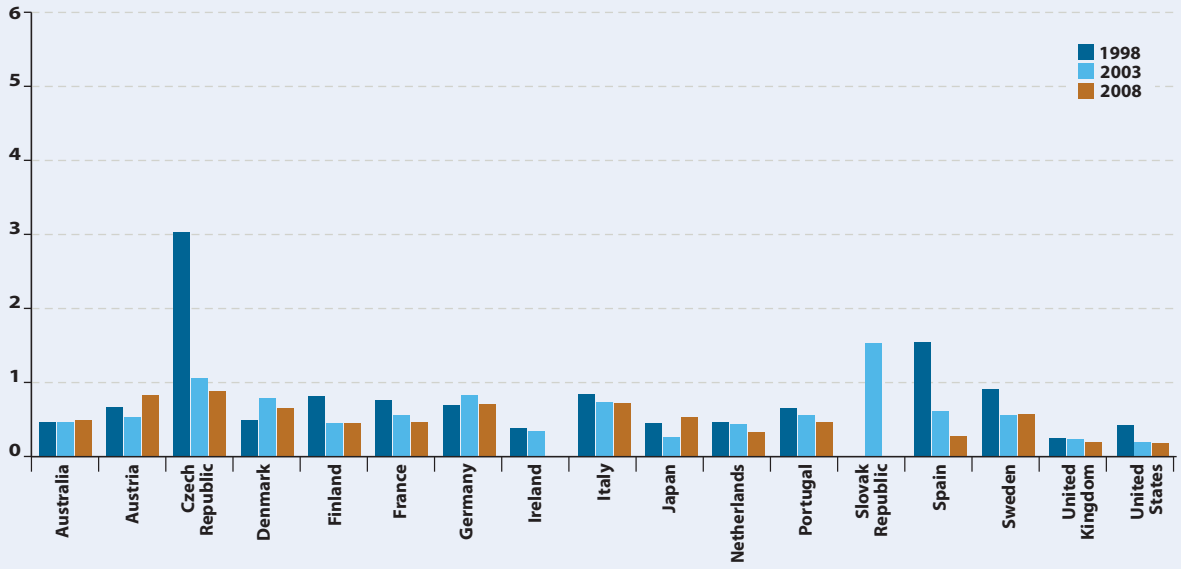


Source: OECD International Regulation Database.

ment are found to be higher in the US. Although barriers to trade and investment remain higher in the bigger EU countries such as Germany, France and Italy, restrictions have been significantly reduced during the period from 1998 to 2008.

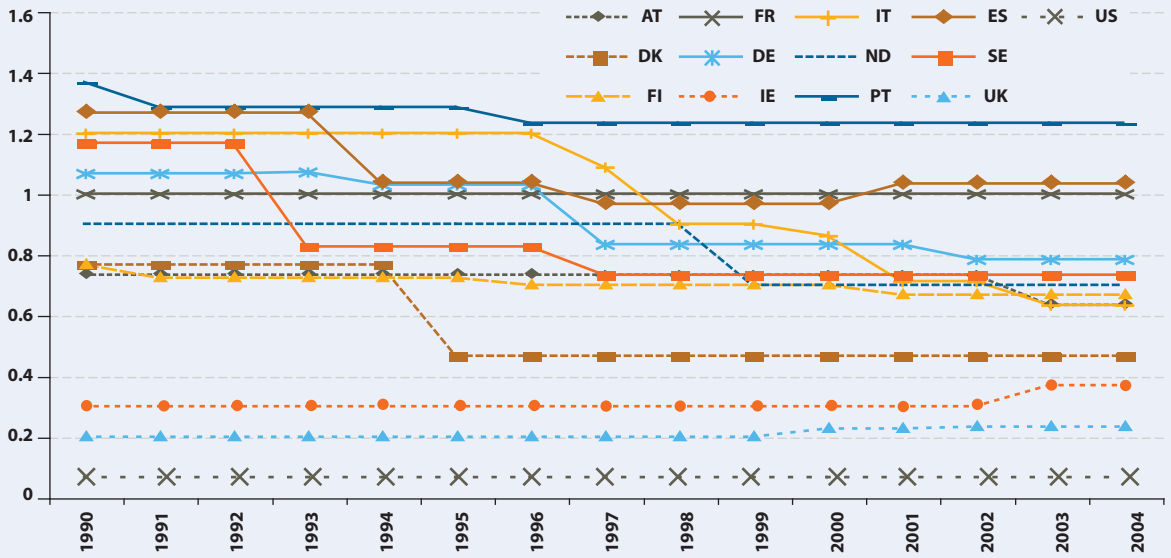
As regards job protection, the level of Employment Protection Legislation (EPL) is a proxy for rigidity of the labour markets. The US is undoubtedly the country with the lowest level of EPL, and the UK and Ireland are the two European countries that rank closest to it. The countries with the strictest job protection are Portugal, Spain, France and Germany (cf. figure 5.6).

Figure 5.5: OECD PMR, barriers to trade and investment,1999, 2003 and 2008



Source: OECD International Regulation Database.

Figure 5.6: OECD Indicators of Product Market Regulation, employment protection legislation, 1999, 2003 and 2008

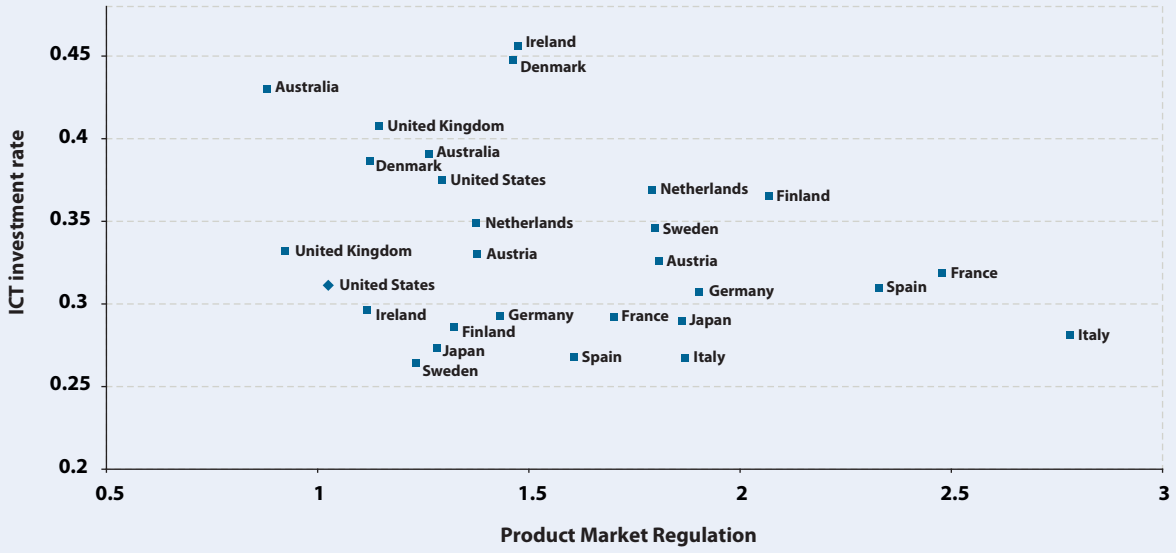


Source: OECD International Regulation Database.

Figure 5.7 below reveals the existence of a negative correlation between ICT investment rates[112] and the degree of product market regulation at the economy level. A similarly negative relationship is observed between ICT investment rates and the degrees of employment protection legislation, as one would expect given the high existing correlation between the degree of product market regulation and the level of employment legislation (Figures 5.8 and 5.9). These graphs show that, in general, those countries with a more restrictive product and labour market regulation spend less of their resources on ICT investment. In the next section, an econometric analysis is undertaken in order to investigate whether the divergent ICT investment rates can be explained by the regulatory restrictions. The analysis also addresses the causality of the relationship, as well as the possible influence of other factors.

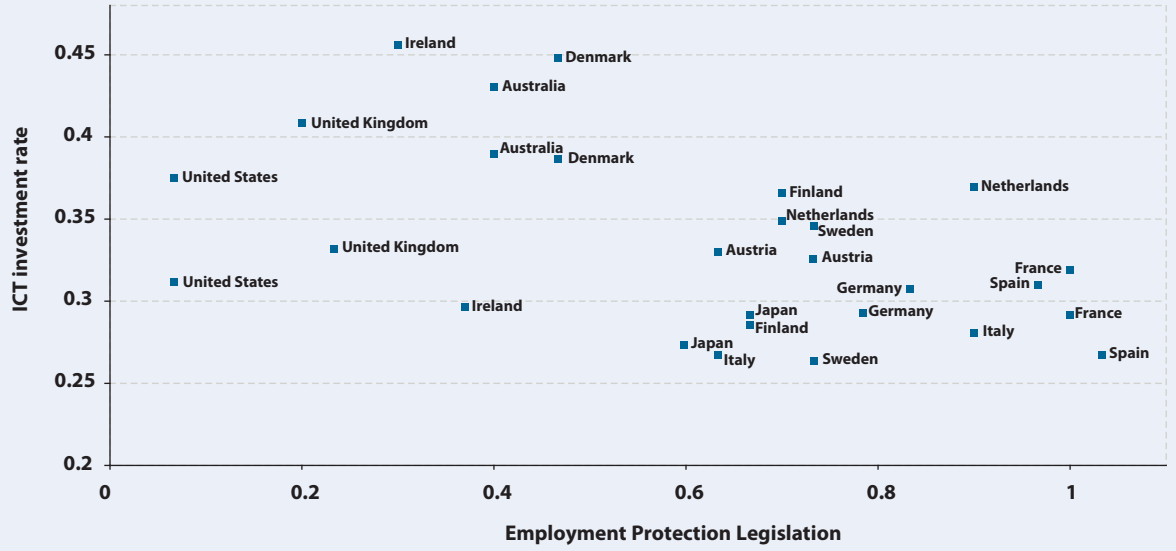
112 Defined as gross fixed capital formation in constant terms divided by real capital stocks.

Figure 5.7: Scatter Plot of PMR and ICT Investment Rate (Sources: EU KLEMS and OECD)



Source: EU KLEMS and OECD.
Note: Spearman rank correlation = -0.27 (P-value = -0.17).

Figure 5.8: Scatter Plot of EPL and ICT Investment Rate (Sources: EU KLEMS and OECD)



Source: EU KLEMS and OECD-CEP.
Note: Spearman rank correlation = -0.49 (P-value = 0.01).

Figure 5.9: Scatter Plot of Product Market Regulation (OECD) and Employment Protection Legislation (CEP-OECD) for 1998 and 2003

Source: OECD and OECD-CEP.
Note: Spearman rank correlation = 0.72 (P-value = 0.00).

Methodology

The assessment of how regulatory environment can shape capital formation is based on a general model of investment by Hasset and Hubbard (1997), where the outcome variable is the gross fixed capital formation of a particular asset, scaled by its stock of capital. The following equation is employed to estimate the influence that the level of regulation can have on investment in asset *a* in country *i* in time *t*. A lagged dependent is introduced to take account of dynamics of the investment process, as in Alesina et al. (2005).

$$\left(\frac{GFCF}{K}\right)^{a}_{it} = \left(\frac{GFCF}{K}\right)^{a}_{it-1} + REG_{it} + Z_{it} + u_{it} \qquad (1)$$

Equation (1) is estimated separately for ICT assets and non-ICT assets as in Oliner and Sichel (2000). Note that, in the above equation, *GFCF* represents gross fixed capital formation in constant terms, *K* represents real capital stock[113], REG is a vector of regulatory variables, OECD PMR or CEP LMR, Z is a vector of control variables and u represents the standard error term.

The vector Z consists of a set of country-specific, time-varying control variables that can affect country-level investment. This includes the ratio of the deflator for asset k relative to the value added deflators. Despite the predictions of the neoclassical model that firms use prices as signals for their investment decisions, there is not much evidence that investment can be explained by the cost of capital.

The inclusion of the price of ICT assets as a control variable is appropriate here, given that the ICT investment boom in the second half of the 1990s was linked to the sharp fall in the relative price of computers.[114] Although the user cost of capital consists of a price component and a non-price component, the downward trend has been mainly related to the fall in prices of ICT capital goods (Bakhshi et al. 2003). A measure of the profitability of capital is also included in order to gauge the possibility that investment may react to changes in the desired capital stock, which can be determined by demand/output conditions. All control variables are available within the EU KLEMS database for the total economy.

Econometric results

This section presents the econometric results of evaluating the impact of product and labour market regulations on country-level investment rates. Equation (1) is estimated for the period 1990-2005, including a variety of indicators. An OLS estimation technique[115] with time dummies to control for common macroeconomic effects

113 In the EU KLEMS database it is assumed that all investment in year *t* takes place at the beginning of the year and that the stock of capital in year *t* corresponds to the stock available at the end of the prior period or t-1.

114 EU KLEMS take account of rapidly falling prices in their capital input calculations by using constant-quality price indices for each asset type, which is particularly important for those assets that are subject to rapid technological change and improvements in quality, such as IT assets.

115 Ordinary least squares (OLS) is a technique for estimating the unknown parameters in a linear regression model. The OLS method minimises the sum of squared distances between the observed responses in a set of data, and the fitted responses from the regression model.

Table 5.1: Impact of product market regulation on ICT investment at the economy-wide level plus control variables 1990-2005, OECD economy-wide indicators (Medium- and High-Level Indicators)

Dependent variable: log (GFCF ICT/Capital stock ICT)	High Level Product Market regulation.	Economic and Administrative	Inward and Outward policies	Medium Level Indicators
Laged dependent variable	0.828***	0.778***	0.814***	0.804***
	(0.0415)	(0.0423)	(0.0412)	(0.0414)
Product market regulation	-0.0357**			
	(0.0144)			
Administrative regulation		-0.0364***		
		(0.0101)		
Economic regulation		-0.00266		
		(0.0112)		
Inward-oriented policies			-0.0447***	
			(0.0121)	
Outward-oriented policies			0.0198	
			(0.0170)	
State control				-0.0128
				(0.00832)
Barriers to entrepreneurship				-0.0385***
				(0.0142)
Barriers to trade and investment				0.0198
				(0.0150)
Gross Operating Surplus/ICT capital	0.00551	9.57e-06	0.0121	0.00542
	(0.0183)	(0.0182)	(0.0187)	(0.0184)
ICT deflator/VA deflator	-0.0475**	-0.0612***	-0.0508**	-0.0526**
	(0.0206)	(0.0206)	(0.0206)	(0.0206)
Observations	206	206	206	206
R-squared	0.906	0.911	0.906	0.910
Year dummies	Yes	Yes	Yes	Yes

is employed[116]. Country dummies are not included in the specification since the identification strategy used here relies mainly on cross-country variation in the levels of regulation[117].

The main drawback with the use of OECD PMR indicators is the lack of time-series data on regulatory conditions at country level, which makes it difficult to establish causality between regulation and investment. Caution is therefore advised as other country-specific unobservable characteristics which are correlated with the restrictiveness of the regulatory environment may influence the investment decisions of firms. Despite this drawback, the association between regulation indicators and investment performance will offer an invaluable insight into how different cross-country patterns of regulation may be relevant in explaining differences in ICT investment outcomes. Some additional tests that evaluate the robustness of the results are also presented.

The role of product market regulations

OECD High and Medium Level Indicators of Product Market regulation

The results of estimating equation (1) using the High and Medium level indicators of regulation are shown in Table 5.1. The High Level indicator comprises the overall degree of product market regulation in an economy, column 1, as well the degree of restrictions in the economic and administrative, column 2, and in the inward and outward-oriented policy areas, column 3. Robust standard errors are shown in brackets[118]. The coefficient of the lagged dependent variable is displayed in row 1 of Table 5.1.

The results show a negative and significant effect for the aggregate indicator of product market regulation on ICT investments (column 1). The coefficient of the administrative regulation indicator is negative and significant, while the coefficient of economic regulation is not significantly different from zero (column 2). It can also be seen that inward-oriented policies have an adverse impact on

116 Given that the efficiency of the standard OLS estimation relies on the homoskedasticity (or constant variance) of the residuals, standard errors are adjusted to allow for within-country and within-industry correlation.

117 An ANOVA analysis shows that country effects absorb more than half of the variation in the investment rates.

118 The statistical significance of the coefficients is indicated by a series of stars, with "*" indicating that the results are significant at the 10 per cent level, "**" at the 5 per cent level, and "***" at the 1 per cent level.

ICT investment (column 3), while the coefficient on the outward policies indicators is not significantly different from zero.

The Medium-Level Indicators represent the extent to which "Barriers to entrepreneurship", "State control" and "Barriers to trade and investment" have an influence on the adoption of ICT by an economy. The coefficient of the "Barriers to entrepreneurship" indicator is the only coefficient which has a negative sign at conventional levels of significance.

With regard to the coefficients of the control variables, prices of the ICT assets have a significant negative impact on investment, while the measure of profitability, namely gross operating surplus[119] over capital, does not appear to have a significant impact on this type of capital formation. Equation (1) was estimated both with and without the set of control variables. The inclusion of other potential determinants of investment did not alter the finding that the degree of regulation, particularly of an administrative nature, has a significant negative impact on ICT capital accumulation.

OECD Low Level Indicators of Product Market Regulation Indicators

Next, the results for the ICT investment equation (1) with the OECD Low-Level Indicators are presented, see table 5.2. The results presented in table 5.1 showed that restrictions of an administrative nature are likely to adversely affect the adoption of ICTs for aggregate economies. However, the question is whether it is possible to identify which areas of the administrative environment can have the most deterrent effect when decisions are being taken to invest in new technologies such as ICTs. The availability of detailed regulatory indicators makes it possible to distinguish between the specific regulatory areas that are driving the results.

The results in table 5.2 indicate that "Administrative burdens to start-ups" have a significant negative influence on ICT investment – see column 1 – which is also the case for the "Licences and permits system". Within the areas of "Administrative burdens to start-ups", the indicator for "Administrative burdens for sole proprietor firms", column 2, has a major negative influence on ICT, as does "Sector-specific administrative burdens", column 3, although to a lesser extent than the former. On the other hand, the "Administrative burdens for corporations", column 4 indicator, does not seem to have a significant negative impact on this type of investment.

The results in table 5.2 also show that neither the degree of state control, nor the size or scope of the public enterprise sector or the degree of direct control over business enterprise has a significant influence on the aggregate ICT investment of the economies.

Instead, it is observed that "Antitrust exemptions" have a significant positive impact on ICT investment, while "Barriers to trade and investment" have no significant influence.

Table A.2 in the appendix shows the set of results for non-ICT investment. While this is not the prime objective of this analysis, it does present an interesting comparison with respect to the investment behaviour of ICT assets.

The group of non-ICT assets conceals a highly heterogeneous situation, including a diversity of assets such as machinery and other equipment and residential constructions. The coefficient of the lagged dependent variables is higher than in the case of ICT investment. This reflects the lower depreciation rates of non-ICT assets, which make the investment rate, as it has been defined, more persistent[120]. In other words, non-ICT investment is explained by investment in previous periods to a larger extent than ICT assets, consistent with a priori expectations.

Table A.3 and A.4 provide further detail on the effect of product market regulation and detailed asset level[121].

Robustness Analysis

In this section, an additional check is conducted to assess the robustness of the relationship between the strictness of the regulatory settings and ICT investment.

The robustness test that is carried out relies on the use of an aggregate indicator of regulatory conditions in seven non-manufacturing sectors, known as OECD ETCR indicators.[122] This indicator was used to interpolate economy-wide regulation information described in the previous section, OECD PMR, which is available for the years 1998, 2003 and 2008, to the period 1990-2005. An interpolation technique known as the Kalman filter

119 Gross operating surplus is defined as value added at basic prices minus compensation of employees minus taxes net of subsidies.

120 The investment rate is defined as I/K ; capital stocks are constructed following the PIM method as $K_t = K_{t-1}(1-\delta) + I_t$, therefore a higher depreciation rate, *ceteris paribus*, would encompass more persistence in the investment rate.

121 Results in table A.3 and A.4 show that product market regulation has a negative and significant effect upon investment in IT, Software and Other Machinery and Equipment, while the effects on other assets are not significant. Looking specifically at IT, it appears that the effects of regulation are being driven by inward, economic regulation. Using more disaggregated indicators, the only significant variable is "Barriers to entrepreneurship", which falls within the grouping of administrative regulation. With regards to Software, both economic and administrative regulation have important parts in restricting investment, with "Barriers to entrepreneurship" as well as "State control" driving the results. Finally, a look at "Other Machinery" reveals "State control" again as the main barrier to investment. The indicator for "State control" has a significant and negative effect upon transport equipment, while "Barriers to entrepreneurship" has an effect upon investment in residential structure.

122 The OECD ECTR data is not available for New Member States. See Conway et al. (2006) for information on this data source.

Table 5.2: Impact of product market regulation on ICT investment at the economy-wide level, 1990-2005, OECD economy-wide level (Low-Level indicators)

Dependent variable: log (GFCF ICT/Capital stock ICT)	Aggregate Barriers to entrepreneuship	Administrative burden for sole proprietors	Sector specific burdens	Administrative burden for corporations
Lagged dependent variable	0.794***	0.729***	0.791***	0.835***
	(0.0439)	(0.0536)	(0.0424)	(0.0404)
Size of public enterprise sector	0.00481	0.000674	0.00618	0.00408
	(0.00576)	(0.00556)	(0.00577)	(0.00589)
Scope of public enterprise sector	-0.00865	-0.00567	-0.0112	-0.0123
	(0.00858)	(0.00851)	(0.00841)	(0.00879)
Direct control over business enterprise	0.00216	0.00163	0.00180	6.02e-05
	(0.00345)	(0.00312)	(0.00334)	(0.00378)
Price controls	0.00151	-0.00257	0.00137	-0.00255
	(0.00802)	(0.00741)	(0.00782)	(0.00873)
Use of command & control regulation	-0.000128	0.00120	0.000142	-0.00332
	(0.00457)	(0.00466)	(0.00439)	(0.00426)
Licence and permits system	-0.00655**	-0.00913***	-0.00679**	-0.00522*
	(0.00314)	(0.00333)	(0.00313)	(0.00307)
Communication and simplification of rules and procedures	0.00351	0.0114	0.00541	0.00171
	(0.00951)	(0.00921)	(0.00944)	(0.0103)
Administrative burdens on startups	-0.0215**			
	(0.00906)			
Administrative burdens for sole proprietor firms		-0.0282***		
		(0.00861)		
Sector specific administrative burdens			-0.0179***	
			(0.00647)	
Administrative burdens for corporation				-0.00509
				(0.00709)
Legal barriers	-0.00754	-0.0159**	-0.00861	-0.00675
	(0.00684)	(0.00760)	(0.00693)	(0.00700)
Antitrust exemptions	0.0202**	0.0191**	0.0220**	0.0186*
	(0.00929)	(0.00912)	(0.00923)	(0.00947)
Barriers to trade and investment	0.0237	0.0234	0.0230	0.0224
	(0.0181)	(0.0173)	(0.0180)	(0.0192)
Observations	221	221	221	221
R-squared	0.913	0.916	0.913	0.910
Year dummies	Yes	Yes	Yes	Yes

was used to form smoothed estimates of the aggregate OECD PMR indicators. Although it is not feasible to incorporate the latest 2008 information into the econometric analysis, this additional information is useful as a way of obtaining smoothed estimates of the product market regulation for the period 1990-2005.

The ETCR summary measures provide a summary of regulatory conditions in telecoms, electricity, gas, post, rail, air passenger transport and road freight, on an annual basis, for the period 1975-2007.

Definitions and descriptions of how these indicators are constructed can be found in an OECD working paper, Conway & Nicoletti (2006) where the purpose and scope of the indicators are provided: "The overarching criterion on which this paper surveys and addresses regulations is their effect on competition where competition is viable. Therefore, each of the OECD sectoral indicators reflects regulations that curb efficiency-enhancing competition, whereas regulations in areas in which competition would not lead to efficient outcomes (e.g. natural monopolies) are not considered. All of these indicators

are constructed from the perspective of regulations that create barriers to entrepreneurship and restrict competition in domestic markets where technology and demand conditions make competition viable. It is important to note from the onset that the sole objective of the indicators is to quantify the degree to which regulatory settings in a given sector are anti-competitive."

The ETCR indicators are often used as a proxy for overall economy-wide regulation, given the high level of correlation between the ETCR indicator and the indicator at country level, OECD PMR indicators, in the two years during which they overlap (Conway et al. 2006). The implicit assumption for the validity of the smoothed estimates is that the trend of the overall product market regulation is similar to the regulation in non-manufacturing sectors.

The introduction of the interpolated series as the alternative indicator of regulation, i.e. the estimation of the baseline equation (1), shows the significant negative impact of the level of product market regulation on ICT investment, with a coefficient of -0.0730. The coefficient on the non-ICT investment is insignificant, see table 5.3.

The results of estimating equation (1) with the interpolated series appear to be consistent with the evidence presented so far, but again care has to be taken in inferring causality from these results, for two reasons. Firstly, the slow evolution of product market regulation implies that identification is still likely to come mainly from variation in the cross-section dimension rather than through changes in regulation over time. Secondly, all interpolation techniques are likely to be subject to measurement error. The interpolated series provide additional time series variation on the regulation variable and make it possible to check for unobservable characteristics in the country that affect investment decisions[123].

Table 5.3: ICT and non-ICT investment using interpolated series for product market regulation, 1990-2005

Dependent variable: GFCF ICT/ICT capital stock	ICT capital	Non-ICT capital
Interpolated Product Market Regulation	-0.0730***	-0.00109
	(0.0166)	(0.00266)
Gross operating surplus/ICT capital stock	-0.0189	0.102*
	(0.0340)	(0.0524)
ICT Deflator/VA deflator	-0.0956**	-0.0807**
	(0.0437)	(0.0382)
Lagged dependent variable	No	No
Country dummies	Yes	Yes
Year dummies	Yes	Yes
Observations	162	159
R-squared	0.901	0.984

Complementarities between product and labour market regulations

The analysis in this section goes a step further by examining whether the impact of product market regulations on ICT adoption could depend on one feature of the labour market institutional arrangements – the degree of employment protection legislation – which is often used in the empirical literature as a proxy for market rigidity. Several studies find that product market regulation appears to be linked to employment protection legislation (Nicoletti, Scarpetta and Boylaud, 2000), which raises the question of whether policies in the two regulatory areas are "politically complementary" (Conway et al. (2005)). The complementarities highlighted in the literature between product and labour market regulations provided the inspiration for the analysis of these interactive effects.

Using cluster analysis techniques, the sample of countries was divided into three groups according to the average level of employment protection legislation from the CEP-LMR dataset. The countries that are characterised by a low level of employment protection legislation include the United States, Australia, Ireland and United Kingdom; the countries with a medium level include Austria, Denmark, Finland, Netherlands, Japan and Sweden; and the countries with a high level of employment protection legislation include Italy, Germany, Portugal, Spain and France. The CEP-OECD institutional data set does not cover the new EU Member States.

Equation (1) is now estimated subject to the inclusion of an additional interaction term: namely the product of the aggregate product market regulation indicator, OECD PMR, and two dummies characterising the High and Medium Employment Protection Legislation regime.[124] Additionally, results for a further breakdown of ICT assets, namely computers, software and communications equipment, are presented. The estimation of the coefficient on the interaction terms will provide an indication of the additional impact that product market regulation has on investment in countries with higher levels of job security.

Results in table 5.4 below show a significant negative coefficient for the interaction term of the product

123 In order to quantify how important the country fixed effects are in determining investment, an ANOVA analysis was carried out which makes it possible to attribute the observed variation in ICT-intensity to factors that both change over time, and factors that change between countries. For ICT assets, over 50% of the variation in ICT intensity is accounted for by country effects and almost 25% by time effects. The unexplained residual accounts for 20% of the variation in the ICT investment rate; so there is still a significant part of the variation to be explained by variables that vary by country and over time (e.g. regulation).

124 The dummy for countries with Low Employment Protection Legislation is omitted in the estimation to avoid multicollinearity problems.

Table 5.4: Effect of general product market regulation on ICT investment according to level of employment protection legislation

Dependent variable: GFCF asset/Capital stock asset	IT	CT	Software
Prodreg*Medium EPL	-0.00658*	-0.00274	-0.000140
	(0.00391)	(0.00371)	(0.00273)
Prodreg*High EPL	-0.00588	-0.00286	-0.00231
	(0.00360)	(0.00311)	(0.00219)
Ecreg*Medium EPL	-0.00336	-0.00234	0.000660
	(0.00314)	(0.00288)	(0.00225)
Ecreg*High EPL	-0.00325	-0.00210	-0.00153
	(0.00287)	(0.00238)	(0.00177)
Adreg*Medium EPL	-0.00723**	-0.00199	-0.00144
	(0.00323)	(0.00299)	(0.00210)
Adreg*High EPL	-0.00624**	-0.00262	-0.00256
	(0.00300)	(0.00259)	(0.00177)
Lagged dependent variable	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	206	206	206

market regulation indicator and the dummy variable representing Medium EPL in the case of Information Technology assets. It can also be seen that the negative impact of product market regulation on IT investment arises mainly from the restrictions in the administrative environment. This is shown by the significant negative impact of such investment on the interaction between administrative regulation and the dummies characterising both high and medium employment protection regimes. The interpretation of this finding is that a restrictive product market regulation is likely to have had a greater deterrent effect on investment in computers in countries with high employment protection legislation than in countries with a low level of employment protection legislation. These results are consistent with the view that product regulation and labour market regulation are complementary.

These results are in tune with recent empirical evidence which finds that the benefits from deregulating one market increase as the level of regulation in the other market decreases (Nicoletti and Scarpetta, 2005 and Griffith, Harrison and McCartney 2006). Although these results appear promising, further research would be needed to understand the dynamics involved, the direction of the effects, and how the interactions are bound to depend on the role played by other variables, such as turnover and employment.

5.3.2. Impact of anti-competitive regulation on industry ICT investments

This section addresses the issue of whether anti-competitive regulation of an economic nature has had an impact on ICT investment performance at the industry level. Competition has been highlighted as one of main drivers of economic growth (Aghion and Griffith, 2005), but more research is needed in order to understand the mechanisms underpinning the links between competition forces and several dimensions of economic growth.

The analysis is relevant from a policy perspective, given that a large proportion of the productivity gap experienced by the European countries can be attributed to the productivity trends in a few industries. Further understanding of why Europe lags behind in productivity can be of prime interest for policy makers.

The usual way to examine the link between competition and economic outcomes is to relate some indicators of market structure, e.g. price cost margins and concentration indices to variables such as productivity, innovative activity, employment etc. However, this work follows Nicoletti and Scarpetta (2003) by assessing the relationship between productivity growth and several indicators that measure the restrictiveness of regulatory conditions. The availability of time series basis data will be helpful for assessing dynamic effects on the relationship between regulation and productivity, such as the short-term versus the long-term effects.

In this section we explore how anti-competitive regulation has affected ICT investment in what are traditionally heaviest-regulated sectors of the economy (electricity, gas, air passenger transport, rail transport, road freight, postal services and telecommunications)[125]. For this purpose, the OECD ETCR indicators for the period 1975-

125 Conway & Nicoletti (2006) constructed the ETCT indicator in order to cover "some of the non-manufacturing industries in which anti-competitive regulation has traditionally been heaviest in OECD countries".

2007 are used[126]. For this part of the analysis the newly released data from the GGDC-EU KLEMS have also been used (see Inklaar and Timmer, 2008).

The OECD ETCR indicators measure regulation on a scale from 0 to 6, with 0 being the least restrictive, reflecting regulations that curb efficiency-enhancing competition.[127] Four main areas are covered: "Public ownership" (prevailing ownership structure); "Barriers to entry" (e.g. number of competitors in markets and choice of supplier for consumers); "Vertical integration" (available for the electricity, gas and rail industries only and refer to whether activities such as generation of electricity, production of gas and supply of both to the final consumers are separated from natural monopoly activities, such as national grid or local distributions, or the assessment of economies of scale vs. unbundling in the transport sectors); and "Market structure" (available for the gas, rail and communications industries only, and refers to the shares of the largest companies). These measures do not cover regulation areas in which competition does not yield efficient outcomes, such as natural monopolies.

In order to match the OECD ETCR regulation data to the EU KLEMS list of industries, the regulation indices for the seven sectors were aggregated into three broader sectors: utilities (including electricity and gas); communication (including telecommunication and post); and transportation (including airlines, road freight, and railways). This analysis builds on the analysis developed by Alesina et al. (2005), using more recently released data and focusing on ICT assets.

Short-run versus long-run effects

Despite widespread regulatory reforms in recent years, significant differences remain across countries and industries in terms of their regulatory settings, as well as in the pace at which countries are implementing economic reforms. In general, the levels of anti-competitive regulation in these sectors remain high. Given that the changes over time in the OECD ETCR indicators used here are small, and that the data show a high degree of country-specific variation, it is useful to distinguish between the impact of the level and the changes in the degree of regulation.

In this section, the effect of anti-competitive regulation is estimated using an error correction methodology (ECM). This methodology offers an insight into the "levels effect" (or long-run effect) and "differences" effects (short-run effect). The expression for the error correction estimation is the following[128]:

$$\Delta\left(\frac{GFCF}{K}\right)_{ijt}^{k} = \gamma_0 - (1-\alpha)\left(\frac{GFCF}{K}\right)_{ijt_{-1}}^{k} + \beta_1 \Delta REG_{ijt} + \gamma_1 (1-\alpha) REG_{ijt-1} + Z_{ijt} + u_{ijt} \quad (2)$$

In this model, the long-run effect is given by the level of regulation lagged by one period, $\gamma_1(1-\alpha)$, and the short-run effect by the coefficient of the change in the regulation indicator, β_1 .

The results of estimating equation (2) using indicators for the "Overall regulatory conditions", "Public ownership", "Barriers to entry", "Vertical integration" and "Market structure", are displayed in Table 5.5 for ICT assets (See Appendix table A.7 for non-ICT assets). The results in Table 5.5 show the coefficients on the "lagged" and "differences" terms of the several indicators, which gives an indication of short and long-run effects. Fixed effects by time, industry and country were added in the regression.

The coefficient of the error correction term or - $(1-\alpha)$ in table 6 is between zero and minus one, which shows that this modelling strategy is consistent with the existence of an error mechanism that ensures convergence towards equilibrium. The estimates show a significant negative coefficient for "Vertical integration" in the long run. The magnitude of the impact is -(0.00397/0.330)=0.0102. This means that ICT investment will increase by slightly more than one percentage point if the indicator of regulatory conditions decreases in one unit (note that the average ICT investment rate for the period 1975-2005 is 0.26). This finding is consistent with the literature on the topic, where cross-industry studies conclude that "Vertical integration" is negatively associated with ICT investment (Dewan et al. 1998; Acemoglu et al. 2004).

The results reveal that regulatory reforms in the utilities, transport and communications sectors have had a greater impact on non-ICT investment than on ICT investment. The impact of public ownership in these sectors is found to be non-significant for both ICT and non-ICT investment. The short-term effects, which are related to changes in regulatory conditions, appear more relevant for non-ICT investment than for ICT investment.

A word of caution is in order when interpreting the results. The analysis of the impacts of regulation on investment only refers to anti-competitive regulation. The impacts of pro-competitive regulation of network industries which are implemented to foster competition, for instance by facilitating access to the network for competing companies, are not analysed here.

126 Conway & Nicoletti (2006), " The sole objective of the indicators is to quantify the degree to which regulatory settings in a given sector are anti-competitive." Conway and Nicoletti (2006) also provide a detailed explanation of sources and construction of the indicators see.

127 The description of the ETCT indicators follow closely Conway and Nicoletti (2006).

128 See Appendix for derivation of the ECM equation.

Table 5.5: ICT Investment and Regulation in non-manufacturing sectors, 1975-2005

Dependent variable:Δ(Log GFCF ICT/ICT capital stock)	Aggregate indicator	With barriers to entry	With public ownership	With market structure	With vertical integration
	(1)	(2)	(3)	(4)	(5)
Lagged dependent variable	-0.316***	-0.331***	-0.332***	-0.330***	-0.331***
	(0.0374)	(0.0363)	(0.0365)	(0.0471)	(0.0362)
Lagged regulatory conditions	0.000160				
	(0.00223)				
Lagged public ownership		0.000786			
		(0.00153)			
Lagged barriers to entry			0.00221		
			(0.00188)		
Lagged vertical integration				-0.00397*	
				(0.00218)	
Lagged market structure					0.000377
					(0.00142)
Δ Regulatory conditions	-0.00142				
	(0.00575)				
Δ Public ownership		-0.00133			
		(0.00546)			
Δ Barriers to entry			-0.000241		
			(0.00376)		
Δ Vertical integration				-0.00312	
				(0.00390)	
Δ Market structure					-0.00515
					(0.00384)
Gross operating surplus/ICT Capital	0.00958***	0.0102***	0.00998***	0.0119***	0.0102***
	(0.00212)	(0.00205)	(0.00203)	(0.00384)	(0.00204)
ICT deflator/VA deflator	-0.0102	-0.00914	-0.00908	-0.00708	-0.00910
	(0.00685)	(0.00675)	(0.00678)	(0.00833)	(0.00677)
Country dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	971	997	997	670	997
R-squared	0.237	0.246	0.247	0.238	0.247

Anti-competitive regulation and investment across the economy

This section examines the extent to which restrictions of competition have a detrimental effect on ICT investment in different sectors of the economy. It is very difficult to obtain direct measures of prevailing competitive conditions that can be compared across industries. Therefore, the OECD regulation impact indicators for the period 1975-2003 are used as a proxy (Conway et al. 2006). These indicators measure the extent to which restrictions of competition in key services sectors impact on other sectors of the economy. Given the increasing role of the services sectors as a supplier of inputs, this is considered to be a useful proxy for quantifying the stringency of competitive conditions. The value that the regulation impact indicators take for a particular sector will depend on two main factors: the level of regulatory conditions in the electricity, communications and transport industries, ETCR indicators, as well as in the retail and the finance sector; and, secondly, the weight of the inputs from this sector in the total input requirements.

ICT Taxonomy

Given the wide sectoral variation in the rates of ICT investment and the regulation impact measures, the industries are grouped according to a number of common features for the industries. The aim is to investigate whether the relationship between anti-competitive regulation and ICT investment differs for industries that make intensive use of ICT, as compared with those that do not (OECD 2002)[129]. According to Inklaar et al. (2003),

129 The ICT sector is defined by the OECD as a combination of manufacturing and services industries that capture, transmit and display data and information electronically. One important feature of this definition, based on an international standard classification of activities (ISIC Rev. 3), is that it breaks the traditional ISIC dichotomy between manufacturing and services activities. While the production or distribution of ICT products can be found everywhere in the economy, the identification of sectors whose main activity is to produce or distribute ICT products constitutes a first-order approximation of the ICT sector.

an ICT taxonomy is used to classify industries according to whether they are producers or users of ICT.

From a policy perspective this analysis is likely to be highly significant, given that some of the sectors at the heart of the differences in productivity between the US and the EU, such as wholesale and retail, business services and financial intermediation, were heavy users of ICT[130]. Stiroh (2002b) showed that the acceleration in productivity growth in the US was entirely accounted for by ICT-Producing and ICT-Using sectors.

Econometric results

Equation (2) was estimated using OLS. Time and sector dummies were added to check for common macroeconomic effects. While country fixed effects are not explicitly included in the estimation, the estimated standard errors are clustered to account for within-country correlation in the residuals[131]. Standard errors are shown in brackets[132].

The results for ICT investment are shown in table 5.6. They reveal a negative and significant long-run effect of regulation on ICT investment in the ICT-producing manufacturing sector and the non-ICT manufacturing sectors[133]. A short-run effect is found for the ICT-producing services sector, which relates to the post and telecommunications sectors, consistent with the idea that liberalisation and ex-ante regulation implemented in previous public monopolies have boosted ICT investment.

With regard to the coefficients of the control variables, the ratio of gross operating surplus relative to the stock of ICT capital is – as one would expect – positive and significant, while the estimate of the price of ICT yields no significant results. The coefficient of the error correction term, which is given by the level of ICT investment lagged by one period, $-(1-\alpha)$, is between zero and minus one, as expected.

These findings suggest that restrictions to competition in the markets are potentially harmful in the long run for those manufacturing sectors that are not considered heavy users of ICT, such as the traditional manufacturing sectors. No significant effect is found for services or manufacturing sectors that are more intensive users of ICT. A cautious approach should be taken in interpreting these effects. This is due to the fact that the regulation impact indicator only serves as a proxy for competitive conditions in the sectors, because of the lack of data on sector-specific regulations.

5.4. Regulations and productivity growth

The analysis in this section attempts to explore whether regulatory restrictions have had an effect not only on the accumulation of ICT capital, as investigated in previous sections, but also on its productivity impact. A flexible econometric approach is employed to assess whether the realisation of the returns to ICT across countries and industries may depend on the strictness of regulatory regimes. Evidence for both labour productivity and multifactor productivity will be provided. This will present a comprehensive picture of direct and indirect gains associated with the use of ICT. The multifactor productivity analysis provided at the industry level will be of particular interest in determining the role of spillover effects, since these cannot be captured using a growth accounting methodology.

5.4.1. Impact of regulations on ICT contributions to aggregate productivity growth

The aim of the analysis in this section is to investigate the extent to which different dimensions of the regulatory environment can hinder the realisation of the returns to ICT. Economy-wide indicators of restrictions in the product market indicators are used: OECD PMR and the EU KLEMS database for the total economies for the period 1990-2005.

Methodology

A standard Cobb-Douglas production function, including ICT capital as a separate input of production, is used to estimate the contribution of ICT capital to output and the role that regulation can play in terms of realising these returns, Hempell (2002):

$$Y = AK^{\alpha}L^{1-\alpha} \tag{3}$$

Dividing by employment and taking logs, a linearised version of the production function in terms of labour productivity is obtained:

$$\ln\left(\frac{Y}{L}\right)_{jt} = \alpha + \beta_1 \ln\left(\frac{KICT}{L}\right)_{jt} + \beta_2 \ln\left(\frac{KNICT}{L}\right)_{jt} + T_t + \varepsilon_{jt} \tag{4}$$

The dependent variable is value added relative to labour input. ICT capital, non-ICT capital and labour input are

130 See Table A.8 in the Annex.

131 This increases the reliability of the estimates, given that OLS technique relies on the assumption of the independence between residuals and the explanatory variables.

132 The statistical significance of the coefficients is indicated by a series of stars, with "*" indicating that the results are significant at the 10 per cent level, "**" at the 5 per cent level, and "***" at the 1 per cent level.

133 When country effects are included, the estimation yields ambiguous results for non-ICT manufacturing sectors, with counteracting short-run and long-run effects. Given this, and the fact that regulation largely varies by country, the country fixed effects are excluded from the estimation. This provides more intuitive results on how economies that differ in their regulatory settings may fare in terms of investment. The results for the other groups of sectors were not altered significantly by the inclusion of country fixed effects.

right-hand side or explanatory variables. The aggregate production function set out in (4) is augmented by indicators of product/labour market regulation and estimated for a sample of EU countries and the US for the period 1990-2005. The advantage of an econometric approach relative to the growth accounting method is its flexibility to evaluate further influences on labour productivity that are not fully captured by the use of inputs.

$$\ln\left(\frac{Y}{L}\right)_{jt} = \alpha + \beta_1 \ln\left(\frac{KICT}{L}\right)_{jt} + \beta_2 \ln\left(\frac{KNICT}{L}\right)_{jt} + \beta_3 REG_{jt} + \beta_4\left(REG_{jt} * \ln\left(\frac{KICT}{L}\right)_{jt}\right) + T_t + \varepsilon_{jt} \quad (5)$$

Y denotes value added in real terms, L denotes hours, $KICT$ denotes the stock of ICT capital and $KNICT$ the stock of non-ICT capital.

The sign on the coefficients of the regulation variables in (5), β_3 , will reveal whether restrictions to competition in the product markets affect labour productivity directly. The coefficient of the interaction of regulation with ICT capital, β_4 , will indicate whether regulation affects productivity indirectly, by hindering the returns to ICT. This may be a reflection of the fact that labour productivity is not constant across all values of the regulation indicator.

Equation (5) is estimated using OLS in levels with robust standard errors and including time effects to check for common macroeconomic developments, e.g. the high growth rate in ICT capital stocks since the second half of the 1990s. Estimating the level will provide an insight into the long-run relationship between the variables, which seems appropriate at the economy level, as the impact of ICT on the production process is more likely to materialise in the long run (Venturini, 2008).

Although OLS is a suitable econometric technique, it is useful to keep in mind some issues that can potentially bias the estimated coefficients, including the endogeneity of the right-hand side variables, such as input and regulation variables. Given that richer countries are in a position to devote more resources to reforming their regulatory environment, it is not unrealistic to think that the effect of productivity on the state of regulation itself can be reflected in the values shown by the indicators. Despite this acknowledgement, the potential endogeneity of the regulation variables is likely to be minor, given the lack of time variation of the regulation indicators and its slow response to reflect changes in economic conditions. The use of regulation indicators rather than other measures used in the literature, such as mark-ups or concentration ratios, is therefore intended to minimise endogeneity problems.

Table 5.6: ICT Investment and Regulation across ICT and non-ICT sectors, ECM

	ICT-Producing			ICT-Using			Non-ICT		
Dependent variable: Δ(GFCF ICT/ICT Capital)	All industries	Manufacturing	Services	All industries	Manufacturing	Services	All industries	Manufacturing	Services
ecm	-0.279***	-0.459***	-0.217***	-0.318***	-0.361***	-0.237***	-0.320***	-0.357***	-0.261***
	(0.0432)	(0.0743)	(0.0323)	(0.0799)	(0.0991)	(0.0194)	(0.0769)	(0.0837)	(0.0609)
ΔRegulation Impact	-0.187	-0.881	-0.235*	-0.520	-0.876	-0.278	-0.0364	-1.647	0.0147
	(0.160)	(1.315)	(0.128)	(0.602)	(1.119)	(0.646)	(0.0419)	(0.942)	(0.0380)
Lagged regulation impact	-0.0245	-0.384**	-0.0782	-0.00541	-0.136	0.0114	-0.0599***	-0.253*	-0.0214
	(0.0305)	(0.170)	(0.0485)	(0.0375)	(0.171)	(0.0232)	(0.0186)	(0.129)	(0.0196)
Gross operating surplus/ICT capital	0.00900**	5.88e-05	0.0138**	0.00467	0.0120*	-0.000227	0.00997***	0.0128***	0.00770**
	(0.00391)	(0.00558)	(0.00559)	(0.00436)	(0.00579)	(0.00283)	(0.00314)	(0.00327)	(0.00252)
ICT deflator/VA deflator	0.0116	-0.0138	0.00390	-0.000834	0.000298	-0.00127	-0.00683	-0.0108	0.000251
	(0.0101)	(0.0132)	(0.0174)	(0.00837)	(0.00986)	(0.00641)	(0.00689)	(0.00661)	(0.00852)
Dummy 1995-2000	0.0344*	0.0298	-0.00854	0.0273	0.0343***	0.0194	0.0253	-0.0104	0.0334
	(0.0168)	(0.0306)	(0.0221)	(0.0154)	(0.0109)	(0.0108)	(0.0176)	(0.0182)	(0.0203)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	475	242	233	1465	746	719	3141	2161	980
R-squared	0.294	0.434	0.283	0.257	0.288	0.293	0.240	0.277	0.195

The role of product market regulations

The results of estimating equation (5) are shown in Table 5.7[134]. The indicators for "Administrative barriers to start-up", column 1, the indicators on "Administrative burdens for sole proprietors" column 2, "Sector-specific administrative burdens", column 3 and "Administrative burdens for corporations", column 4 all have a negative and significant influence on productivity. The coefficient for the indicator on "Barriers to trade and investment" is also negative and significant. Other indicators that negatively influence productivity include "Legal barriers" and "Communication and simplification of rules and procedures". Some regulatory areas within the economic regulation areas, such as "Direct control over business enterprises", on the other hand, display a positive influence on productivity.

With regard to the coefficient of the interactive terms in equation (5), the interaction between "Barriers to start-ups" and ICT capital shows a negative and significant coefficient. This is the case when the overall indicator of "Administrative burdens on start-up" is included (column 1) and also when more disaggregated indicators of barriers to start-ups are used; here, the largest negative impact is for "Administrative barriers to corporations" (column 4)[135]. The coefficient of the interaction between "Barriers to trade and investment" and ICT capital also presents a negative coefficient. When interactions are introduced, the main effects of the regulation indicators remain negative and significant.

The results presented above suggest that the more restrictive the product market regulation, particularly as regards barriers to start-up and barriers to trade and investment, the lower the impact of ICT on productivity for the aggregate economy, *ceteris paribus*. This finding is in line with evidence that demonstrates the crucial role of regulations for the establishment of new business in the dissemination of ICTs (Bassanini and Scarpetta, 2002).

134 Estimation was carried out with and without interaction terms. The results of the main effects of the regulation indicators when one includes interactions are close to those in the model without interactions.

135 When interaction effects are not included in the specification, the "Barriers to start-ups" indicator did not have a significant impact on labour productivity.

Table 5.7: Labour Productivity and OECD PMR, Low-Level Indicators

Dependent variable: Log value added/hour	With aggregate barriers to start-ups	With barriers sole proprietors	With sector-specific barriers	With barriers corporations
Log ICT capital/hour	0.0548	-0.00796	0.0422	0.0785
	(0.0714)	(0.0729)	(0.0713)	(0.0832)
Log non-ICT capital/hour	0.578***	0.507***	0.511***	0.631***
	(0.0623)	(0.0671)	(0.0573)	(0.0618)
Size of public enterprise sector	-0.0108	-0.0275**	-0.0114	-0.00333
	(0.0130)	(0.0131)	(0.0140)	(0.0135)
Scope of public enterprise sector	0.0922***	0.0978***	0.0811***	0.0799***
	(0.0180)	(0.0211)	(0.0188)	(0.0186)
Direct control over business enterprise	0.0237***	0.0190**	0.0215***	0.0293***
	(0.00819)	(0.00838)	(0.00791)	(0.00789)
Price controls	-0.0323	-0.0505**	-0.0376*	-0.0340*
	(0.0202)	(0.0203)	(0.0208)	(0.0179)
Use of command & control regulation	0.00247	-0.00409	-0.00658	-0.00902
	(0.0136)	(0.0150)	(0.0119)	(0.0104)
Licence and permits system	-0.00502	-0.000848	-0.000639	-0.00152
	(0.0103)	(0.0125)	(0.0105)	(0.00786)
Communication and simplification of rules and procedures	-0.0935***	-0.112***	-0.103***	-0.0771***
	(0.0209)	(0.0206)	(0.0197)	(0.0251)
Administrative burdens on startups	-0.103***			
	(0.0298)			
Administrative burdens for sole proprietor firms		-0.0422*		
		(0.0228)		
Sector specific administrative burdens			-0.0461**	
			(0.0196)	
Administrative burdens for corporation				-0.104***
				(0.0255)
Legal barriers	-0.0661***	-0.0445**	-0.0530***	-0.0636***
	(0.0186)	(0.0211)	(0.0182)	(0.0152)

Table 5.7: Labour Productivity and OECD PMR, Low-Level Indicators (continued)

Dependent variable: Log value added/hour	With aggregate barriers to start-ups	With barriers sole proprietors	With sector-specific barriers	With barriers corporations
Antitrust exemptions	-0.0230	-0.0160	-0.00696	-0.0340*
	(0.0226)	(0.0238)	(0.0232)	(0.0204)
Barriers to trade and investment	-0.178***	-0.248***	-0.223***	-0.133**
	(0.0639)	(0.0622)	(0.0647)	(0.0579)
Interaction size public*ICT	0.0231	0.0134	0.0307*	0.0410**
	(0.0170)	(0.0178)	(0.0176)	(0.0173)
Interaction scope public*ICT	0.0247	0.0189	-0.00419	0.0396
	(0.0232)	(0.0260)	(0.0237)	(0.0245)
Interaction control business enterprise*ICT	0.00479	0.00398	0.00299	0.0166
	(0.00954)	(0.00922)	(0.00944)	(0.0115)
Interaction price controls*ICT	-0.0392	-0.0186	-0.0143	-0.0502*
	(0.0261)	(0.0248)	(0.0240)	(0.0303)
Interaction command control*ICT	-0.00362	-0.00745	-0.0238	-0.0368
	(0.0256)	(0.0294)	(0.0246)	(0.0248)
Interaction licences and permits*ICT	0.0129	0.0228	0.0226	0.0135
	(0.0153)	(0.0165)	(0.0167)	(0.0154)
Interaction communication and simplification*ICT	0.115**	0.0413	0.0728*	0.176**
	(0.0499)	(0.0421)	(0.0400)	(0.0719)
Interaction barriers to start-up*ICT	-0.125***			
	(0.0240)			
Interaction Barriers sole proprietors*ICT		-0.0639***		
		(0.0224)		
Interaction sector-specific barriers*ICT			-0.0470**	
			(0.0191)	
Interaction barriers corporations*ICT				-0.136***
				(0.0251)
Interaction legal barriers*ICT	0.0642**	0.0843***	0.0615**	0.0395
	(0.0249)	(0.0258)	(0.0264)	(0.0267)
Interaction antitrust exemptions*ICT	0.0495*	0.0638**	0.0645**	0.0364
	(0.0265)	(0.0258)	(0.0277)	(0.0287)
Interaction barriers to trade and investment*ICT	-0.0475	-0.0850*	-0.0841*	-0.0564
	(0.0437)	(0.0442)	(0.0464)	(0.0386)
Year dummies	Yes	Yes	Yes	Yes
Country dummies	No	No	No	No
Observations	242	242	242	242

The role of labour market regulations

Table 5.8 shows the results of estimating equation (5) using institutional characteristics of the labour market as indicators. Owing to a high correlation across the indicators, the estimation strategy is based on introducing the indicators sequentially.

The institutional features of the labour market summarised by the indicators include: the strictness of employment legislation, union coverage, the degree of bargaining coordination, the degree of bargaining centralisation, benefit replacement rates and the share of GDP spent on active labour market policies. The interaction of the labour market indicator variables with ICT capital reveals that employment protection legislation may have a negative impact on productivity. This may however also indicate insufficient training opportunities provided by companies. Moreover, one can also find evidence of positive interaction effects of specific variables, such as the degree of union coverage, bargaining centralisation, gross benefit replacement rates and labour market policies per unemployed.

With regard to the coefficients of the inputs of the production function, the coefficient of the non-ICT capital is positive and significant, while the coefficient of the ICT capital is small or non-significant. These results are in line with most of the empirical evidence on the magnitude of the returns to ICT.

5.4.2. Impact of anti-competitive regulations on ICT contributions to industry productivity growth

In this section, an industry perspective to investigate whether a regulation that is anti-competitive hinders the translation of ICT capital into multifactor productivity gains is adopted.

Table 5.8: Labour Productivity and Labour Market Institutions, OECD-CEP

Dependent variable: log (VA/hour)				
Log (ICT capital/hour)	0.0818	0.179**	0.00557	0.0363
	(0.0708)	(0.0738)	(0.0624)	(0.0678)
Log (Non-ICT capital/hour)	0.436***	0.423***	0.412***	0.410***
	(0.0427)	(0.0461)	(0.0479)	(0.0522)
EPL* (ICT capital/hour)	-0.103***	-0.0641*	-0.299***	-0.275***
	(0.0344)	(0.0376)	(0.0594)	(0.0591)
Union coverage* (ICT capital/hour)	0.184**	0.251**	0.133	0.0853
	(0.0929)	(0.107)	(0.0906)	(0.0875)
Bargaining coordination* (ICT capital/hour)		-0.0956*	-0.0896**	-0.111**
		(0.0507)	(0.0407)	(0.0442)
Bargaining centralisation* (ICT capital/hour)			0.163***	0.161***
			(0.0379)	(0.0407)
Benefit replacement rates* (ICT capital/hour)			0.298***	0.360**
			(0.0788)	(0.156)
Active labour market policies* (ICT capital/hour)				0.0256
				(0.189)
Observations	220	220	220	206
R-squared	0.585	0.597	0.634	0.632

Anti-competitive regulation and the returns to ICT in key service sectors

This section explores the links between anti-competitive regulation, ICT capital and multifactor productivity for non-manufacturing sectors during the period 1975-2005. The ETCR indicators and the EU KLEMS database are used for this analysis.

A specification of the regression equation similar to equation (5) is used, but with multifactor productivity as the dependent variable (Stiroh, 2002a). Multifactor productivity is regressed on ICT capital, non-ICT capital, labour, indicators of regulation and the interaction between the ICT capital and the regulation indicators in equation (6):

$$\Delta MFP_{ijt} = \alpha + \beta_1 \Delta KICT_{ijt} + \Delta\beta_2 KNIT + \Delta\beta_3 LAB + \Delta\beta_4 REG + \beta_5 \left(REG_{ijt} * \Delta KICT_{ijt} \right) + T_t + I_i + \varepsilon_{ijt} \quad (6)$$

Multifactor productivity is defined as the change in output after taking into account the growth of capital and the quantity and quality of labour input. It is calculated using the growth accounting assumptions of constant returns to scale and remuneration of inputs according to their marginal productivities. In the neoclassical setting, capital deepening contributes directly to labour productivity growth, but not to total factor productivity growth, and it therefore fails to account for the interaction between different inputs to production, particularly human capital or ICT capital. Multifactor productivity, i.e. efficiency gains associated mainly with the use of ICT, are not fully captured in that framework. The hypothesis that ICT has an impact on multifactor productivity on top of capital deepening is tested.

The results from the estimation of equation (6) are presented in table 5.9. They show a negative coefficient for the indicators of aggregate regulatory conditions. This finding is consistent with the idea that liberalisation in these sectors has led to increases in multifactor productivity growth, as in Nicoletti and Scarpetta (2003). A similar impact is observed when the measures for "Public ownership" and "Vertical integration" are used, which suggest that fewer restrictions regarding vertical integration and more privatisations are associated with increases in multi-factor productivity in these sectors. In turn, the role of the barriers to entry appears insignificant in terms of productivity in these sectors.

The coefficient of the interaction term between regulation and ICT capital is negative and significant for the specification with the aggregate regulatory conditions indicator, as well as for the indicators for "Public ownership" and restrictions on "Market structure".

Short vs. long run effects

The econometric analysis in this section provides evidence of short- and long-run effects between regulation and productivity for the most heavily regulated sectors of the economy. The results of estimating the model in an error correction form are set out in the equation in table 5.10. The results reveal a significant negative impact of the aggregate regulatory conditions on multifactor productivity growth in the short- and longer-run. The results for the detailed indicators point to the existence of a fairly long-term negative correlation between concentration in the industry, barriers to entry and

Table 5.9: Multifactor productivity and non-manufacturing regulation, first difference estimation, 1975-2005

Δ(MFP)	Aggregate regulatory conditions		Barriers to entry		Public ownership		Market structure		Vertical integration	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ(ICT Capital)	0.132***	0.413***	0.128***	0.121**	0.126***	0.431***	0.128***	0.536***	0.127***	0.199**
	(0.0339)	(0.0968)	(0.0334)	(0.0615)	(0.0333)	(0.0792)	(0.0335)	(0.0698)	(0.0364)	(0.0909)
Δ(Non-ICT Capital)	-0.282***	-0.349***	-0.301***	-0.299***	-0.301***	-0.338***	-0.301***	-0.314***	-0.171	-0.193
	(0.0878)	(0.0926)	(0.0834)	(0.0835)	(0.0833)	(0.0876)	(0.0828)	(0.0868)	(0.147)	(0.154)
Δregulatory conditions	-0.0148**	-0.0108								
	(0.00742)	(0.00747)								
Regulatory*ΔICT capital		-0.0713***								
		(0.0204)								
ΔBarriers to entry			-0.00307	-0.00316						
			(0.00436)	(0.00447)						
Barriers to entry*ΔICT capital				0.00171						
				(0.0146)						
ΔPublic ownership					-0.0126*	-0.00471				
					(0.00744)	(0.00751)				
ΔPublic ownership*ΔICT capital						-0.0766***				
						(0.0146)				
ΔMarket structure							0.00312	0.0120		
							(0.00740)	(0.00777)		
Market structure*ΔICT capital								-0.0877***		
								(0.0131)		
ΔVertical integration									-0.00675*	-0.00593
									(0.00406)	(0.00405)
Vertical integration*ΔICT capital										-0.0166
										(0.0194)
Observations	1038	1038	1059	1059	1059	1059	1059	1059	706	706
R-squared	0.298	0.315	0.293	0.293	0.295	0.343	0.293	0.349	0.402	0.403

Table 5.10: Error Correction Model for ICT vs. non-ICT sectors, multi factor productivity, 1975-2003

ΔMFP	Regulatory conditions	Barriers to entry	Public ownership	Vertical integration	Market structure
ecm	-0.0269***	-0.0286***	-0.0271***	-0.0319***	-0.0269***
	(0.00562)	(0.00566)	(0.00550)	(0.00588)	(0.00549)
Δ(ICT Capital)	0.101***	0.0970***	0.100***	0.109***	0.0909***
	(0.0289)	(0.0287)	(0.0291)	(0.0343)	(0.0277)
Lagged ICT capital	-0.00610***	-0.00667***	-0.00687***	-0.00223	-0.00762***
	(0.00229)	(0.00230)	(0.00228)	(0.00301)	(0.00231)
Δ(Non-ICT Capital)	-0.284***	-0.281***	-0.278***	-0.204	-0.288***
	(0.0897)	(0.0842)	(0.0892)	(0.152)	(0.0843)
Lagged non-ICT capital	0.0166	0.0219**	0.0145	0.00457	0.0158
	(0.0107)	(0.0108)	(0.0107)	(0.0164)	(0.0105)
ΔRegulatory conditions	-0.0150**		-0.00729		
	(0.00740)		(0.00787)		
Lagged regulatory conditions	-0.00796***				
	(0.00307)				
ΔBarriers to entry		-0.00253			
		(0.00438)			
Lagged barriers to entry		-0.00465**			
		(0.00211)			
ΔPublic ownership			-0.0122		
			(0.00828)		
Lagged public ownership			-0.00717***		
			(0.00194)		
ΔVertical integration				-0.00677	
				(0.00435)	
Lagged vertical integration				-0.00181	
				(0.00299)	
ΔMarket structure					0.00396
					(0.00751)
Lagged market structure					-0.00638***
					(0.00194)
Observations	1038	1059	1038	706	1059
R-squared	0.337	0.331	0.343	0.440	0.337

prevalence of public ownership. Estimates were made using OLS, with country, industry and year dummies[136].

A multi-factor productivity equation in error correction form is given by:

$$\Delta MFP^{k}_{ijt} = \gamma_0 - (1-\alpha) MFP^{k}_{ijt_{-1}} + \beta_1 \Delta REG_{ijt} + \gamma_1 (1-\alpha) REG_{ijt-1} + Z_{ijt} + u_{ijt} \quad (7)$$

Anti-competitive regulation and multifactor productivity across the economy

The analyses in this section focus on the direct and indirect effects that the regulation burden has had on the productivity performance of the economy. Although the analysis covers both manufacturing and services sectors, particular attention is devoted to industries that are regarded as a key source of productivity gains.

The OECD Regulation Impact indicators data from OECD are used, together with data on output, inputs and productivity from EU KLEMS for the period 1975-2005. The industry detail and the time series dimension of the data are useful for analysing differences in the impact of regulation on productivity across groups of industries, while also checking for common industry effects. Additionally, the time dimension is valuable for disentangling short- versus long-run effects – something which is likely to be of prime interest given the longstanding productivity problems experienced by many European countries.

First, equation (5) is estimated at the industry level, including the regulation impact indicators and their interaction with ICT capital. The objective is to show what effects the regulatory barriers to competition may have on productivity, both directly and indirectly. The

136 The inclusion of country dummies in this analysis did not alter the main findings.

Table 5.11: Impact of regulation on multifactor productivity, 1975-2003, Differences estimation

Dependent variable: ΔMFP	Manufacturing		Services	
Δ(ICT capital)	0.305***	0.305***	0.254***	0.254***
	(0.110)	(0.110)	(0.0463)	(0.0463)
ΔLabour	-0.247*	-0.250*	-0.375***	-0.375***
	(0.129)	(0.129)	(0.0424)	(0.0426)
Interaction ΔICT*Regimpact	-1.393*	-1.422*	-0.361***	-0.361***
	(0.840)	(0.837)	(0.0906)	(0.0907)
Regulation impact	0.0535	0.799	-0.0960*	-0.0963
	(0.539)	(0.602)	(0.0541)	(0.0939)
Regulation impact squared	1.604	0.937	0.130**	0.130**
	(1.759)	(1.777)	(0.0530)	(0.0581)
Techology gap	0.00266***	0.00912***	0.00613***	0.00612***
	(0.000737)	(0.00212)	(0.00127)	(0.00191)
Technology gap*Regulation impact		-0.0597***		2.42e-05
		(0.0153)		(0.00461)
Industry dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	3298	3298	2037	2037
R-squared	0.175	0.178	0.526	0.526

interaction of the ICT capital with the level of regulation impact is designed to capture how the level regulatory playing field may restrict the impact of ICT in production[137]. A negative coefficient indicates that the lower the level of regulation, the stronger the contribution of ICT capital to productivity growth.

The results from equation (5) are shown in table 5.11. While specification in differences are often estimated without fixed effects, the introduction of industry-, country- and time-fixed effects is aimed to control for sector and country specific factors that can have an impact on labour productivity growth. Standard errors corrected for clustering on country are shown in brackets[138].

The results show that the coefficient of the ICT capital input is positive and significant, and the interaction term between ICT capital and regulation is negative and significant. These results demonstrate the potential efficiency gains associated with the use of ICT and show that such gains can be restricted by stringent regulatory conditions. These results will be able to withstand the introduction of other variables, such a squared term of regulation, which are intended to capture the importance of non-linearities, and a technology gap to gauge the influence of the catch-up effects. The influence of labour input on multifactor productivity growth is negative, although this did not alter the significance of the other variables.

By introducing a squared term of the regulation variables into the productivity equation, evidence of a non-linear relationship between regulation and productivity in the services sectors can be found. The coefficient of the regulation impact variable remains negative and significant in the services sectors, while the coefficient of the square term is positive and significant at a 5% level of significance. This suggests that the marginal effects of the regulatory reform from a very high level are zero, and that the marginal effects are positive when starting from a less regulated environment.

The technology gap variable is used as a direct measure of the potential for technology transfer, and it is defined as the difference between the local level of multifactor productivity and the level of multifactor productivity of the leader country in each industry for each year. The technology gap variable is positive at conventional levels of significance. As expected, this shows that countries which are further behind the technological frontier show higher rates of productivity growth. The effect of the regulation indicator interacting with the technology gap variable shows that restrictions to competition may affect technology transfer in manufacturing sectors more than in services sectors.

ICT Taxonomy

The relationship between regulation and multifactor productivity at the industry level is further explored

137 In an alternative version, ICT capital was interacted with the growth in regulation. A negative coefficient in this case would indicate that the impact of ICT on capital has increased (decreased) with a decrease (increase) in the magnitude of the change in the regulation impact. The coefficient on this interaction term was not significantly different from zero.

138 The statistical significance of the coefficients is indicated by a series of stars, with "*" indicating that the results are significant at the 10 per cent level, "**" at the 5 per cent level, and "***" at the 1 per cent level.

Table 5.12: Multifactor productivity and Regulation Impact, ICT and non-ICT sectors, 1975-2003

Dependent variable: ΔMFP		
Δ(ICT capital)	0.145***	0.146***
	(0.0304)	(0.0305)
ΔLabour	-0.273***	-0.269***
	(0.0895)	(0.0898)
ΔRegimpact	-0.0568	-0.0535
	(0.0425)	(0.0456)
Technology gap	0.00318***	0.00319***
	(0.000622)	(0.000622)
Dummy ICT Producing Manufacturing	0.0297***	0.0794***
	(0.00610)	(0.0270)
Dummy ICT Producing Services	0.0241***	0.0476***
	(0.00560)	(0.0154)
Dummy ICT Using Manufacturing	0.00113	-0.00199
	(0.00522)	(0.0115)
Dummy ICT Using Services	-0.00772	0.0270**
	(0.00787)	(0.0119)
Dummy Non-ICT Services	0.0114*	0.0104
	(0.00594)	(0.0123)
Regimpact*Dummy ICT Producing Manufacturing		-0.427**
		(0.202)
Regimpact*Dummy ICT Producing Services		-0.0480*
		(0.0266)
Regimpact*Dummy ICT Using Manufacturing		0.0246
		(0.0752)
Regimpact*Dummy ICT Using Services		-0.107***
		(0.0241)
Regimpact*Non- ICT Services		0.00188
		(0.0181)
Observations	5335	5335
R-squared	0.233	0.235

by estimating productivity equations (6) for different industries in the ICT taxonomy – see table 5.12. Previous research has highlighted the relevance of this grouping, as these industries differ not only in their ICT intensity, but also in their productivity developments (Stiroh 2002a). The table 5.13 shows the results of regressions of the growth in multifactor productivity on ICT capital and labour, and a measure of regulation and dummies for ICT groups[139]. The results show that, on average, ICT-producing manufacturing industries have experienced the highest multifactor productivity growth rates. The other groups displaying a high multifactor productivity growth are ICT-producing services and non-ICT services, which include network industries such as transport and storage, and electricity, gas and water. The coefficient for the ICT-using services group is not significantly different from zero. When ICT group dummies are interacted with the level of regulation impact, the results show a negative and significant impact for the ICT-using services group, while the main effect for ICT-using services becomes positive and significant. These findings suggest that while ICT-using services sectors may have the potential to achieve high rates of productivity growth, the strictness of the regulatory environment may be significantly hampering the achievement of those productivity gains. These findings are again robust to the inclusion to the technological distance to the frontier which controls for catch-up effects.

Firstly, difference models discard all information regarding the levels of the variables. Recognising that dynamic effects can be very important in evaluating the impact of ICT and regulation on productivity, an error correction model was estimated in order to allow flexibility in the analysis of the relationship. The multifactor productivity equation in error correction, equation (7), is estimated for the sectors in the ICT taxonomy, see Table 5.13. Standard errors corrected for within-country correlation are shown in brackets[140].

139 The omitted category is the Non-ICT Manufacturing group.

140 The statistical significance of the coefficients is indicated by a series of stars, with "*" indicating that the results are significant at the 10 per cent level, "**" at the 5 per cent level, and "***" at the 1 per cent level.

Table 5.13: Error Correction Model for manufacturing and non-manufacturing, 1975-2003

	ICT producing		ICT using		Non-ICT	
ΔMFP	Manufacturing	Services	Manufacturing	Services	Manufacturing	Services
ecm	-0.0151	-0.0231	-0.0477***	-0.0544***	-0.0388***	-0.0377***
	(0.0208)	(0.0148)	(0.00920)	(0.0109)	(0.00948)	(0.00792)
ΔRegulation Impact	0.967	0.0681	0.397	1.482	1.486	-0.109
	(3.282)	(0.137)	(0.841)	(1.415)	(1.722)	(0.0756)
Lagged Regulation Impact	-1.091***	-0.0610	-0.643**	-0.157*	-0.156	-0.149**
	(0.328)	(0.0617)	(0.211)	(0.0830)	(0.257)	(0.0508)
ΔICT Capital	0.272**	0.0417	0.138*	0.139	0.216	0.236
	(0.114)	(0.0587)	(0.0751)	(0.116)	(0.132)	(0.152)
Lagged ICT capital	0.00457	0.00323	0.0147**	0.0166	0.0143**	0.0172*
	(0.00547)	(0.00350)	(0.00600)	(0.0117)	(0.00654)	(0.00951)
ΔLabour	-0.108	-0.345**	-0.159*	-0.264**	-0.195	-0.196
	(0.146)	(0.118)	(0.0865)	(0.0907)	(0.144)	(0.114)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	264	264	792	792	2368	1056
R-squared	0.325	0.164	0.365	0.373	0.123	0.349

The results show a negative and significant long-run impact of regulation on productivity in ICT-producing manufacturing, ICT-using manufacturing, ICT-using services and non-ICT services. No significant impact of regulation on productivity can be found in the non-ICT manufacturing sectors. These results suggest that less regulation boosts productivity not only in sectors that use ICT intensively, but also in some non-ICT services sectors, which include network industries. However, it has been suggested in the literature that this could be due to reductions in employment caused by privatisation initiatives in these sectors (Faini et al., 2006). No evidence of short-run effects is found, which suggests that year-on-year changes in regulation are not related in any significant way to changes in multifactor productivity.

As regards the coefficient of the other variables in equation (7), a positive and significant long- and short-run impact of ICT capital is observed, in particular for the ICT-using manufacturing sectors, while the labour term displays a negative coefficient. The coefficient of the error correction term, $-(1-\alpha)$, is negative and significant as expected, but it is rather small considering the high persistence of the productivity series.

The results are consistent with findings in the literature. Conway et al. (2006) find that product market regulations slow the process of adjustment by which positive productivity shocks spread across borders and new technologies are incorporated into the production processes. They find no direct effect of anti-competition regulation on productivity growth for all industries, but when the coefficient of the direct effect is estimated separately for the ICT intensive sectors, a negative effect is observed.

5.5. Summary

The analyses consider the links between regulation, ICT investment and productivity for the EU and the US. First, the focus is on the impact that the stringency of the regulatory function has had on ICT capital accumulation. After that, the focus is on the indirect impact that ICT has on productivity, and the extent to which this is hindered by restrictive regulatory regimes.

The findings suggest that, at the aggregate economy level, restrictive regulatory regimes hinder ICT investment and have a negative effect on productivity[141]. The regulatory dimensions that are regarded as being more important are those of an administrative nature, such as barriers to start-ups. On the productivity side, barriers to trade and investment play a significant role.

At the more detailed industry level, while restrictions to competition in the product markets do not appear to have a big influence on the rate of ICT capital accumulation for most of sectors, they do hinder investment in the less ICT-intensive manufacturing industries. The results for key services industries sectors, such as the network industries, show that restrictive regulation conditions – particularly barriers to entry and the degree of vertical integration – harm capital accumulation and productivity growth. More importantly, the knock-on effects on other sectors of the economy are widespread, and it is possible to see negative long-run effects of regulation on multifactor productivity in most ICT-intensive using sectors,

141 Regulations can however have other positive effects in terms of safety and security, for example. These effects may be difficult to quantify, but are nonetheless important welfare effects.

whether in manufacturing or services. Maintaining competitive conditions in these sectors – which are a proxy for competition throughout an economy – is essential if long-term productivity growth is to be achieved across all sectors of the economy. On the one hand, restrictions to competition are found to restrict the realisation of ICT capital into productivity gains in both manufacturing and services sectors. On the other hand, it is observed that the potential for harming sustained productivity growth is greater in those sectors that use ICT more intensively.

For the overall economy, there is consistent evidence of a negative relationship between ICT investment and the strictness/stringency of the product markets. The results are robust to alternative specifications, and the inclusion of other potential determinants of ICT investment. The dimensions of the product market that appear more detrimental to ICT investment tend to be administrative in nature, such as barriers to start-up, especially for sole proprietors, and sector-specific barriers. These findings support the idea that, in a more competitive environment where barriers to start-up are lower, there are more incentives to invest in ICT technologies to catch up with technology leaders or to maintain market shares. Regarding productivity, barriers to start-up are manifestly hindering the translation of ICT capital into productivity gains. Additionally, there is evidence that barriers to trade and investment are not only having a direct impact on productivity, but also impeding the successful contribution of ICT capital to productivity.

With regard to the labour market, since ICT often requires more skilled labour, it is important to ensure that competitive conditions are maintained, so that the firm can allocate their factors of production in an optimal manner including through an enhanced training of their employees. The influence of other labour market characteristics appears more ambiguous, revealing a complex combination of effects. The active labour market policies appear positively related to productivity. There is also some evidence that the benefits of deregulating product markets in terms of ICT investment could be greater if labour markets had a degree of flexibility that allowed firms to reorganise their factors of production more efficiently.

Care must be taken when interpreting economy-wide results. While the analysis has attempted to check for a number of other characteristics that vary across countries and over time, identification is mainly based on cross-sectional data. Sufficient time series variation in product and labour market regulation data to identify the changes in product and labour market regimes has not been observed. Despite this, the evidence is persuasive and consistent with most of the concerns raised in the empirical literature.

The role of sector specific barriers to entry has been further explored in the industry analysis, where detailed information on regulation measures on a time series basis is available for electricity gas and water, post and telecommunications and transport and storage. In these network industries, barriers to entry are found to be a determinant of non ICT investment, although their impact on ICT investment is not particularly significant. The only restrictions that appear to adversely affect the adoption of ICT are related to vertical integration issues, reflecting the potential harmful effects of anti-competitive behaviour along the supply chain.

In the short run there is not much evidence to show that de-regulation has boosted ICT investment across sectors of the economy, with the exception of the ICT-Producing service sector: post and telecommunications. This sector has seen profound developments in regulatory reform over the last decades. However, the results of the analysis show that there is strong evidence that regulation in key non-manufacturing sectors has long-run negative effects on some non-ICT intensive manufacturing sectors, which are traditional sectors that do not make intensive use of these technologies in their production processes.

The effects on productivity as a result of de-regulating non-manufacturing sectors seem to be more widespread across the economy. A stringent regulatory environment prevents ICT capital being translated into productivity gains, in both the manufacturing and services sectors. Moreover, a long-run negative effect of regulation on productivity growth is found in sectors that use ICT and network sectors. The above results give rise to a number of policy implications, particularly as regards the role played by structural reforms in promoting both the adoption of ICT and in establishing the best framework conditions for ICT to have an impact on productivity and growth (Barrios and Burgelman, 2007).

The results also demonstrate the importance of taking into account the dynamics of the relationship between regulatory reforms, ICT and productivity. On the one hand, the analysis of the impact of ICT capital on productivity is not straightforward, and many studies have stressed that it takes time for the returns on ICT to materialise. On the other hand, the relationship between the level of, and changes in, the regulatory conditions and many economic outcomes requires an analysis of short-run and long-run effects. While short-run effects of de-regulation are found in some highly regulated sectors, more significant long-run effects of maintaining competition are found to be fundamental for sectoral productivity performance.

As regards policy implications, the importance of reducing administrative burdens, introducing *flexibility* in the labour markets, upgrading training capacities and impact, and liberalising key sectors in the economy has been highlighted. On the product market side, the industry analysis reveals that liberalisation of non-

manufacturing sectors can stimulate productivity gains in ICT-using industries in particular, where spillover and network effects can be sizeable and where most of the post-1995 differences in productivity growth between the Unites States and Europe are to be found. On the labour market side, there is evidence of a negative relationship between employment protection and productivity growth. The empirical literature concludes that it is the flexibility of the US economy in adapting to major changes (such as the IT revolution) that has given it a temporary productivity advantage, and predicts that Europe will start to see enhanced IT-enabled productivity growth over the next few years.

However, the empirical evidence put forward from other studies on these relationships is not as straightforward as it may appear. Nickell et al. (1999) find no evidence between EPL and productivity growth. Scarpetta et al. (2002) find a significant negative impact on productivity from EPL only in countries with an intermediate degree of centralisation and coordination in wage bargaining. Autor et al. (2007) find that EPL increases labour productivity by raising capital-labour productivity, but also find that EPL lowers multifactor productivity. The issue of whether to increase flexibility in the labour market is a controversial one, particularly at the present time when major economies are focusing their policies on recovering from a situation of job losses and negative growth. Even in recessionary periods, however, consideration should be given to policies and reforms in Europe that can not only help maintain employment, but have the potential to boost long-term growth.

Box 5.1 – The error correction model

The relationship between regulation and investment and productivity is modelled using an error correction framework (ECM), a technique that combines the long-run or co-integrating relationship between the level variables with the short-run relationship. The aim is to capture both short and longer-term effects of regulatory conditions on an outcome variable. The estimation of models in ECM is also considered suitable as it reduces measurement errors, endogeneity and omitted variable problems.

$$y_{ijt}^{k} = y_{ijt-1}^{k} + X_{ijt} + Z_{ijt} + u_{ijt} \quad \text{(A.1)}$$

where the y is a dependent variable, X a vector of explanatory variables and Z a vectors of control variables and u is the standard error terms. Assuming a richer dynamic structure for the explanatory vector of variables X an equation like (A.1) can be re-written as:

$$\Delta y_{ijt}^{k} = \gamma_0 + \beta_1 \Delta_{ijt} - (1-\alpha)[y_{ijt_{?1}}^{k} - \gamma_1 X_{ijt_{-1}}] + Z_{ijt} + u_{ijt} \quad \text{(A.2)}$$

The long-run relationship in the model is captured by the term in brackets which represents the deviation of the dependent variable from is long-run equilibrium values. If these levels terms were omitted, all of the variables would be in first differences and one would only pick up short-run effects. As long as α is less than 1, a model in first differences is inadequate from the point of view of the estimation, as the levels term may play a key role. Suppose that the term in brackets becomes positive because investment or productivity has increased above its equilibrium values. Since $(1-\alpha)$ is negative the overall effect is to slow down short-term growth in investment or productivity. This term is therefore said to be the error correction mechanism of the model.

Re-arranging equation A.2 can be expressed as:

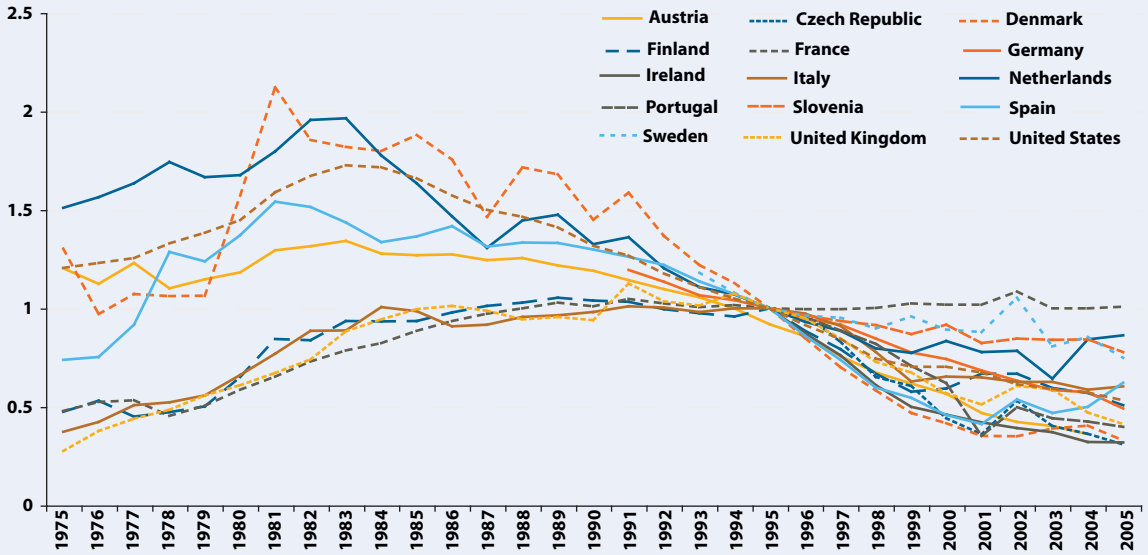
$$\Delta y_{ijt}^{k} = \gamma_0 - (1-\alpha) y_{ijt_{-1}}^{k} + \beta_1 \Delta X_{ijt} + \gamma_1 (1-\alpha) X_{ijt-1} + Z_{ijt} + u_{ijt} \quad \text{(A.3)}$$

The coefficient β_1 measures the short-term impact of changes of variable x on the growth rate of variable y, the coefficient γ measures the long-term impact and u_{it} is the standard error term. Although the short-term impact cannot be obtained directly from the linear estimation, it can be derived by dividing the coefficient on X_{ijt-1}, $\gamma_1(1-\alpha)$, by the adjustment coefficient, represented by $-(1-\alpha)$.

Box 5.2 – The role of ICT Deflators

The conclusions drawn in part II (Regulation and investment) are not likely to be biased by the choice of ICT deflators, given that EU KLEMS provides adjusted measures of inputs; investment is measured in constant-quality efficiency units, which is determinant for assets subject to rapid technological change and improvements in quality, such as IT assets. Many countries have followed the US in adopting hedonic prices for computers, and recently this approach has been adopted by other National Statistical Institutes (Netherlands, Slovenia, Sweden, Germany, France, United Kingdom), and other countries base their national deflators on the US hedonics, adjusting for international price or exchange rate movements. For the countries using IT deflators that are not adjusted for quality, EU KLEMS uses the harmonisation procedure introduced by Schreyer (2002). Bartelsman et al. (2004) emphasize that differences in industrial specialisation across countries complicate the harmonisation of deflators. However, EU KLEMS does not harmonise the output deflators. In the sector that includes ICT equipment manufacturing, 30t33, the fall in value added deflators in the US is considerably greater than in the EU (-9.4% against -1.6% per annum (Sectoral Growth Drivers, 2008). While this difference is influenced by the greater relative size of the sub-sector "Office, accounting and computing machinery" in the US (NACE 30), it is mostly driven by the deflators for this sub-sector. To the extent that the industries are producing similar outputs in the two regions that are traded in international markets, this difference might reflect a measurement assumption rather than any real differences. In the industry analysis in section 5.4 (Regulation, ICT and productivity), the breakdown of sectors employed enables this effect to be accounted for by modelling the ICT-producing manufacturing sectors (30t33) separately. At an aggregate level, for the whole manufacturing sector or the total economy, this potential source of bias is likely to be minor.

ICT Deflator – Electrical and Optical Equipment



Source: EU KLEMS.

Box 5.3 – The role of Regulation in times of crisis

The general initial response to the current financial crisis has been to cut interest rates and extend the role of the State in the banking sector: guaranteeing personal savings, injecting funds into the banking system (quantitative easing) and state control/interests in the commercial banking sector. While this wholesale support of the banking sector seems counter-productive to structural reform, Lyons (2009) argues that the banking sector is unique in requiring this degree of intervention because of the underlying essential element of confidence that is required in order for the bank to survive. In addition, banks perform a central role in the economy, "oiling the wheels" of industry. Fundamentally, this difference in the banking sector means that intervention is necessary. The initial EU response to the crisis entailed a number of actions, starting in 2007/2008, including:

* coordinating action by the Member States to raise minimum deposit guarantee levels,
* adopting a number of different initiatives on financial services policy (Capital Requirements Directive, deposit protection schemes, credit rating agencies),
* starting the process towards a reform of the European financial supervisory system,
* issuing guidance to clarify the application of State aid rules,
* launching a European recovery plan,
* initiating international discussions, in the G-20 framework, on policies to strengthen the financial services sector.

In this paper the issues are about whether regulatory reforms actually have a role to play in facilitating recovery and what is the likely impact of the current recession and subsequent recovery on ICT investment in the medium to long term?

Economic downturns are likely to result in firm overcapacity, and thus investments from within the firm are likely to be lower. In terms of regulation, one might think that regulatory reform in such economic circumstances would become less of a priority, and yet the OECD (2009) highlights the fact that many structural reforms have been implemented in times of economic crisis. In an overview that considers the role for structural reform in dealing with financial crises, OECD (2009) points to the fact that, at such times, institutional weaknesses are revealed and solutions are generally more palatable to a nervous electorate, who want to see governments find solutions. The OECD (2009) gives four examples of growth-enhancing structural reform policies that might make a positive contribution to recovery:

* introducing infrastructure projects – e.g. improvements in education;
* increasing expenditure on active labour market policies through training;
* reducing tax on labour income;
* reforming anti-competitive product market regulation, particularly barriers to entry.

It is argued that this last point should encourage the innovation of new products and make new business entry easier in the short run and raise competition in the longer run.

Short run negative effects from structural reform policies that affect demand:

* easing of entry barriers may lead to greater firm turnover – exits and unemployment;
* relaxing employment protection is likely to reduce job security, as firing costs are cut, although there is some evidence of employment rising when the costs are reduced – e.g. Italy and temporary contracts.

However, in unfavourable economic conditions, there is a temptation to extend the role of the State in a number of directions, counteracting the structural reform policies, particularly with regard to trade. Commentators suggest this has not happened yet, but there is some evidence that it might occur, and history shows that a move to more protectionist policies is counter-productive and can extend the scope and the duration of the downturn (Cole and Ohanian, 2004 – cited in Lyons, 2009).

References

Acemoglu, D., P. Aghion., R. Griffith, and F. Zilibotti (2004), "Vertical integration and technology: theory and evidence", IFS Working Paper, W04/34.

Acemoglu, D. and R. Shimmer (1999), "Efficient Unemployment Insurance," *Journal of Political Economy*, October, 1999, Vol. 107, 893-928.

Addison, J. and J. Wagner (1994), "UK Unionism and Innovative Activity: Some cautionary remarks on the basis of a simple cross-country test", *British Journal of Industrial Relations 32,* pp. 85-98.

Aghion, P., and R. Griffith (2005), "Competition and growth".

Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt, (2005), "Competition and innovation: An inverted-U relationship", *The Quarterly Journal of Economics*, May.

Alesina, A., S. Ardagna, G. Nicoletti, and F. Schiantarelli (2005), "Regulation and Investment", *Journal of the European Economic Association,* June 2005, 3(4), 791-825.

Arnold, J., G. Nicoletti and S. Scarpetta (2008), "Regulation, Allocative Efficiency and Productivity in OECD Countries – Industry and Firm Level Evidence", *OECD Economics Department Working Paper No. 616.*

Arnold, J., B. Javorcik, and A. Mattoo (2007), "Does Services Liberalization Benefit Manufacturing Firms? Evidence from the Czech Republic", *World Bank Policy Research Working Paper Series 4109.*

Bakhshi, H., N. Oulton and J. Thompson (2003), "Modelling Investment when Relative Prices are Trending: Theory and Evidence for the United Kingdom", Bank of England Working Paper No. 189.

Barrell, R., and S. Kirby (2007), "Notes on the Lisbon process: An analysis of the impacts of reaching the Lisbon targets for skills, R&D and the administrative burden in the European Union", Industrial Policy and Economic Reforms Paper No. 7, European Commission.

Barrios, S., and J.-C. Burgelman, (2007), "Information and Communication Technologies, Market Rigidities and Growth: Implications for EU Policies", MRPC Paper No. 5838.

Bartelsmam, E., A. Bassanini, J. Haltiwanger, R. Jarmin, and T. Schank (2004), "The spread of ICT and productivity growth: Is Europe really behind in the New Economy", in The ICT revolution: Productivity differences and the digital divide, Oxford.

Bassanini, A., L. Nunziata and D. Venn (2009), "Job protection legislation and productivity growth in OECD countries", Economic Policy, pp. 249-402.

Bassanini, A., and E. Ernst (2002), "Labour Market Institutions, Product Market Regulation, and Innovation: Cross-Country Evidence", OECD Economics Department Working Papers, No. 316.

Bassanini, A., and S. Scarpetta (2002), "Growth, Technological Change, and ICT Diffusion: Recent Evidence from OECD Countries", *Oxford Review of Economic Policy* 18, 3, 324-344.

Basu, S., J. Fernald, N. Oulton, and S. Srinivassan (2003), "The Case of the Missing Productivity Growth: Or, Does Information Technology Explain why Productivity Accelerated in the US but not the UK?" *National Bureau of Economic Research, NBER Working Paper No. 10010.*

BERR (2008), "The impact of regulation on productivity", *Economics paper No. 3*, September.

Blanchard, O. and F. Giavazzi (2003), "Macroeconomic Effects of Regulation and Deregulation in Goods and Labor Markets", *The Quarterly Journal of Economics,* 2003(3), 879-907.

Blundell, R., R. Griffith, and J. Van Reenen (1999), "Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms", *Review of Economic Studies,* 66, 529-554.

Brynjolfsson, E. and S. Yang, (1997), "The Intangible Benefits and Costs of Computer Investments: Evidence from Financial Markets", in Proceedings of the International Conference on Information Systems, Atlanta, GA.

Connolly, R., Hirsch, B.T. and Hirschey, M. (1986), "Union Rent Seeking, Intangible Capital, and Market Value of the Firm", *The Review of Economics and Statistics,* 68, 567-577.

Conway, P., de Rosa, D., Nicoletti, G. and F. Steiner (2006), "Regulation, Competition and Productivity Convergence", OECD Economics Department Working Paper No. 509.

Conway, P. and G. Nicoletti (2006), "Product Market Regulation in the Non-Manufacturing Sectors of OECD Countries: Measurement and Highlights", OECD Economics Department Working Paper No. 530.

Conway, P., V. Janod, and G. Nicoletti (2005), "Product Market Regulation in OECD Countries: 1998 to 2003", OECD Economics Department Working Papers No. 419.

Crafts, N. (2006), "Regulation and Productivity Performance", *Oxford Review of Economic Policy,* Vol. 22, 186-202.

Daveri, F. (2000), "Is Growth an Information Technology Story in Europe too?", IGIER Working Paper No. 168, September.

Denny, K., and S. Nickell (1992), "Unions and Investment in British Industry", *The Economic Journal,* 102, 874-887.

Dewan, S., S.C. Michael, and C. Min, (1998), "Firm Characteristics and Investments in Information Technology: Scale and Scope Effects," *Information Systems Research*, Vol. 9, No. 3, September 1998, pp. 219-232.

Disney, R., J. Haskel and Y. Heden (2003), "Restructuring and Productivity Growth in UK Manufacturing", *Economic Journal*, 113(489), 666-694.

Faini, R., J. Haskel, G. Navaretti, C. Scarpa, and C. Wey (2006), "Contrasting Europe's decline: do product market reforms help?" in *Structural Reforms Without Prejudices*, Edited by T. Boeri, M. Castanheira, R. Faini and V. Galasso, Oxford University Press).

Freeman, R., and J. Medoff (1984), *What Do Unions Do?* New York: Basic Books.

Griffith, R, and G. Macartney (2008), "Employment protection legislation, multinational enterprises and innovation", AIM Working paper.

Griffith, R, R. Harrison and G. Macartney (2006), "Product Market Reforms, Labour Market Institutions and Unemployment", The Institute for Fiscal Studies Working Papers, WP06/06.

Griffith, R., R. Harrison and H. Simpson (2006), "*Product Market Reform and Innovation of the EU*", The Institute for Fiscal Studies, WP06/17.

Griffith, R. and R, Harrison (2004), "The Link Between Product Market Reform and Macro-Economic Performance", European Economy, European Commission, Directrate-General for Economic and Financial Affairs, Economic Papers No. 209.

Gust, C. and J. Marquez (2004), "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices", Labour Economics, 11, 33-58.

Hassett, K., and R. Hubbard (1997), "Tax Policy and Investment", NBER Working Paper No. 5683.

Havik, K., K. MacMorrow, W. Roger, and A. Turrini (2008), "The EU-US Total Factor Productivity Gap: An Industry Perspective", EC, Economic Papers 339.

Hempell, T. (2002), "What's Spurious, What's Real? Measuring the Productivity Impacts of ICT at the Firm-level", ZEW Discussion Paper 02-42, Mannheim.

Hernando, I., and S. Nunez (2004), "The Contribution of ICT to Economic Activity: a Growth Accounting Exercise with Spanish Firm-level Data", *Investigaciones Economicas,* Vol. 28, 315-348.

Hirsch, B. (2003), "What do Unions do for Economic Performance?", Institute for the Study of Labour, Discussion Paper No. 892.

Inklaar, R., M. O'Mahony, and M. Timmer (2003), "ICT and Europe's Productivity Performance: Industry-Level Growth Account Comparisons with the United States", Groningen Growth and Development Centre, Research Memorandum GD-68.

Inklaar, R. and Timmer, M.P. (2008). "GGDC Productivity Level Database: International Comparisons of Output, Inputs and Productivity at the Industry Level", Groningen Growth and Development Centre Research Memorandum GD-104, Groningen: University of Groningen, September.

Inklaar, R., M.P. Timmer, and B. van Ark (2008), "Market services productivity across Europe and the US" *Economic Policy*, 23(53), pp. 139-194.

Jorgenson, D. and K. Stiroh (2000), "Raising the Speed Limit: US Economic Growth in the Information Age", OECD Economics Department Working Papers 261, OECD, Economics Department.

Loayza, N., A. Oviedo, and L. Serven (2004), "Regulation and Macroeconomic Performance", World Bank, mimeo.

Lyons, B. (2009), "Competition Policy, Bailouts and the Economic Crisis", CCP Working Paper 09-4.

Nickell, S. (1996), "Competition and Corporate Performance", *Journal of Political Economy,* 104, 724-746.

Nicodeme, G., and J. Sauner-Leroy (2007), "Product Market Reforms and Productivity: A Review of the Theoretical and Empirical Literature on the Transmission Channels", *Journal of Industry Competition*, Vol. 7 (1), 53-72.

Nicoletti, G. and S. Scarpetta (2005), "Regulation and Economic Performance: Product Market Reforms and Productivity in the OECD", OECD Economics Department Working Papers No. 460.

Nicoletti, G., S. Golub, D. Hajkova, D. Mirza and K.Y. Yoo (2003), "The Influence of Policies on Trade and Foreign Direct Investment", OECD Economic Studies, No. 36.

Nicoletti, G., and S. Scarpetta (2003), "Regulation, Productivity and Growth: OECD evidence", Economic policy, 36, 11-72.

Nicoletti, G., Scarpetta, S. and O. Boylaud (2000), "*Summary Indicators of Product Market Regulation with an Extension to Employment Protection Legislation*", OECD Economics Department Working Paper No. 226.

OECD(2004), "The Economic Impact of ICT: Measurement, Evidence and Implications".

OECD(2007), *Innovation and Growth: Rational for an Innovation Strategy*.

OECD (2009), "Economic Policy Reforms: Going for Growth – Structural Policy Indicators, Priorities and Analysis", OECD Publishing.

OECD (2002) *Measuring the information economy*, Paris, OECD.

OECD (1997), "*The OECD Report of Regulatory Reform: Synthesis*", Paris, OECD.

Oliner, S. and D. Sichel (2000), "The resurgence of growth in the late 1990s: is information technology the story?", *Journal of Economic Perspectives, American Economic Association*, vol. 14(4), pages 3-22, Fall.

O'Mahony, M. and M. Timmer (2008),"Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database", *Economic Journal,* accepted for publication.

O'Mahony, M. and M. Vecchi (2005), "Quantifying the impact of ICT on output growth: A heterogeneous dymamic panel approach", *Economica*, 72,(288), 615-633.

O'Mahony, M., Vecchi, M. and C. Robinson (2008), "The impact of ICT on the demand of skilled labour: a cross-country comparison", Labour Economics, (6), 1435-1450.

O'Mahony and B. van Ark (Eds), "EU productivity and competitiveness: An industry perspective: Can Europe resume the catching-up process", European Commission.

Rincon, A. and M. Vecchi (2004), "The dynamic impact of ICT spillovers on companies' productivity performance", NIESR Discussion Paper No. 245.

Schiantarelli, F. (2008), "Product Market Regulation and Macroeconomic Performance: A Review of Cross-Country Evidence", *Boston College Working Papers in Economics* No. 623.

Schreyer, P. (2002), "Computer Price Indices and International Growth and Productivity Comparisons", *Review of Income and Wealth*, 48 (1), pp. 15-31.

Stiroh, K. (2002a), "Are ICT spillovers driving the new economy", *Review of Income and Wealth*, Series 48, 1, March.

Stiroh, K. (2002b), "Information technology and the US Productivity Revival: What do the Industry-Data Say", *American Economic Review* 92(5), 1559-76.

Stiroh (2001), "What drives productivity growth", *Economic Policy Review*, March, pp. 37-50.

Van Ark, B. (2006), "Europe's Productivity Gap: Catching up or Getting Stuck?", The Conference Board Europe Economics Program, EPWP 06-02.

Venturini, F. (2008) "The long-run impact of ICT", Quaderno di Ricerca No. 254, Universita Politecnica delle Marche, Dipartamento di Economia, *forthcoming in Empirical Economics.*

Welfens, P. (2008). "*ICT-productivity and economic growth in Europe*" in "Digital Excellence-University meets economy", Welfens and Walther-Klaus (eds).

Wölfl, A., I. Wanner, T. Kozluk and G. Nicoletti (2009), "Ten Years of Product Market Reform in OECD Countries – Insights from a Revised PMR Indicator", OECD Economics Department Working Papers No. 695.

Appendix tables

Table A.1: Availability and coverage of data sources

Source	Period	Sectoral Detail	Main Regulatory Measures	Countries Covered
EU KLEMS Country Performance Data	1970-2005	Economy-level data and industry level data for 22 sectors	Performance Data only (investment, productivity, etc)	EU15 (not BE, LU, EL) and CZ, SL, AU, JA, US
OECD Product Market Regulation Indicators	1998, 2003	Available at economy-level only	State Control; Barriers to Entrepreneurship; and Barriers to Trade and Investment	EU15 (not BE, LU, EL) and CZ, SL, AU, JA, US
CEP-OECD Labour Market Institutions Data	1970-2004	Available at economy-level only	Employment Protection Legislation; Unions, Bargaining and Minimum Wage; Income Support for Unemployed; Active Labour Market Policies; and Labour Market Taxation	EU15 (not BE, LU, EL) and US
Fraser Insitute Business & Labour Indicators	1970-2005	Available at economy-level only	Firing and Hiring Legislation; Minimum Wage; Centralised Bargaining; Unemployment Insurance; and Conscription	EU15 (not BE, LU, EL) and CZ, SL, US
OECD Regulation Impact Indicators	1975-2003	Industry-level data for 22 sectors	Regulation Impact data	EU15 (not BE, LU, EL) and US
OECD ECTR Regulation Indicators	1975-2005	Telecoms, Electricity, Gas, Post, Rail, Air Passenger Transport and Road Freight	Entry Conditions; Public Ownership; Vertical Integration; and Market Structure	EU15 (not BE, LU, EL) and US

Table A. 2: Impact of product market regulation on non-ICT investment at the economy-wide level, 1990-2005, OECD economy-wide level (Low-Level indicators)

Dependent variable: log(GFCF Non-ICT/Capital stock Non-ICT)	Aggregate Barriers to entrepreneuship	Administrative burden for sole proprietors	Sector specific burdens	Administrative burden for corporations
Lagged dependent variable	0.999***	0.995***	0.996***	1.013***
	(0.0201)	(0.0205)	(0.0201)	(0.0185)
Size of public enterprise sector	-0.00515	-0.00806	-0.00433	-0.00354
	(0.00533)	(0.00573)	(0.00536)	(0.00559)
Scope of public enterprise sector	0.0229***	0.0243***	0.0215***	0.0184***
	(0.00670)	(0.00770)	(0.00650)	(0.00610)
Direct control over business enterprise	0.00217	0.00101	0.00204	0.00112
	(0.00294)	(0.00275)	(0.00278)	(0.00317)
Price controls	0.00280	1.91e-05	0.00324	-0.000923
	(0.00823)	(0.00759)	(0.00777)	(0.00845)
Use of command & control regulation	0.00664*	0.00615*	0.00693**	0.00508
	(0.00367)	(0.00367)	(0.00345)	(0.00354)
Licence and permits system	-0.00108	-0.00190	-0.00133	-6.79e-05
	(0.00238)	(0.00253)	(0.00237)	(0.00233)
Communication and simplification of rules and procedures	-0.0322***	-0.0302***	-0.0311***	-0.0315***
	(0.00982)	(0.0101)	(0.00961)	(0.00961)
Administrative burdens on startups	-0.0155**			
	(0.00714)			
Administrative burdens for sole proprietor firms		-0.0127**		
		(0.00622)		

Dependent variable: log(GFCF Non-ICT/Capital stock Non-ICT)	Aggregate Barriers to entrepreneuship	Administrative burden for sole proprietors	Sector specific burdens	Administrative burden for corporations
Sector specific administrative burdens			-0.0135**	
			(0.00527)	
Administrative burdens for corporation				-0.00647
				(0.00604)
Legal barriers	-0.00959*	-0.0133**	-0.0105*	-0.00801
	(0.00557)	(0.00594)	(0.00562)	(0.00569)
Antitrust exemptions	-0.00207	-0.00497	-0.00127	0.00127
	(0.00696)	(0.00758)	(0.00687)	(0.00684)
Barriers to trade and investment	-0.0360***	-0.0380***	-0.0365***	-0.0348***
	(0.0113)	(0.0111)	(0.0117)	(0.0107)
Observations	219	219	219	219
R-squared	0.970	0.970	0.970	0.969
Year dummies	Yes	Yes	Yes	Yes

Table A. 3: Impact of Product Market Regulations on the share of ICT investment, 1990-2005, (OECD Low Level Indicator)

Dependent variable: GFCF ICT/Total GFCF	Aggregate barriers to entrepreneurship	Administrative burden for sole proprietors	Sector specific burdens	Administrative burden for corporations
Lagged dependent variable	0.880***	0.877***	0.880***	0.884***
	(0.0452)	(0.0443)	(0.0452)	(0.0456)
Size of public enterprise sector	0.000463	-2.23e-05	0.000693	0.000378
	(0.00157)	(0.00154)	(0.00163)	(0.00157)
Scope of public enterprise sector	-0.00400*	-0.00336	-0.00441*	-0.00472*
	(0.00238)	(0.00239)	(0.00233)	(0.00240)
Direct control over business enterprise	0.00103	0.000979	0.000963	0.000828
	(0.000702)	(0.000594)	(0.000678)	(0.000795)
Price controls	-0.00338	-0.00364*	-0.00342	-0.00397*
	(0.00218)	(0.00196)	(0.00221)	(0.00231)
Use of command & control regulation	-0.000759	-0.000710	-0.000699	-0.00126
	(0.00130)	(0.00116)	(0.00138)	(0.00124)
Licence and permits system	-0.00207**	-0.00232***	-0.00208***	-0.00195**
	(0.000799)	(0.000829)	(0.000796)	(0.000796)
Communication and simplification of rules and procedures	0.00245	0.00285	0.00267	0.00274
	(0.00196)	(0.00185)	(0.00191)	(0.00219)
Administrative burdens on startups	-0.00218			
	(0.00188)			
Administrative burdens for sole proprietor firms		-0.00264*		
		(0.00144)		
Sector specific administrative burdens			-0.00166	
			(0.00149)	
Administrative burdens for corporation				-0.000626
				(0.00170)
Legal barriers	0.000505	-0.000489	0.000503	0.000674
	(0.00141)	(0.00157)	(0.00141)	(0.00147)
Antitrust exemptions	0.00419**	0.00371**	0.00435**	0.00443**
	(0.00187)	(0.00186)	(0.00189)	(0.00190)
Barriers to trade and investment	0.00860*	0.00843*	0.00857*	0.00877*
	(0.00467)	(0.00467)	(0.00466)	(0.00474)
Observations	204	204	204	204
R-squared	0.985	0.985	0.985	0.985
Yes dummies	Yes	Yes	Yes	Yes

Table A. 4: Impact of product market regulation on different capital assets at the economy-wide level 1990-2005, OECD economy-wide level indicators (High-Level Indicators)

Dependent variable: GFCF asset/Capital stock asset	IT	CT	Software	Transport Equipment	Other Machinery	Residential structure	Other Construction	Other
Lag dependent variable	0.642***	0.762***	0.556***	0.808***	0.826***	1.047***	0.860***	0.735***
	(0.0642)	(0.0645)	(0.0584)	(0.0418)	(0.0478)	(0.0231)	(0.0243)	(0.0600)
Product market regulation	-0.0143*	0.00199	-0.0135**	-0.00584	-0.00265*	-0.000997	0.000431	-0.000152
	(0.00798)	(0.00699)	(0.00532)	(0.00468)	(0.00149)	(0.000639)	(0.000587)	(0.00285)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	206	206	206	206	206	191	206	169
R-squared	0.724	0.725	0.619	0.849	0.814	0.964	0.965	0.629

Table A. 5: Impact of product market regulation on different capital assets at the economy-wide level 1990-2005, OECD economy-wide level indicators (High- and Medium-Level Indicators)

Dependent variable: GFCF asset/Capital stock asset	IT	CT	Software	Transport Equipment	Other Machinery	Residential structure	Other Construction	Other
Administrative regulation	-0.00493	-0.00103	-0.00763**	-0.00521*	-0.00229**	-0.000262	0.00102**	0.000550
	(0.00649)	(0.00429)	(0.00308)	(0.00277)	(0.00106)	(0.000771)	(0.000445)	(0.00184)
Economic regulation	-0.0129*	-0.00162	-0.0104***	-0.00630*	-0.00255**	-0.000759	0.000423	0.00153
	(0.00682)	(0.00425)	(0.00318)	(0.00321)	(0.00116)	(0.000593)	(0.000435)	(0.00212)
Inward-oriented policies	-0.0129*	-0.00162	-0.0104***	-0.00630*	-0.00255**	-0.000759	0.000423	0.00153
	(0.00682)	(0.00425)	(0.00318)	(0.00321)	(0.00116)	(0.000593)	(0.000435)	(0.00212)
Outward-oriented policies	-0.00904	0.00956	-0.0111	0.000509	-0.00101	-0.000914	2.18e-05	-0.00435
	(0.00735)	(0.0100)	(0.00861)	(0.00568)	(0.00201)	(0.000673)	(0.000803)	(0.00338)
Barriers to entrepeneurship	-0.0191***	-0.00402	-0.00916**	-0.00521	-0.00236	-0.00219***	-0.000159	0.00266
	(0.00718)	(0.00388)	(0.00373)	(0.00369)	(0.00145)	(0.000598)	(0.000495)	(0.00282)
State control	-0.00477	-0.000274	-0.00728***	-0.00388*	-0.00180**	8.87e-05	0.000469	0.000614
	(0.00468)	(0.00329)	(0.00224)	(0.00206)	(0.000821)	(0.000503)	(0.000325)	(0.00138)
Barriers to trade and investment	-0.00745	0.0103	-0.00927	0.00176	-0.000414	-0.000847	-0.000115	-0.00507
	(0.00686)	(0.00989)	(0.00866)	(0.00538)	(0.00207)	(0.000673)	(0.000781)	(0.00328)
Lag dependent variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table A. 6: Impact of labour market institutions on aggregate ICT investment, CEP-OECD institutions dataset, 1990-2004

Dependent variable: log (GFCF Non-ICT/Non-ICT Capital stock)	(1)	(2)	(3)	(4)	(5)
Lagged dependent variable	0.871***	0.871***	0.848***	0.859***	0.854***
	(0.0288)	(0.0290)	(0.0312)	(0.0320)	(0.0305)
employment protection legislation	-0.0112	-0.0115	0.0286	0.0418*	0.0595**
	(0.0188)	(0.0207)	(0.0229)	(0.0243)	(0.0287)
Union coverage	0.0413*	0.0414*	0.0761**	0.0644**	0.0502
	(0.0223)	(0.0226)	(0.0296)	(0.0314)	(0.0322)
Union density	-0.000253	-0.000255	-3.54e-05	2.17e-05	0.000163
	(0.000191)	(0.000194)	(0.000172)	(0.000172)	(0.000193)
Degree of bargaining coordination		0.000201	0.00680	0.00212	0.00186
		(0.00718)	(0.00779)	(0.00883)	(0.00964)
Degree of bargaining centralisation			-0.0361**	-0.0446***	-0.0551***
			(0.0163)	(0.0166)	(0.0188)
Benefit Replacement rates across 5 first years of unemployment (%)				0.0795*	0.151***
				(0.0409)	(0.0443)
Expenditure on active labour market policies (per unemployed)					-0.0639
					(0.0477)
Gross Operating Surplus/ICT Capital stock	0.110***	0.110***	0.143***	0.157***	0.176***
	(0.0245)	(0.0246)	(0.0297)	(0.0310)	(0.0294)
Non-ICT deflator/Value added deflator	-0.416***	-0.416***	-0.476***	-0.451***	-0.417***
	(0.129)	(0.139)	(0.133)	(0.133)	(0.120)
Observations	158	158	158	156	146
R-squared	0.965	0.965	0.967	0.968	0.969

Table A. 7: Non-ICT Investment and Regulation in non-manufacturing sectors, 1975-2005

Dependent variable:Δ(Log GFCF Non-ICT/Non-ICT capital stock)	Aggregate indicator	With barriers to entry	With public ownership	With market structure	With vertical integration
	(1)	(2)	(3)	(4)	(5)
Lagged dependent variable	-0.266***	-0.259***	-0.257***	-0.230***	-0.255***
	(0.0565)	(0.0500)	(0.0499)	(0.0370)	(0.0505)
Lagged regulatory conditions	-0.00206**				
	(0.000835)				
Lagged public ownership		-0.000502			
		(0.000452)			
Lagged barriers to entry			-0.00157*		
			(0.000811)		
Lagged vertical integration				-0.000769	
				(0.000467)	
Lagged market structure					-0.000256
					(0.000398)
Δ Regulatory conditions	-0.00414**				
	(0.00183)				
Δ Public ownership		-0.00115			
		(0.00187)			
Δ Barriers to entry			-0.00131		
			(0.00114)		
Δ Vertical integration				-0.00125*	
				(0.000741)	
Δ Market structure					-0.00368***
					(0.00116)
Gross operating surplus/Non-ICT Capital	0.00354**	0.00373***	0.00339***	0.00380**	0.00377***
	(0.00138)	(0.00126)	(0.00125)	(0.00174)	(0.00124)
Non-ICT deflator/VA deflator	-0.000476	0.000423	-0.000826	0.00432	0.000875
	(0.00263)	(0.00256)	(0.00261)	(0.00334)	(0.00254)
Observations	966	991	991	666	991
R-squared	0.199	0.202	0.207	0.205	0.209

Table A. 8: ICT Groupings of Industries (following Inklaar et al. (2003) and Conway et al. (2006)

ICT category	Sector	Code (ISIC Revision 3)
ICT Producing	Manufacturing	30t33
	Non-Manufacturing	64
ICT Using	Manufacturing	21t22, 29, 36t37
	Non-Manufacturing	50t52, J, 71t74
Non-ICT	Manufacturing	15t16, 17t19, 20, 23, 24, 25, 26, 27t28, 34t35
	Non-Manufacturing	55, 40-41, 45, 60t63

Table A. 9: Non-ICT Investment and Regulation across ICT and non-ICT sectors, ECM

Dependent variable: Δ(GFCF Non-ICT/ non-ICT Capital)	ICT-Producing			ICT-Using			Non-ICT		
	All industries	Manufacturing	Services	All industries	Manufacturing	Services	All industries	Manufacturing	Services
ecm	-0.297***	-0.332***	-0.270**	-0.235***	-0.309***	-0.203***	-0.287***	-0.338***	-0.149***
	(0.0437)	(0.0473)	(0.101)	(0.0314)	(0.0296)	(0.0494)	(0.0342)	(0.0413)	(0.0420)
Lagged regulation impact	-0.0290*	-0.0136	-0.0360*	0.00681	0.0360	0.00308	-0.00252	0.0130	-0.00149
	(0.0162)	(0.0287)	(0.0188)	(0.0134)	(0.0340)	(0.0105)	(0.00469)	(0.0262)	(0.00344)
ΔRegulation Impact	-0.0347	-1.335**	-0.0252	-0.263	-0.260	-0.197	-0.0153	-0.318	-0.00744
	(0.0757)	(0.498)	(0.0585)	(0.190)	(0.243)	(0.322)	(0.0146)	(0.212)	(0.0203)
Dummy 1995-2000	-0.0192**	-0.00740	-0.0226*	-0.000163	-0.00711	0.000778	-0.00365	-3.81e-05	-0.00404
	(0.00622)	(0.0106)	(0.0108)	(0.00451)	(0.00873)	(0.0103)	(0.00517)	(0.00841)	(0.00362)
Gross operating surplus/Non-ICT capital	0.00573*	0.00558*	0.00693	0.00315	0.00510**	0.00196	0.00519***	0.00589**	0.00241
	(0.00276)	(0.00268)	(0.00467)	(0.00260)	(0.00172)	(0.00426)	(0.00150)	(0.00195)	(0.00139)
Non-ICT deflator/VA deflator	0.00842	0.00999	0.00727	-0.000231	-0.00292	0.00309	0.00177	0.00305	0.000427
	(0.00723)	(0.0114)	(0.0104)	(0.00707)	(0.00934)	(0.00637)	(0.00159)	(0.00224)	(0.00352)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	473	241	232	Yes	743	716	3134	2158	976
R-squared	0.279	0.391	0.263	Yes	0.277	0.181	0.190	0.224	0.143

CHAPTER 6
STATISTICAL ANNEX

6.1. Sectoral competitiveness indicators

Explanatory notes

Geographical coverage: all indicators refer to EU-27

Production index[142]: The production index is actually an index of final production in volume terms.

Labour productivity: this indicator is calculated by combining the indexes of production and number of persons employed or number of hours worked[143]. Therefore, this indicator measures final production per person of final production per hour worked.

Unit Labour Cost: it is calculated from the production index and the index of wages and salaries and measures labour cost per unit of production. "Wages and salaries" is defined (Eurostat) as "the total remuneration, in cash or in kind, payable to all persons counted on the payroll (including homeworkers), in return for work done during the accounting period, regardless of whether it is paid on the basis of working time, output or piecework and whether it is paid regularly wages and salaries do not include social contributions payable by the employer".

Relative Trade Balance: it is calculated, for sector "i", as (Xi-Mi)/(Xi+Mi), where Xi and Mi are EU-27 exports and imports of products of sector "i" to and from the rest of the World.

Revealed Comparative Advantage (RCA):

The RCA indicator for product "i" is defined as follows:

$$RCA_i = \frac{\frac{X_{EU,i}}{\sum_i X_{EU,i}}}{\frac{X_{W,i}}{\sum_i X_{W,i}}}$$

where: X=value of exports; the reference group ("W") is the EU-27 plus 38 other countries (see list below); the source used is the UN COMTRADE database. In the calculation of RCA, X_{EU} stands for exports to the rest of the world (excluding intra-EU trade) and X_W measures exports to the rest of the world by the countries in the reference group. The latter consists of the EU-25 plus the following countries: Algeria, Argentina, Australia, Bangladesh, Brazil, Canada, Chile, China, Colombia, Costa Rica, Croatia, Egypt, Hong Kong, India, Indonesia, Israel, Japan, Kazakhstan, South Korea, Malaysia, Mexico, Morocco, New Zealand, Norway, other Asian countries n.e.s., Pakistan, Peru, Philippines, Romania, South Africa, Singapore, Sri Lanka, Switzerland, Thailand, Tunisia, Turkey, United States, Venezuela.

Statistical nomenclatures: the indicators in tables 6.1 to 6.6 are presented at the level of divisions of the statistical classification of economic activities in the European Community (NACE Rev.2[144]), while those in tables 6.7 and 6.8[145] are presented in terms of divisions of the statistical classification of products by activity (CPA). Data sources: tables 6.1 to 6.6 are based on Eurostat's short-term indicators data. Tables 6.7 and 6.8 are based on United Nations' COMTRADE and Eurostat's COMEXT databases.

142 The data are working-day adjusted for production.
143 The data are working-day adjusted for hours worked.

144 Compared to the statistical annexes of the previous publications, the new activity classification is used: NACE REV 2. The correspondance tables from NACE Rev. 2 – NACE Rev. 1.1 and from NACE Rev. 1.1 to NACE Rev. 2, are available on Eurostat: http://epp.eurostat.ec.europa.eu/portal/page/portal/nace_rev2/introduction
145 Data in tables 6.7 and 6.8 have not been updated since the last report (European Competitiveness Report 2008).

Table 6.1: EU-27 Industry production index, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 2003-2008
B	MINING AND QUARRYING	-2,7	-1,3	1,7	-2,3	-3,0	0,8	-3,2	-2,1	-6,4	-4,3	0,5	-3,7	-3,2
C	MANUFACTURING	4,3	3,6	1,6	5,7	-0,1	-1,1	0,5	2,6	1,5	4,9	4,1	-1,9	2,2
C10	Manufacture of food products	2,7	1,8	1,1	1,2	1,1	2,0	0,1	2,1	2,2	1,3	1,8	-0,7	1,4
C11	Manufacture of beverages	4,3	-0,6	6,2	-1,3	2,6	2,3	2,3	-1,9	0,9	4,3	1,7	-2,0	0,6
C12	Manufacture of tobacco products	0,0	0,6	-3,2	-6,9	-2,8	-2,4	-7,0	-6,7	-4,0	-4,6	1,0	-16,3	-6,3
C13	Manufacture of textiles	4,5	-0,4	-5,6	2,0	-3,2	-4,7	-3,2	-4,5	-5,6	-0,3	-1,3	-9,6	-4,3
C14	Manufacture of wearing apparel	-4,0	-3,6	-9,2	-4,5	-4,5	-10,9	-6,3	-5,1	-8,9	2,5	2,2	-3,4	-2,6
C15	Manufacture of leather and related products	-0,8	-4,5	-4,1	-2,4	-5,2	-7,6	-7,0	-11,5	-9,0	-1,5	-1,5	-7,3	-6,2
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0,9	7,9	3,2	7,1	-3,9	0,5	2,1	3,2	0,0	4,3	0,9	-8,3	-0,1
C17	Manufacture of paper and paper products	5,0	0,4	3,0	3,4	-2,4	3,4	1,7	3,3	-0,4	3,3	2,5	-3,0	1,1
C18	Printing and reproduction of recorded media	0,0	8,8	2,6	1,8	-2,5	-0,5	-1,4	1,2	2,1	0,4	0,3	-2,7	0,2
C19	Manufacture of coke and refined petroleum products	-1,6	0,9	-4,8	6,4	0,2	-3,8	2,0	5,2	0,5	2,0	-0,3	3,1	2,1
C20	Manufacture of chemicals and chemical products	6,6	1,2	2,3	4,9	-1,8	2,3	-0,4	3,2	1,3	3,7	3,3	-3,4	1,6
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	5,2	8,4	8,2	5,1	10,0	6,3	5,8	-0,5	4,5	7,2	1,6	1,7	2,8
C22	Manufacture of rubber and plastic products	5,5	4,6	2,1	4,8	-0,5	-0,1	2,0	1,9	0,8	4,3	4,5	-4,5	1,3
C23	Manufacture of other non-metallic mineral products	2,9	2,6	2,3	4,0	-0,6	-1,7	0,5	2,0	0,5	4,3	2,0	-6,4	0,4
C24	Manufacture of basic metals	6,3	1,6	-3,8	7,1	-1,8	-0,1	-0,3	3,9	-1,7	5,5	1,2	-2,8	1,2
C25	Manufacture of fabricated metal products, except machinery and equipment	4,7	4,6	0,5	6,5	0,4	-0,3	0,8	2,5	1,6	5,1	6,0	-2,2	2,6
C26	Manufacture of computer, electronic and optical products	9,8	5,4	5,3	16,4	-5,6	-8,9	1,5	7,3	4,8	10,0	8,6	1,4	6,4
C27	Manufacture of electrical equipment	4,5	0,0	2,4	9,3	0,0	-2,9	-2,3	3,1	1,1	8,5	4,9	-0,2	3,5
C28	Manufacture of machinery and equipment n.e.c.	2,9	3,0	-2,0	6,1	1,4	-2,0	-0,8	4,0	3,9	8,3	8,6	1,2	5,2
C29	Manufacture of motor vehicles, trailers and semi-trailers	7,8	11,3	3,7	7,3	2,3	0,9	2,0	5,0	1,7	3,2	6,0	-5,9	1,9
C30	Manufacture of other transport equipment	8,8	3,3	-0,3	1,3	0,6	-4,2	1,1	0,7	2,7	9,0	4,2	4,1	4,1
C31	Manufacture of furniture	0,5	6,1	3,2	1,6	-1,7	-4,3	-2,3	0,7	0,2	3,3	3,2	-4,7	0,5
C32	Other manufacturing	2,8	3,5	1,8	5,0	3,6	2,4	-0,9	1,5	1,3	5,0	1,7	-0,8	1,7
C33	Repair and installation of machinery and equipment	-5,4	1,5	0,3	4,7	0,4	-3,7	-0,8	5,1	1,7	9,1	4,3	5,6	5,1
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	0,6	-1,3	2,4	3,3	2,1	0,7	6,0	-0,2	1,2	-0,5	-1,0	-0,5	-0,2
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	0,3	2,4	4,2	4,0	0,4	1,2	1,8	0,7	1,8	3,3	2,1	-3,2	0,9

N/A: Data not available
Source: Eurostat.

Table 6.2: EU-27 Number of persons employed, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 2003-2008
B	MINING AND QUARRYING	-5,4	-6,7	-9,8	-9,3	-3,7	-4,4	-3,9	-4,8	-3,9	-4,5	-3,8	-1,3	-3,7
C	MANUFACTURING	-0,7	0,6	-2,0	-1,3	-0,1	-2,1	-1,9	-1,8	-1,2	-0,8	0,5	-0,2	-0,7
C10	Manufacture of food products	0,0	1,2	-0,8	-1,8	-0,5	-0,6	-0,1	-1,0	0,4	-0,1	0,1	0,3	-0,1
C11	Manufacture of beverages	N/A	N/A	N/A	N/A	-1,3	-0,2	-1,0	-0,8	-1,3	-1,6	-0,2	-1,0	-1,0
C12	Manufacture of tobacco products	0,2	-1,3	-8,8	-4,4	-4,4	-1,6	-7,2	-5,9	-3,3	-1,6	-9,8	-7,7	-5,7
C13	Manufacture of textiles	-2,7	-2,2	-6,9	-4,5	-3,3	-5,1	-6,8	-5,9	-4,2	-6,1	-5,2	-6,4	-5,6
C14	Manufacture of wearing apparel	N/A	N/A	-3,9	-5,3	-2,8	-3,8	-4,1	-6,3	-7,6	-5,8	-5,9	-6,5	-6,4
C15	Manufacture of leather and related products	-2,1	-4,0	-7,7	-4,6	-1,3	-1,3	-4,3	-6,9	-6,1	-2,5	-3,3	-6,1	-5,0
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0,4	1,3	-0,2	-1,6	-1,2	-1,8	-1,4	-0,8	-0,4	-1,2	0,7	-2,0	-0,8
C17	Manufacture of paper and paper products	-1,2	1,3	-3,3	-1,9	-1,6	-0,7	-2,7	-1,4	-2,4	-2,6	-2,8	-1,5	-2,2
C18	Printing and reproduction of recorded media	-1,0	-0,1	-0,2	-1,3	-0,2	-2,3	-3,8	-1,8	-3,4	-1,9	-0,2	-1,9	-1,8
C19	Manufacture of coke and refined petroleum products	-3,8	-6,7	-1,5	0,3	-4,3	-2,6	-3,2	-2,8	-2,0	-4,3	1,1	-0,4	-1,7
C20	Manufacture of chemicals and chemical products	-1,2	-1,2	-2,9	-3,1	-0,8	-1,7	-2,5	-3,1	-1,7	-1,1	-0,5	-1,1	-1,5
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	-1,8	0,5	0,9	1,2	2,4	2,8	0,0	-2,5	-1,0	1,6	1,1	-1,1	-0,4
C22	Manufacture of rubber and plastic products	1,9	3,7	-1,0	2,1	0,7	-0,9	0,3	-0,1	-0,6	-0,4	1,6	0,6	0,2
C23	Manufacture of other non-metallic mineral products	-2,1	0,6	-2,2	-1,2	-0,9	-3,0	-3,1	-2,2	-1,1	-0,8	1,2	-2,1	-1,0
C24	Manufacture of basic metals	-2,7	-0,8	-4,2	-5,6	-1,4	-4,6	-3,5	-4,1	-1,1	-0,9	-0,5	-0,6	-1,5
C25	Manufacture of fabricated metal products, except machinery and equipment	0,1	2,2	0,0	0,4	0,9	-1,1	-0,8	0,4	0,0	1,2	3,2	2,1	1,4
C26	Manufacture of computer, electronic and optical products	-1,0	0,2	-2,2	3,4	1,3	-5,8	-4,4	-3,0	-1,6	-0,6	0,4	-1,4	-1,2
C27	Manufacture of electrical equipment	-1,1	2,4	-1,8	1,3	0,1	-4,4	-4,1	-1,5	-1,1	1,1	2,8	1,4	0,5
C28	Manufacture of machinery and equipment n.e.c.	-0,8	0,6	-3,1	-2,7	0,7	-1,8	-2,1	-2,5	-0,8	0,8	2,9	2,6	0,6
C29	Manufacture of motor vehicles, trailers and semi-trailers	1,5	3,4	0,1	1,5	1,0	-1,5	-0,4	0,3	-0,5	-0,9	-0,1	0,9	-0,1
C30	Manufacture of other transport equipment	-3,2	-1,4	-1,9	-2,6	0,5	-1,4	-2,5	-1,4	1,0	0,1	2,4	2,3	0,9
C31	Manufacture of furniture	N/A	N/A	N/A	N/A	1,0	-3,6	0,4	-2,8	-2,6	-1,3	0,1	-1,9	-1,7
C32	Other manufacturing	-1,4	-0,4	-1,6	-5,4	1,0	-1,8	0,3	-0,7	-1,5	-0,4	0,2	0,2	-0,4
C33	Repair and installation of machinery and equipment	-0,6	0,6	-2,8	-5,7	-0,8	-3,2	-2,8	-1,3	-0,4	0,6	1,7	2,4	0,6
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	-1,3	-3,6	-3,5	-4,0	-2,3	-3,3	-3,8	-3,6	-2,5	-1,6	-1,2	-0,5	-1,9
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	1,2	0,1	1,2	0,6	-1,4	2,8	0,4	0,8	0,6
F	CONSTRUCTION	0,3	1,5	1,1	0,7	0,2	-0,5	0,6	1,3	2,1	3,8	4,8	-0,9	2,2

N/A: Data not available
Source: Eurostat.

Table 6.3: EU-27 Number of hours worked, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2001	2002	2003	2004	2005	2006	2007	2008	Average 2003-2008
B	MINING AND QUARRYING	-3,8	-5,2	-4,6	-3,2	-4,2	-4,9	-3,2	-1,3	-3,3
C	MANUFACTURING	-1,4	-2,7	-2,2	-1,0	-1,5	-0,5	0,2	-0,6	-0,7
C10	Manufacture of food products	-1,1	-1,5	-1,4	-0,6	-1,0	0,0	-0,2	0,4	-0,3
C11	Manufacture of beverages	-0,1	-3,1	-0,2	0,2	-3,5	-3,9	-0,4	-1,2	-1,8
C12	Manufacture of tobacco products	1,2	-3,9	-10,6	-6,3	-3,6	-6,3	-2,9	-8,8	-5,6
C13	Manufacture of textiles	-3,4	-5,1	-6,0	-5,3	-6,5	-5,8	-2,5	-5,2	-5,1
C14	Manufacture of wearing apparel	-3,7	-3,6	-4,5	-4,3	-5,7	-4,5	-5,5	-6,0	-5,2
C15	Manufacture of leather and related products	-2,9	-1,6	-2,6	-3,0	-5,8	-0,9	-5,4	-6,2	-4,3
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-3,3	-2,1	-2,2	-0,3	-1,1	-0,6	-1,0	-3,5	-1,3
C17	Manufacture of paper and paper products	-2,6	-2,0	-0,8	-1,9	-1,7	-1,3	-1,9	-3,1	-2,0
C18	Printing and reproduction of recorded media	-0,1	-3,4	-3,2	-2,5	-3,2	-0,9	0,3	-1,2	-1,5
C19	Manufacture of coke and refined petroleum products	-3,0	-4,0	-3,3	-2,2	-2,1	-3,2	-0,4	1,7	-1,3
C20	Manufacture of chemicals and chemical products	-1,8	-2,7	-2,4	-1,3	-3,0	-1,2	-1,1	-0,5	-1,4
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	-0,2	2,1	-0,1	-1,4	-1,9	-0,7	0,3	1,1	-0,5
C22	Manufacture of rubber and plastic products	0,0	-1,9	-0,6	0,4	-0,8	1,1	0,8	-0,5	0,2
C23	Manufacture of other non-metallic mineral products	-2,5	-3,6	-3,3	-1,2	-1,5	-0,7	0,6	-2,4	-1,0
C24	Manufacture of basic metals	-3,2	-4,1	-5,4	-2,4	-1,9	-0,4	-0,2	-1,1	-1,2
C25	Manufacture of fabricated metal products, except machinery and equipment	-0,9	-1,8	-0,9	0,1	-0,2	0,8	2,2	2,9	1,2
C26	Manufacture of computer, electronic and optical products	-0,3	-5,5	-3,8	-1,9	-1,5	-0,9	0,2	-0,6	-0,9
C27	Manufacture of electrical equipment	-1,5	-3,3	-3,2	-1,5	-1,3	2,0	1,4	1,2	0,3
C28	Manufacture of machinery and equipment n.e.c.	-1,3	-2,8	-2,2	-0,7	-1,4	1,2	2,7	1,7	0,7
C29	Manufacture of motor vehicles, trailers and semi-trailers	-0,7	-2,3	-0,2	1,6	0,1	-1,6	0,4	-1,0	-0,1
C30	Manufacture of other transport equipment	-0,4	-2,7	-2,4	-2,5	0,0	1,2	2,0	1,3	0,4
C31	Manufacture of furniture	1,1	-4,8	-2,6	-0,9	-3,7	0,2	0,3	-3,2	-1,5
C32	Other manufacturing	-0,4	-2,5	-2,0	0,6	-2,7	-0,2	0,3	-0,1	-0,4
C33	Repair and installation of machinery and equipment	-2,9	-2,8	-3,3	-2,3	-0,1	1,6	1,4	0,3	0,2
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	-1,7	-3,6	-3,8	-2,7	-2,8	-2,1	-0,7	-0,3	-1,7
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	0,1	-2,4	1,0	1,2	0,6	0,5	-0,1	3,6	1,2
F	CONSTRUCTION	-0,9	-2,8	0,0	0,3	5,2	4,0	3,6	-1,8	2,2

Source: Eurostat.

Table 6.4: EU-27 Labour productivity per person employed, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 2003-2008
B	MINING AND QUARRYING	2,9	5,7	12,8	7,7	0,7	5,4	0,8	2,8	-2,6	0,2	4,4	-2,4	0,5
C	MANUFACTURING	5,0	2,9	3,7	7,1	0,1	1,1	2,5	4,5	2,7	5,7	3,6	-1,7	2,9
C10	Manufacture of food products	2,7	0,7	1,8	3,1	1,6	2,6	0,2	3,1	1,9	1,4	1,7	-0,9	1,4
C11	Manufacture of beverages	N/A	N/A	N/A	N/A	4,0	2,5	3,3	-1,1	2,2	6,0	1,9	-0,9	1,6
C12	Manufacture of tobacco products	-0,2	2,0	6,2	-2,7	1,8	-0,8	0,2	-0,8	-0,7	-3,0	12,0	-9,3	-0,6
C13	Manufacture of textiles	7,4	1,8	1,4	6,9	0,1	0,4	3,8	1,5	-1,5	6,2	4,2	-3,4	1,3
C14	Manufacture of wearing apparel	N/A	N/A	-5,6	0,8	-1,7	-7,3	-2,4	1,3	-1,5	8,8	8,6	3,4	4,0
C15	Manufacture of leather and related products	1,3	-0,5	4,0	2,3	-4,0	-6,4	-2,8	-5,0	-3,0	1,1	1,8	-1,3	-1,3
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0,6	6,5	3,4	8,8	-2,8	2,3	3,6	4,1	0,4	5,6	0,2	-6,4	0,7
C17	Manufacture of paper and paper products	6,3	-0,9	6,5	5,4	-0,8	4,1	4,6	4,8	2,1	6,1	5,5	-1,5	3,3
C18	Printing and reproduction of recorded media	1,0	8,9	2,8	3,1	-2,3	1,8	2,5	3,1	5,6	2,3	0,5	-0,9	2,1
C19	Manufacture of coke and refined petroleum products	2,3	8,1	-3,4	6,1	4,7	-1,3	5,3	8,2	2,6	6,5	-1,4	3,5	3,8
C20	Manufacture of chemicals and chemical products	7,8	2,4	5,4	8,3	-0,9	4,1	2,2	6,5	3,0	4,8	3,7	-2,4	3,1
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	7,0	7,9	7,3	3,8	7,4	3,4	5,8	2,0	5,5	5,5	0,4	2,8	3,2
C22	Manufacture of rubber and plastic products	3,5	0,9	3,2	2,6	-1,2	0,9	1,7	2,0	1,4	4,7	2,8	-5,1	1,1
C23	Manufacture of other non-metallic mineral products	5,0	2,0	4,6	5,2	0,3	1,4	3,7	4,3	1,6	5,1	0,8	-4,4	1,4
C24	Manufacture of basic metals	9,2	2,4	0,4	13,6	-0,4	4,8	3,4	8,4	-0,6	6,5	1,7	-2,1	2,7
C25	Manufacture of fabricated metal products, except machinery and equipment	4,5	2,3	0,4	6,1	-0,5	0,9	1,7	2,1	1,6	3,9	2,7	-4,2	1,2
C26	Manufacture of computer, electronic and optical products	10,9	5,2	7,7	12,5	-6,8	-3,3	6,2	10,6	6,5	10,6	8,2	2,8	7,7
C27	Manufacture of electrical equipment	5,6	-2,4	4,2	7,8	-0,1	1,5	1,9	4,7	2,2	7,4	2,1	-1,6	2,9
C28	Manufacture of machinery and equipment n.e.c.	3,8	2,4	1,1	9,1	0,6	-0,1	1,4	6,6	4,7	7,4	5,6	-1,4	4,6
C29	Manufacture of motor vehicles, trailers and semi-trailers	6,2	7,6	3,6	5,6	1,3	2,5	2,4	4,7	2,1	4,1	6,2	-6,8	2,0
C30	Manufacture of other transport equipment	12,4	4,8	1,7	3,9	0,1	-2,9	3,6	2,1	1,6	8,9	1,8	1,8	3,2
C31	Manufacture of furniture	N/A	N/A	N/A	N/A	-2,7	-0,7	-2,6	3,6	2,8	4,6	3,1	-2,8	2,2
C32	Other manufacturing	4,2	3,9	3,4	11,0	2,6	4,3	-1,2	2,1	2,8	5,4	1,5	-1,0	2,1
C33	Repair and installation of machinery and equipment	-4,8	0,9	3,2	11,0	1,1	-0,5	2,0	6,5	2,1	8,4	2,6	3,2	4,5
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	1,9	2,5	6,1	7,6	4,6	4,1	10,3	3,5	3,8	1,1	0,2	0,0	1,7
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	0,0	1,0	3,1	3,3	0,2	1,7	1,1	-0,6	-0,3	-0,5	-2,6	-2,3	-1,2

N/A: Data not available
Source: Eurostat.

Table 6.5: EU-27 Labour productivity per hour worked, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2001	2002	2003	2004	2005	2006	2007	2008	Average 2003-2008
B	MINING AND QUARRYING	0,8	6,3	1,4	1,1	-2,3	0,6	3,8	-2,4	0,1
C	MANUFACTURING	1,3	1,7	2,8	3,7	3,1	5,4	3,9	-1,3	2,9
C10	Manufacture of food products	2,3	3,6	1,6	2,8	3,3	1,4	2,0	-1,1	1,7
C11	Manufacture of beverages	2,7	5,6	2,5	-2,1	4,5	8,6	2,1	-0,8	2,4
C12	Manufacture of tobacco products	-3,9	1,6	4,1	-0,4	-0,3	1,8	4,0	-8,2	-0,7
C13	Manufacture of textiles	0,2	0,4	3,0	0,9	0,9	5,8	1,3	-4,7	0,8
C14	Manufacture of wearing apparel	-0,8	-7,6	-1,9	-0,8	-3,4	7,3	8,1	2,8	2,7
C15	Manufacture of leather and related products	-2,4	-6,1	-4,5	-8,8	-3,4	-0,6	4,0	-1,2	-2,1
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0,6	2,7	4,4	3,5	1,1	4,9	1,9	-5,0	1,2
C17	Manufacture of paper and paper products	0,2	5,6	2,5	5,3	1,4	4,7	4,5	0,0	3,2
C18	Printing and reproduction of recorded media	-2,3	3,0	1,8	3,8	5,5	1,3	0,0	-1,5	1,8
C19	Manufacture of coke and refined petroleum products	3,2	0,2	5,5	7,5	2,7	5,4	0,1	1,4	3,4
C20	Manufacture of chemicals and chemical products	0,1	5,1	2,1	4,5	4,4	4,9	4,4	-2,9	3,0
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	10,2	4,1	5,9	0,8	6,5	7,9	1,2	0,6	3,4
C22	Manufacture of rubber and plastic products	-0,5	1,9	2,6	1,5	1,6	3,1	3,6	-4,1	1,1
C23	Manufacture of other non-metallic mineral products	1,9	2,1	3,9	3,2	2,0	5,1	1,5	-4,2	1,5
C24	Manufacture of basic metals	1,5	4,2	5,5	6,5	0,2	5,9	1,4	-1,7	2,4
C25	Manufacture of fabricated metal products, except machinery and equipment	1,2	1,6	1,7	2,4	1,8	4,3	3,6	-4,9	1,4
C26	Manufacture of computer, electronic and optical products	-5,3	-3,6	5,5	9,4	6,4	11,0	8,4	1,9	7,4
C27	Manufacture of electrical equipment	1,5	0,4	1,0	4,6	2,4	6,4	3,5	-1,3	3,1
C28	Manufacture of machinery and equipment n.e.c.	2,7	0,8	1,4	4,7	5,3	7,0	5,8	-0,5	4,4
C29	Manufacture of motor vehicles, trailers and semi-trailers	2,9	3,2	2,2	3,3	1,6	4,9	5,6	-4,9	2,0
C30	Manufacture of other transport equipment	1,0	-1,5	3,5	3,3	2,7	7,7	2,1	2,8	3,7
C31	Manufacture of furniture	-2,8	0,6	0,4	1,6	4,0	3,1	2,9	-1,5	2,0
C32	Other manufacturing	4,1	5,1	1,1	0,9	4,1	5,2	1,3	-0,7	2,1
C33	Repair and installation of machinery and equipment	3,3	-0,9	2,7	7,5	1,8	7,5	2,9	5,2	5,0
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	3,9	4,4	10,2	2,6	4,1	1,6	-0,3	-0,2	1,5
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	1,3	4,2	1,8	0,4	-3,2	-0,6	-1,5	-1,3	-1,3

N/A: Data not available
Source: Eurostat.

Table 6.6: EU-27 Unit labour cost, annual growth rate (%)

Code (NACE Rev. 2)	Sector	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 2003-2008
B	MINING AND QUARRYING	2,2	-0,6	-1,9	-2,8	6,6	-2,3	4,2	2,4	7,9	8,7	5,0	10,3	6,8
C	MANUFACTURING	-2,6	-0,5	1,0	-1,1	3,0	2,0	0,0	-1,2	-0,4	-2,3	-0,1	5,7	0,3
C10	Manufacture of food products	-0,6	0,5	1,6	-0,6	2,6	1,0	2,9	-0,5	-0,8	0,4	1,6	4,9	1,1
C11	Manufacture of beverages	N/A	N/A	N/A	N/A	0,9	-1,0	2,1	3,2	-1,4	-4,1	0,7	4,9	0,6
C12	Manufacture of tobacco products	0,3	2,3	5,0	8,1	5,6	2,7	8,2	8,8	5,6	5,9	-2,4	15,7	6,6
C13	Manufacture of textiles	-2,6	2,4	6,7	7,6	2,1	3,1	0,6	0,7	2,7	-2,8	0,9	9,0	2,0
C14	Manufacture of wearing apparel	3,5	4,1	10,1	14,5	1,6	9,4	2,7	2,1	3,9	-3,6	-0,3	2,7	0,9
C15	Manufacture of leather and related products	2,5	6,3	4,6	16,2	9,1	7,4	4,1	9,5	5,4	4,3	4,8	9,6	6,7
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1,9	-4,6	-0,7	-4,7	5,0	-0,6	-1,8	-0,5	1,0	-0,3	4,8	11,3	3,2
C17	Manufacture of paper and paper products	-2,9	1,4	-0,4	-0,3	5,2	-2,4	-1,7	-1,8	1,3	-2,9	-1,1	3,6	-0,2
C18	Printing and reproduction of recorded media	0,8	-6,1	0,1	2,7	5,6	0,8	-1,3	-0,8	-1,5	-0,4	0,9	5,1	0,6
C19	Manufacture of coke and refined petroleum products	1,6	-2,1	7,7	5,2	-0,4	9,4	-4,9	-1,4	2,2	1,2	2,2	5,3	1,9
C20	Manufacture of chemicals and chemical products	-5,7	-0,5	-1,0	-0,2	3,4	-1,1	1,9	-3,1	-0,3	-3,4	-0,6	5,1	-0,5
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	N/A	N/A	N/A	N/A	-5,7	-0,5	-0,8	1,0	-2,8	-4,1	3,7	-0,4	-0,6
C22	Manufacture of rubber and plastic products	-2,5	-0,6	1,4	-0,1	3,3	1,5	-0,3	0,7	0,3	-3,0	-0,8	7,8	0,9
C23	Manufacture of other non-metallic mineral products	-2,1	-0,5	0,0	-1,8	2,1	2,8	0,2	-1,1	0,6	-1,5	2,5	8,9	1,8
C24	Manufacture of basic metals	-3,9	1,3	4,6	-5,7	-2,2	-1,5	0,2	-2,5	4,2	-2,2	3,2	5,8	1,7
C25	Manufacture of fabricated metal products, except machinery and equipment	-2,5	-1,2	2,2	-4,2	3,9	1,5	-0,1	0,3	-0,2	-1,1	0,9	9,7	1,8
C26	Manufacture of computer, electronic and optical products	-8,3	-2,6	-2,3	-3,4	12,0	6,1	-5,8	-7,2	-4,5	-8,3	-5,4	1,1	-4,9
C27	Manufacture of electrical equipment	-4,6	3,0	-0,3	-4,2	2,5	1,9	0,1	-1,3	-0,8	-4,2	0,4	5,2	-0,2
C28	Manufacture of machinery and equipment n.e.c.	-1,7	0,2	3,9	-2,9	2,8	2,8	1,6	-1,7	-2,4	-3,6	-1,8	4,8	-1,0
C29	Manufacture of motor vehicles, trailers and semi-trailers	-4,3	-5,7	1,2	0,6	0,8	0,7	0,4	-2,5	-0,2	0,0	-5,3	9,2	0,1
C30	Manufacture of other transport equipment	-7,6	-0,9	3,6	0,6	4,1	8,2	0,6	-1,3	0,5	-4,8	1,1	1,9	-0,5
C31	Manufacture of furniture	N/A	N/A	N/A	N/A	5,3	4,4	-0,8	-1,6	-0,3	-0,4	0,6	7,1	1,0
C32	Other manufacturing	-2,3	-1,8	0,1	-11,6	1,1	-0,5	1,1	0,8	-0,9	-2,3	3,5	3,1	0,8
C33	Repair and installation of machinery and equipment	7,8	1,8	2,4	-1,5	4,0	5,0	0,9	-3,3	0,6	-5,7	0,4	1,1	-1,4
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	-0,1	-0,8	-1,3	-1,9	-0,7	2,2	-4,3	1,2	0,8	5,5	5,6	5,2	3,6
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	-0,7	-0,7	-0,2	-3,3	4,5	3,1	0,6	2,1	6,9	3,4	7,5	6,4	5,2

N/A: Data not available
Source: Eurostat.

Table 6.7: EU-27 revealed comparative advantage index

Product	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Food products, beverages and tobacco	1.05	1.10	1.07	1.09	1.12	1.03	1.04	1.03	1.02	1.00	1.01
Textiles	0.82	0.82	0.82	0.80	0.79	0.77	0.73	0.72	0.71	0.65	0.64
Wearing apparel; dressing; dyeing of fur	0.65	0.61	0.57	0.56	0.55	0.57	0.57	0.55	0.55	0.55	0.55
Tanning, dressing of leather; manufacture of luggage	1.19	1.14	1.09	1.12	1.18	1.13	1.09	1.04	1.03	0.97	0.98
Wood and products of wood and cork	0.56	0.59	0.67	0.64	0.75	0.75	0.81	0.84	0.81	0.84	0.86
Pulp, paper and paper products	0.96	1.01	0.96	0.99	1.00	0.98	1.05	1.11	1.17	1.14	1.23
Publishing, printing, reproduction of recorded media	1.28	1.38	1.36	1.38	1.42	1.34	1.38	1.42	1.49	1.43	1.45
Coke, refined petroleum products and nuclear fuel	1.00	0.99	1.02	0.96	1.03	0.94	1.03	1.06	1.12	1.13	1.17
Chemicals and chemical products	1.29	1.31	1.36	1.43	1.44	1.43	1.48	1.45	1.41	1.41	1.42
Rubber and plastic products	0.93	0.96	0.93	0.93	0.92	0.90	0.90	0.93	0.94	0.91	0.93
Other non-metallic mineral products	1.56	1.56	1.55	1.55	1.51	1.46	1.42	1.39	1.36	1.30	1.30
Basic metals	0.87	0.84	0.76	0.79	0.87	0.85	0.82	0.80	0.79	0.85	0.77
Fabricated metal products	1.23	1.21	1.20	1.21	1.13	1.12	1.11	1.13	1.14	1.11	1.13
Machinery and equipment n.e.c.	1.46	1.48	1.49	1.49	1.42	1.45	1.45	1.45	1.45	1.44	1.48
Office machinery and computers	0.52	0.45	0.48	0.51	0.51	0.52	0.49	0.44	0.43	0.46	0.43
Electrical machinery and apparatus n.e.c.	0.96	0.96	0.98	0.95	0.91	0.94	0.91	0.92	0.95	0.93	0.97
Radio, television and communication equipment and apparatus	0.57	0.57	0.61	0.62	0.65	0.59	0.52	0.52	0.53	0.57	0.50
Medical, precision and optical instruments, watches and clocks	0.98	1.01	1.02	1.05	1.04	1.06	1.12	1.12	1.13	1.11	1.11
Motor vehicles, trailers and semi-trailers	0.88	0.90	0.89	0.84	0.93	0.95	0.98	1.04	1.06	1.04	1.07
Other transport equipment	1.27	1.31	1.23	1.30	1.32	1.25	1.22	1.22	1.19	1.21	1.21
Furniture; manufacturing n.e.c.	1.07	1.09	1.02	1.01	1.04	1.01	0.95	0.88	0.85	0.80	0.82

Source: Commission services' calculation with COMTRADE data.

Table 6.8: EU-27 Relative trade balance (X-M)/(X+M)

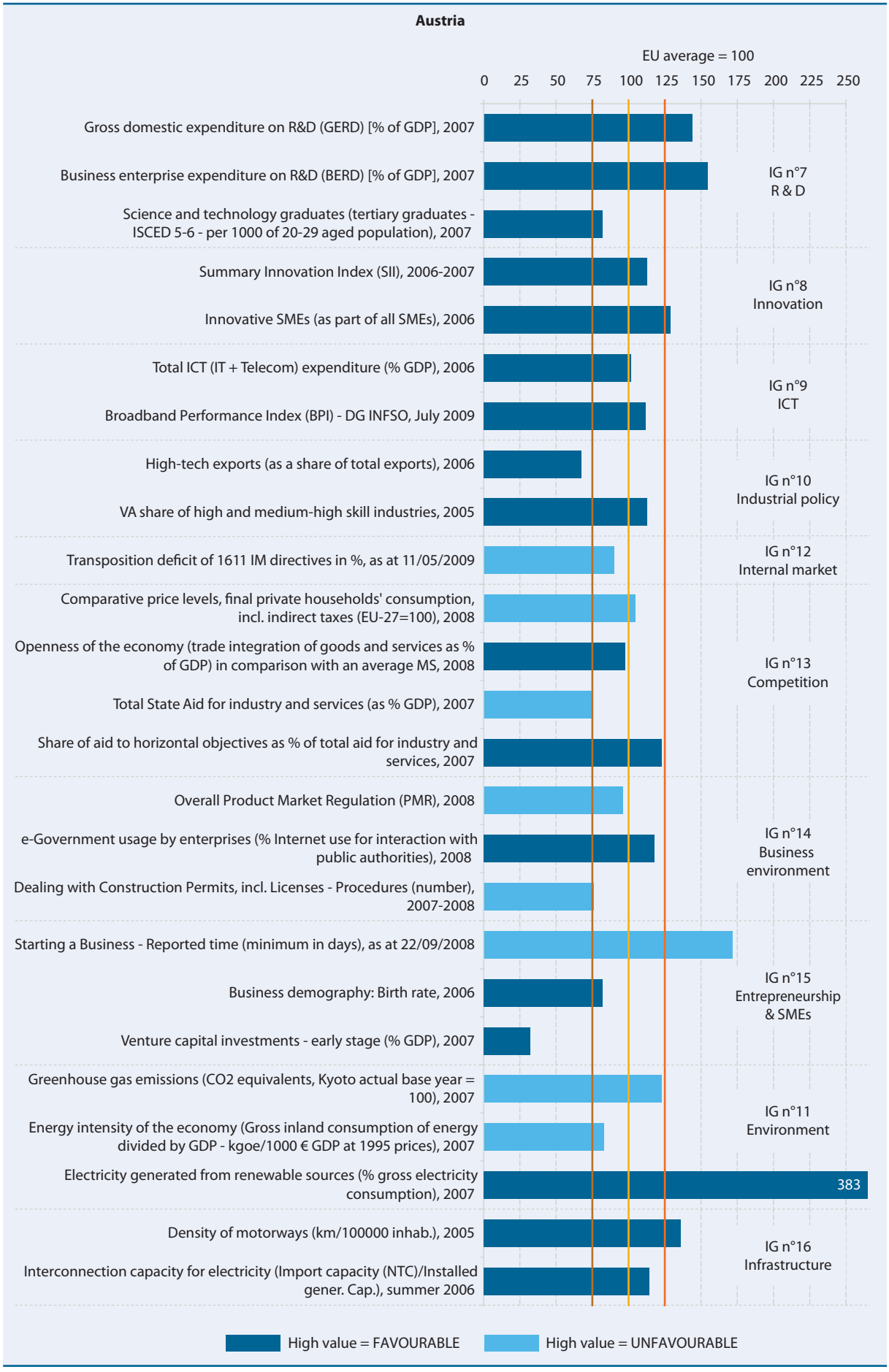
Product	1999	2000	2001	2002	2003	2004	2005	2006	2007
Food products, beverages and tobacco	0.09	0.10	0.07	0.09	0.08	0.07	0.08	0.08	0.11
Textiles	-0.13	-0.12	-0.12	-0.11	-0.13	-0.16	-0.19	-0.25	-0.24
Wearing apparel; dressing; dyeing of fur	-0.48	-0.48	-0.45	-0.46	-0.49	-0.50	-0.50	-0.51	-0.50
Tanning, dressing of leather; manufacture of luggage	-0.13	-0.12	-0.13	-0.16	-0.20	-0.21	-0.24	-0.25	-0.26
Wood and products of wood and cork	-0.17	-0.15	-0.11	-0.03	-0.05	-0.04	0.05	-0.05	-0.04
Pulp, paper and paper products	0.14	0.11	0.14	0.20	0.24	0.18	0.17	0.20	0.16
Publishing, printing, reproduction of recorded media	0.29	0.28	0.32	0.30	0.31	0.31	0.29	0.27	0.22
Coke, refined petroleum products and nuclear fuel	-0.04	-0.02	-0.10	-0.08	-0.06	-0.04	-0.04	-0.01	-0.00
Chemicals and chemical products	0.22	0.22	0.23	0.25	0.25	0.25	0.25	0.26	0.25
Rubber and plastic products	0.02	0.03	0.04	0.08	0.08	0.10	0.09	0.08	0.06
Other non-metallic mineral products	0.40	0.36	0.35	0.37	0.34	0.30	0.26	0.26	0.19
Basic metals	-0.16	-0.18	-0.17	-0.15	-0.16	-0.16	-0.07	-0.18	-0.25
Fabricated metal products	0.20	0.15	0.17	0.21	0.19	0.19	0.19	0.16	0.14
Machinery and equipment n.e.c.	0.31	0.29	0.33	0.37	0.37	0.39	0.38	0.43	0.44
Office machinery and computers	-0.46	-0.44	-0.42	-0.43	-0.45	-0.46	-0.42	-0.51	-0.53
Electrical machinery and apparatus n.e.c.	0.05	0.01	0.06	0.07	0.07	0.07	0.11	0.21	0.26
Radio, television and communication equipment and apparatus	-0.09	-0.13	-0.11	-0.17	-0.18	-0.21	-0.17	-0.26	-0.34
Medical, precision and optical instruments, watches and clocks	-0.05	-0.05	-0.02	0.04	0.06	0.11	0.09	0.08	0.07
Motor vehicles, trailers and semi-trailers	0.27	0.36	0.39	0.42	0.40	0.39	0.41	0.38	0.38
Other transport equipment	-0.00	0.01	0.05	0.02	-0.02	-0.01	0.02	-0.09	0.11
Furniture; manufacturing n.e.c.	-0.05	-0.06	-0.04	-0.06	-0.09	-0.11	-0.16	-0.15	-0.15

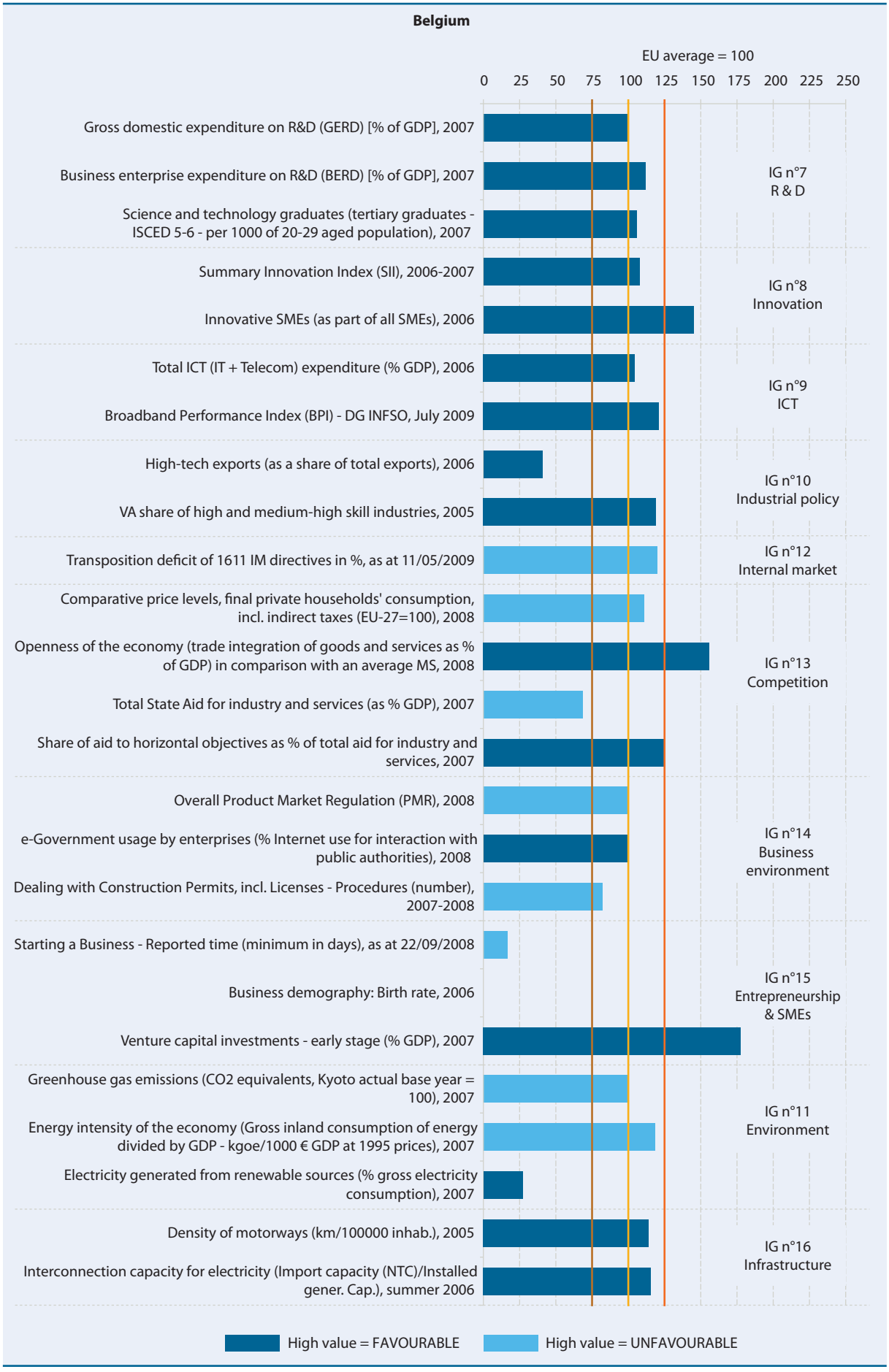
Source: Calculated from Eurostat's COMEXT database.

6.2. Microeconomic Data – Country Fiches

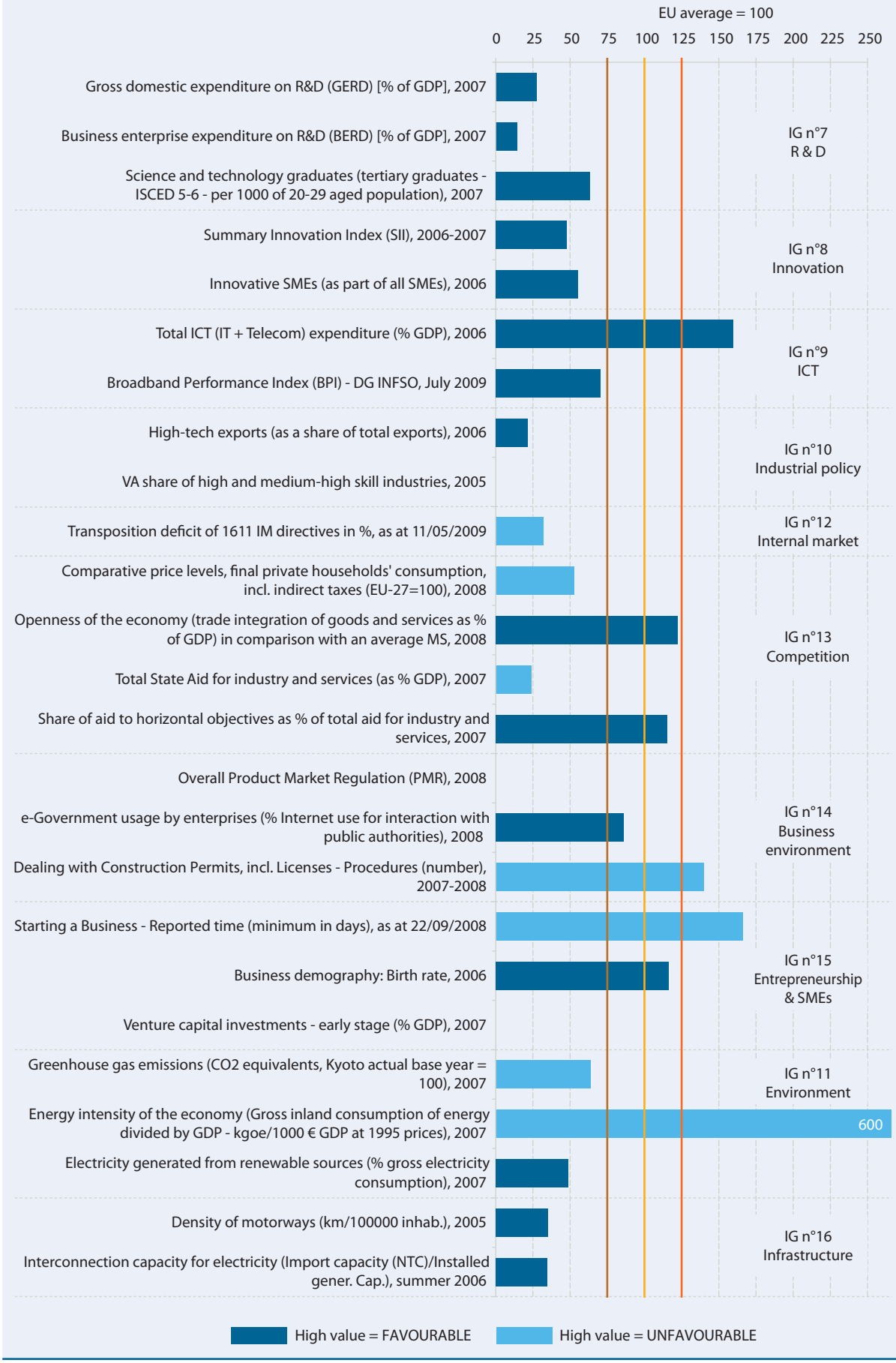
The country fiches present the performance of each Member State in the policy areas covered by the microeconomic pillar of the Strategy for Growth and Jobs (the Lisbon agenda). The EU average is given as a benchmark. Providing a common framework for all Member States, the integrated guidelines for growth and jobs specify the overarching objectives to be pursued in each policy area. The main policies constituting the microeconomic pillar (guidelines 7 to 16) are: Research, Innovation, encouraging investments in ICT, Industry, internal market, competition, encouraging the sustainable use of resources and the synergies between environmental protection and growth, creating a more attractive business environment, promoting entrepreneurship and expanding infrastructure. The link between these policies and competitiveness – taken here as the "capacity to grow" – is well established (for example, see Competitiveness Report 2007 for a review of empirical evidence). Higher productivity growth is the main channel through which these policies improve competitiveness. In this context, the country fiches give a snapshot picture of the competitiveness profile of the Member States.

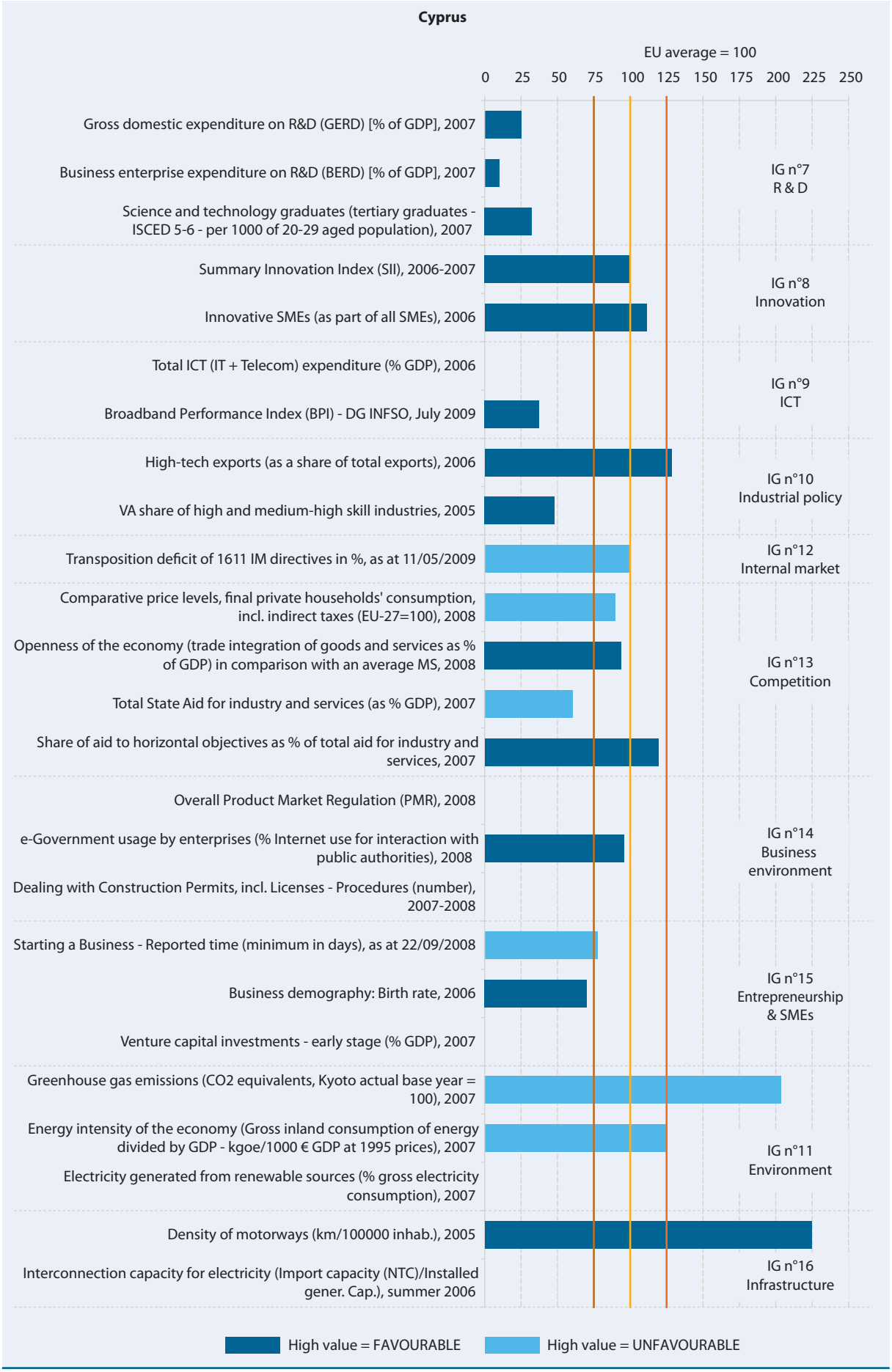
The source and a short description of the indicators used in the country fiches are presented at the end of the document. Readers wishing a more complete picture may refer to the EUROSTAT's Structural Indicators database. Internet links are provided to sources other than EUROSTAT.

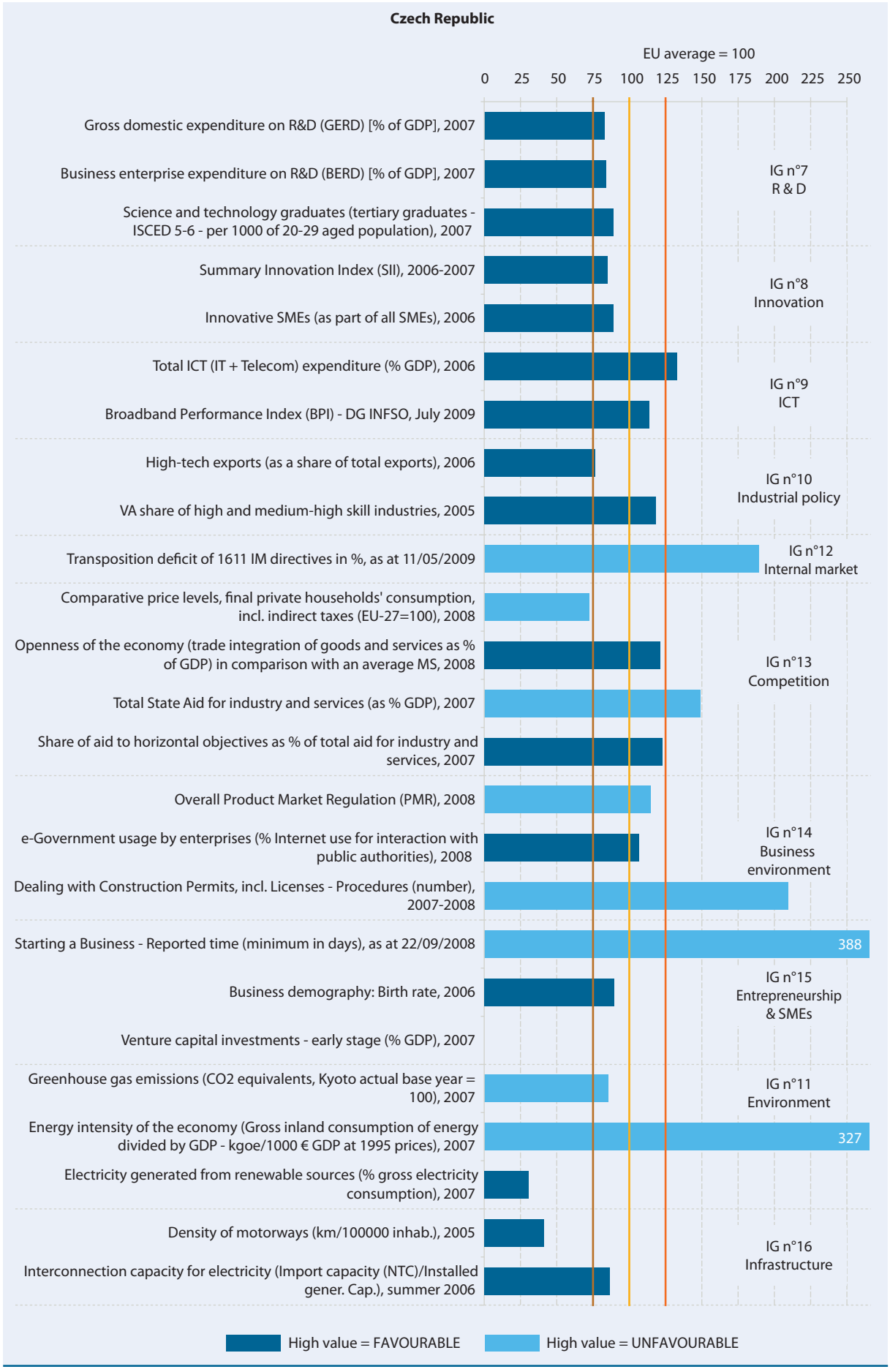

Austria
EU average = 100
0 25 50 75 100 125 150 175 200 225 250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
IG n°7 R & D
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
Summary Innovation Index (SII), 2006-2007
IG n°8 Innovation
Innovative SMEs (as part of all SMEs), 2006
Total ICT (IT + Telecom) expenditure (% GDP), 2006
IG n°9 ICT
Broadband Performance Index (BPI) - DG INFSO, July 2009
High-tech exports (as a share of total exports), 2006
IG n°10 Industrial policy
VA share of high and medium-high skill industries, 2005
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
383
Density of motorways (km/100000 inhab.), 2005
IG n°16 Infrastructure
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
High value = FAVOURABLE
High value = UNFAVOURABLE

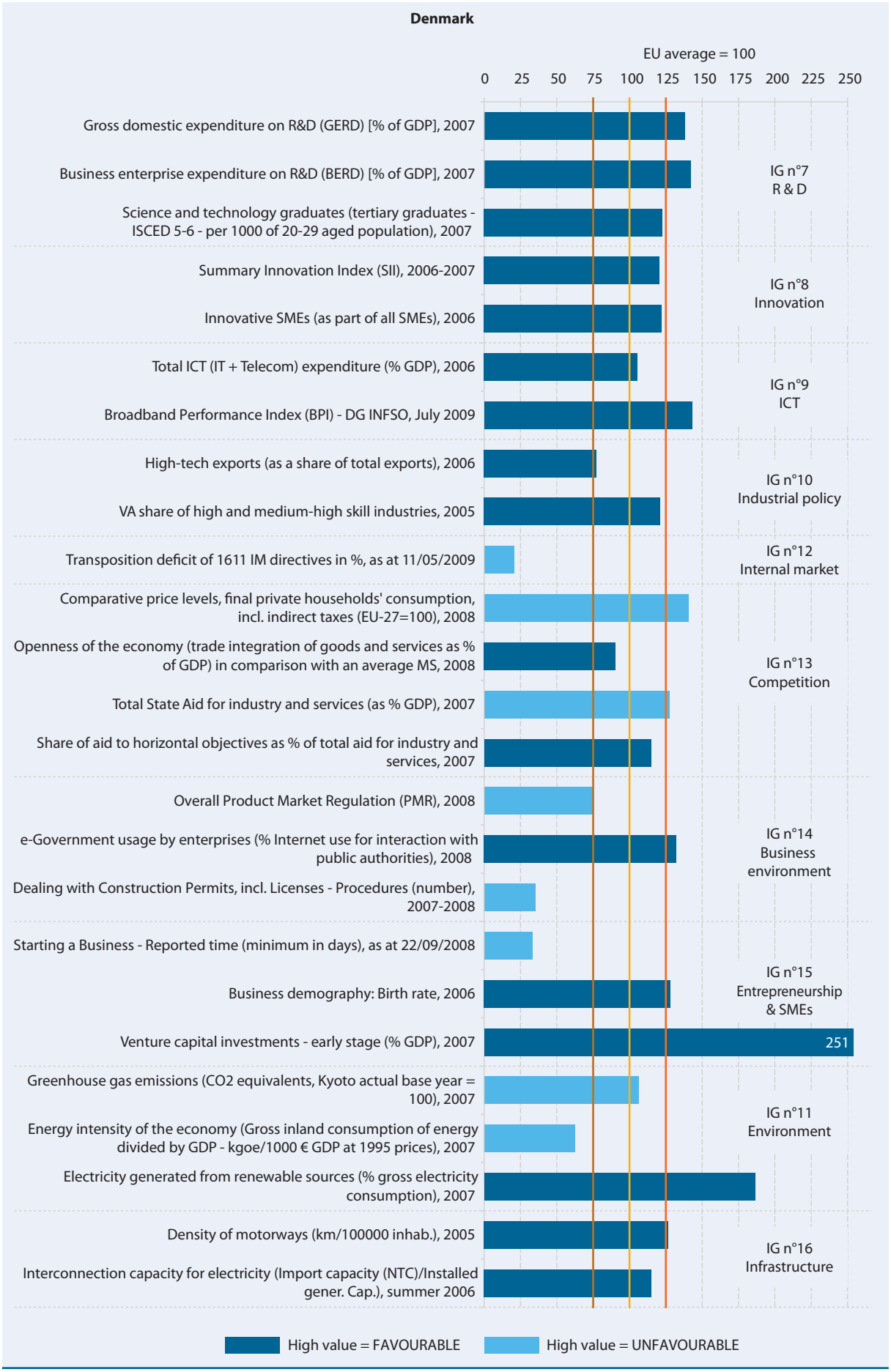

Belgium
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

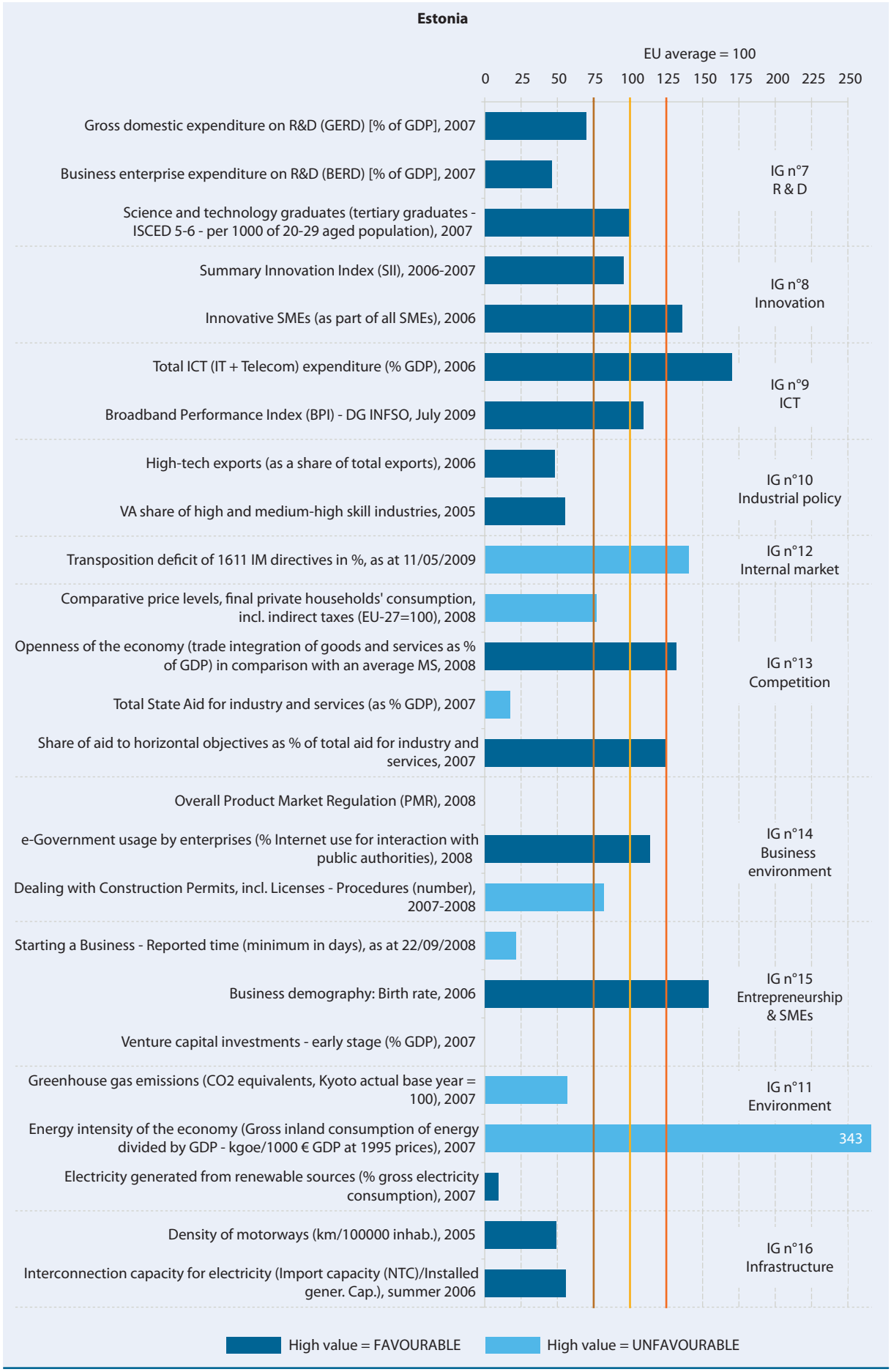
Bulgaria

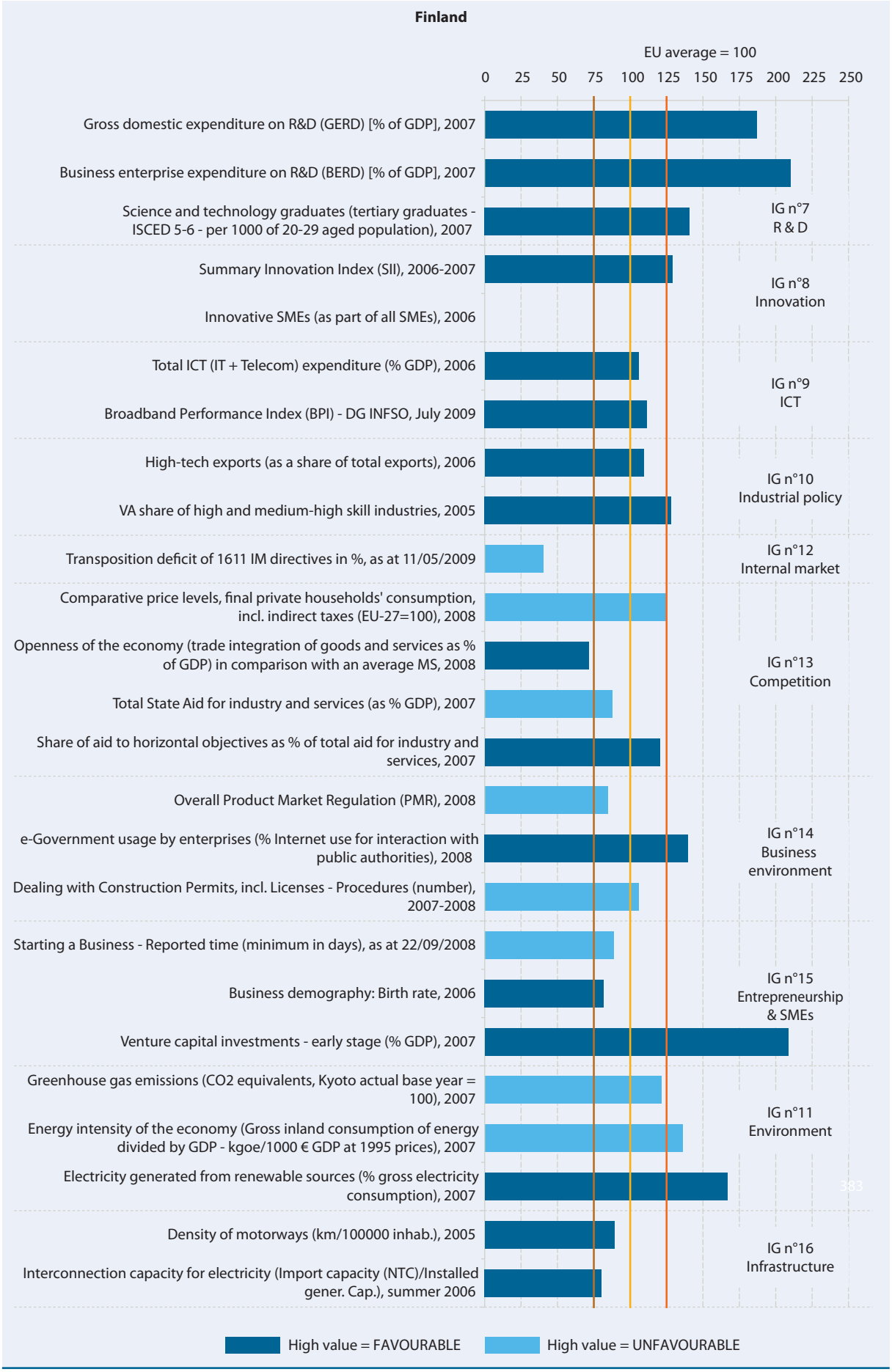

EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
IG n°11 Environment
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
600
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

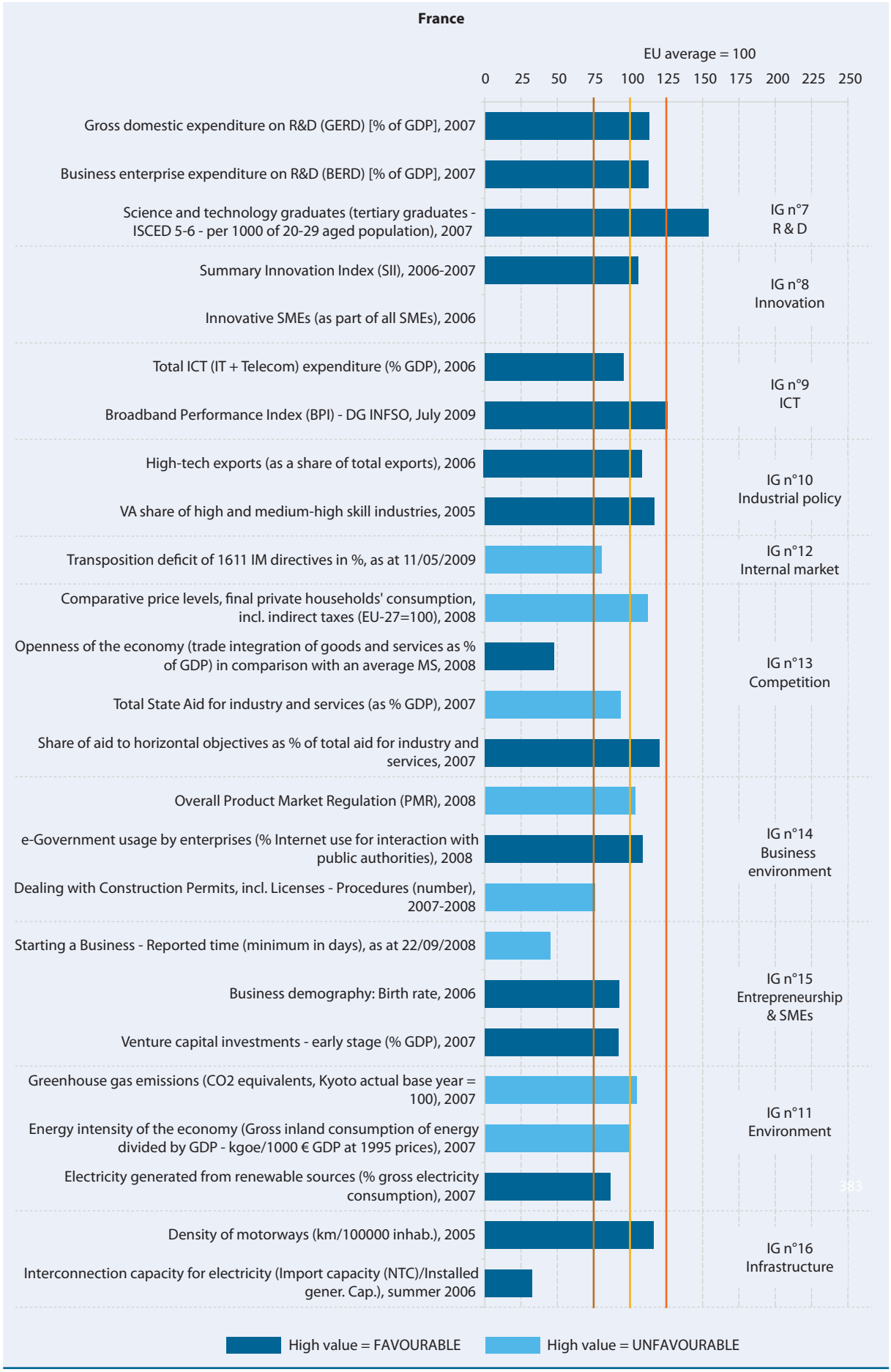

Cyprus
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

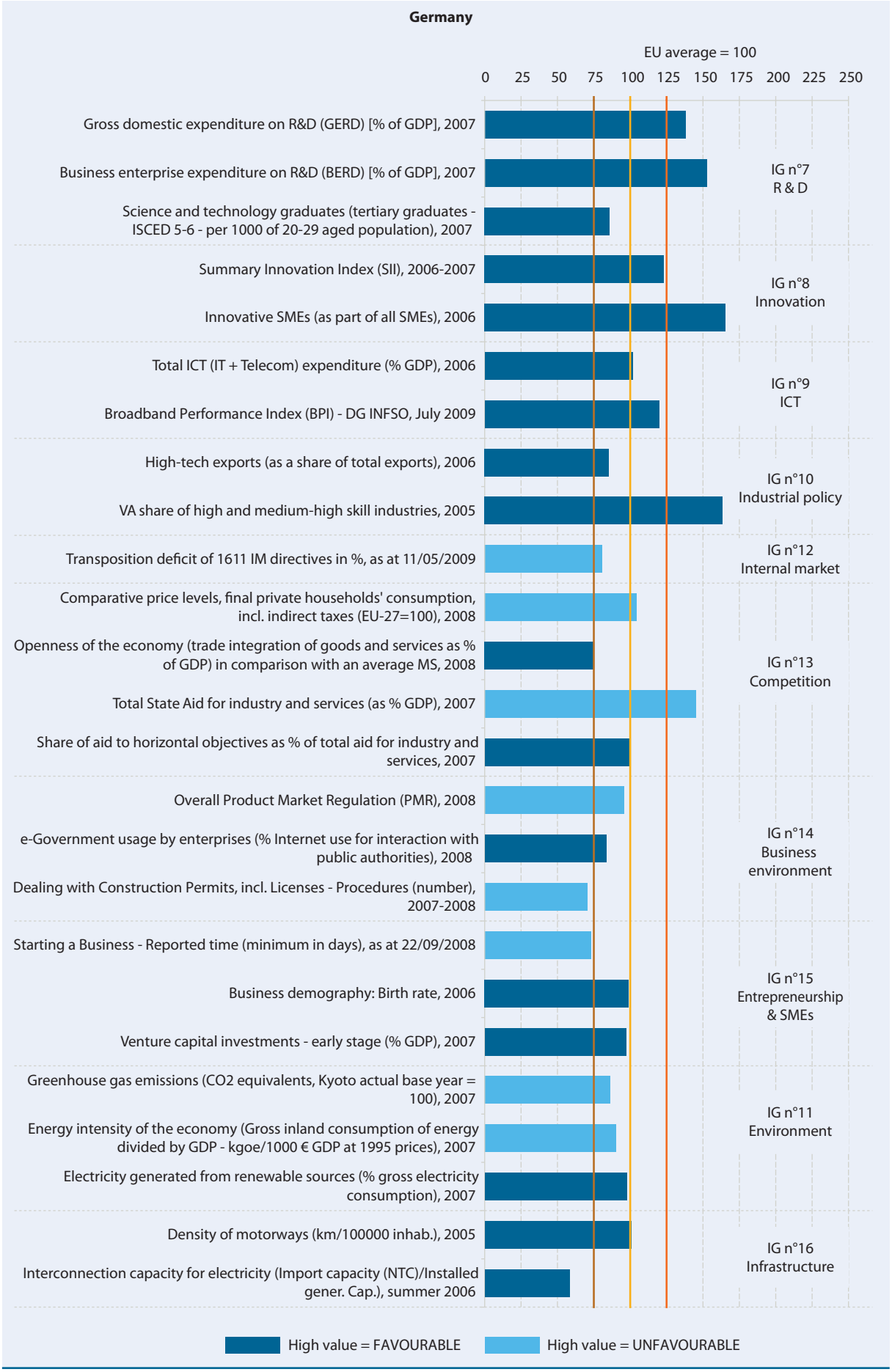

Czech Republic
EU average = 100
0 25 50 75 100 125 150 175 200 225 250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
388
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
IG n°11 Environment
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
327
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
IG n°16 Infrastructure
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
High value = FAVOURABLE
High value = UNFAVOURABLE

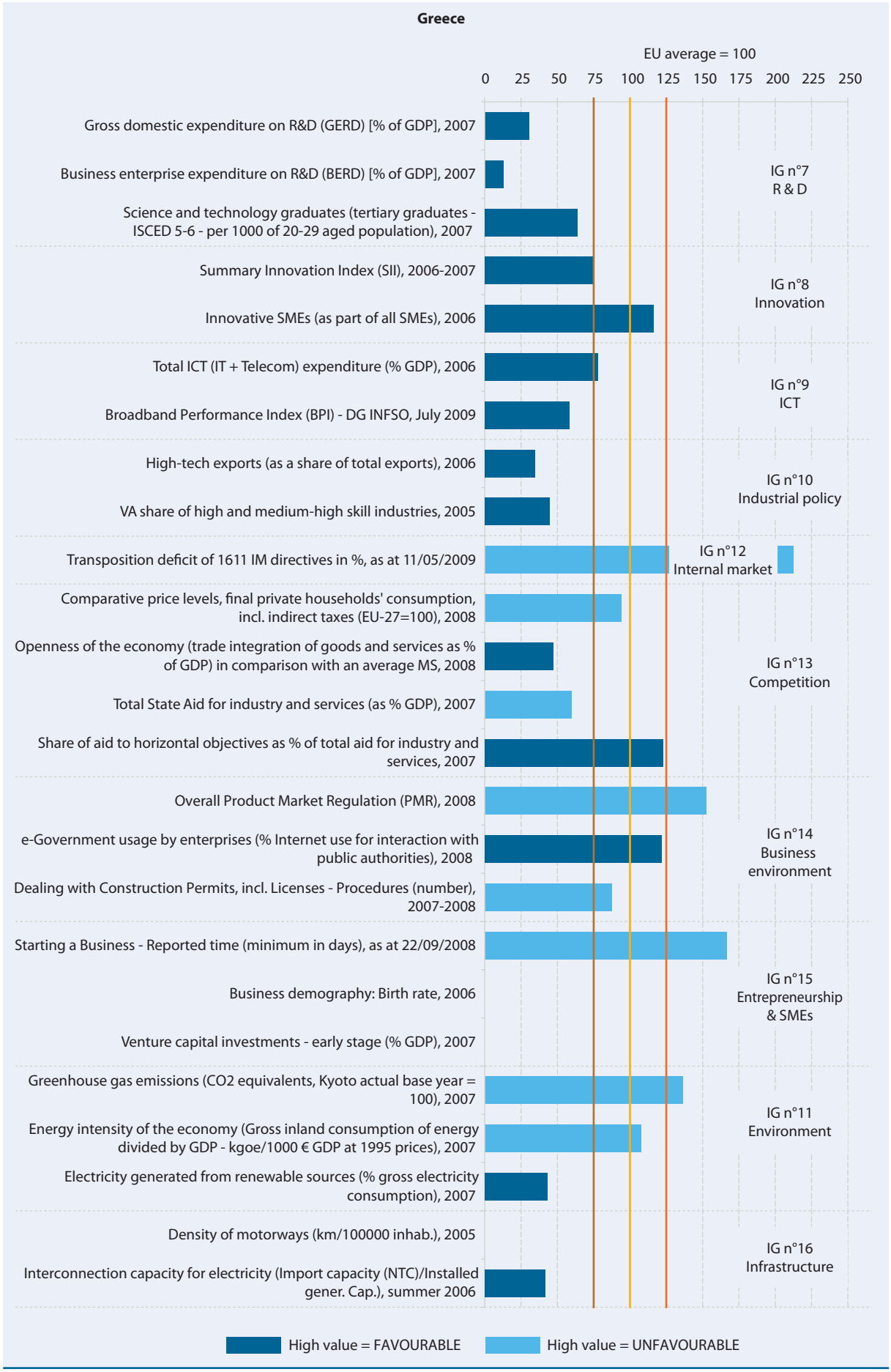

Denmark
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
251
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

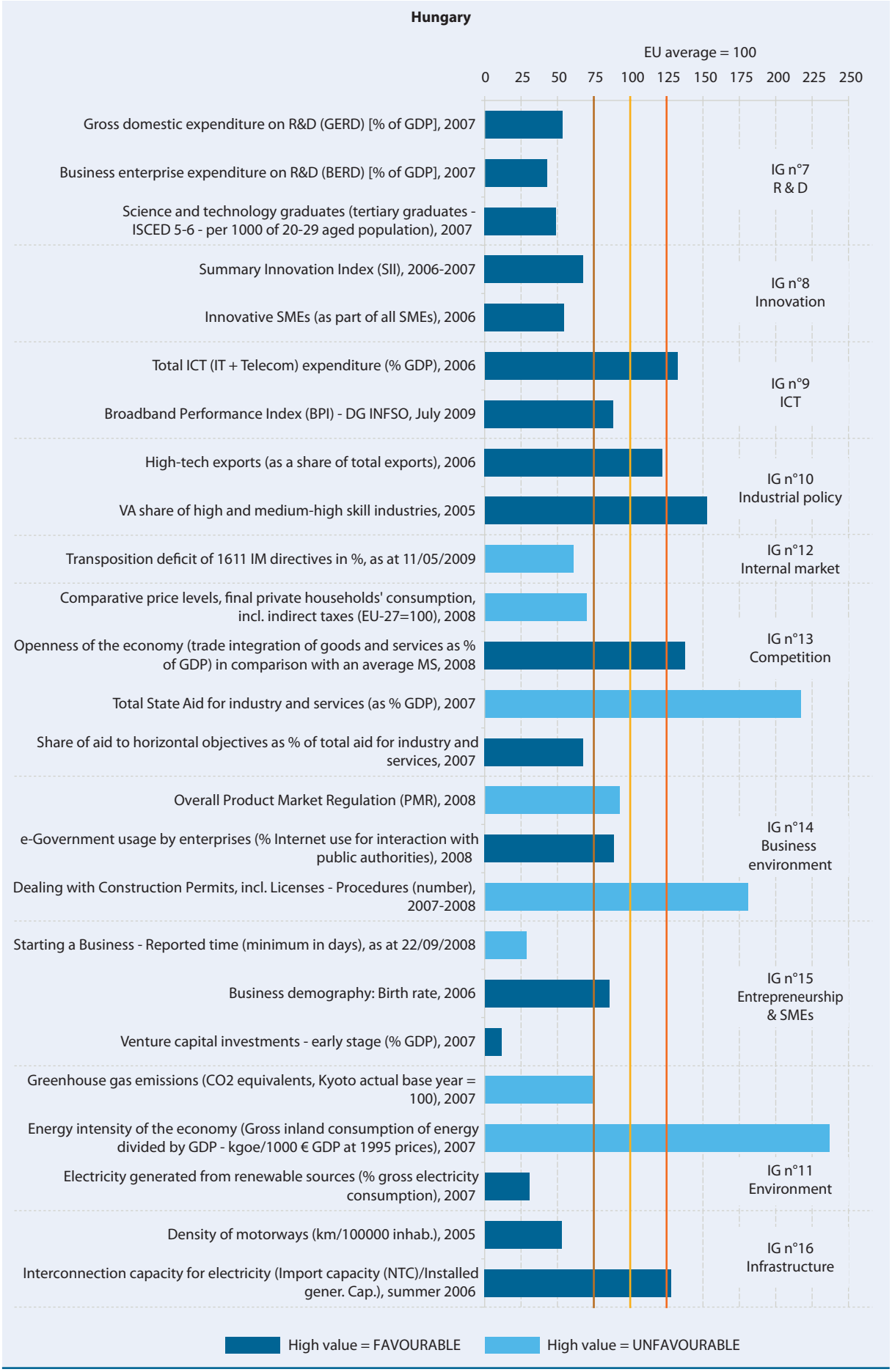

Estonia
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
IG n°11 Environment
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
343
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

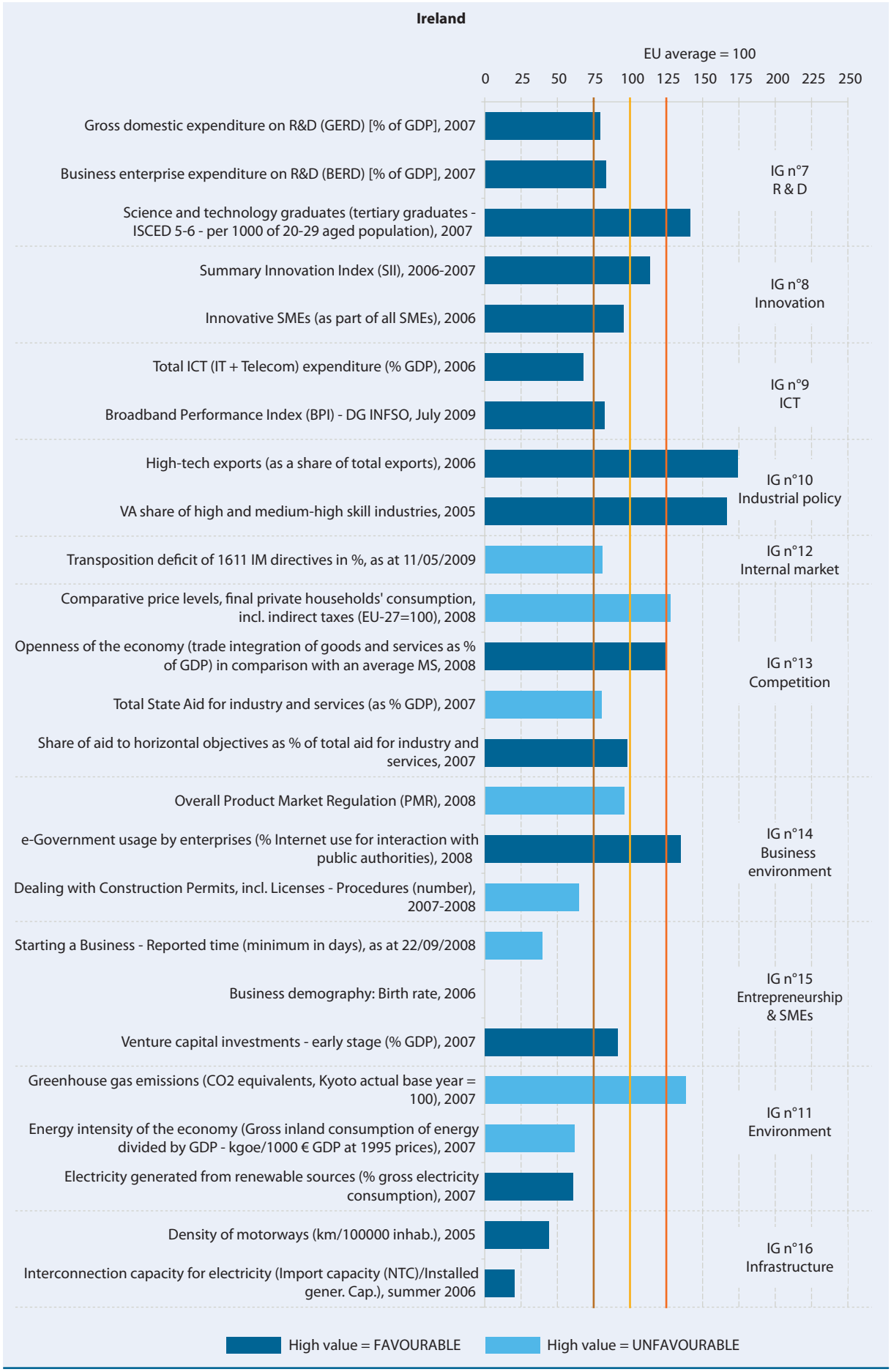

Finland
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

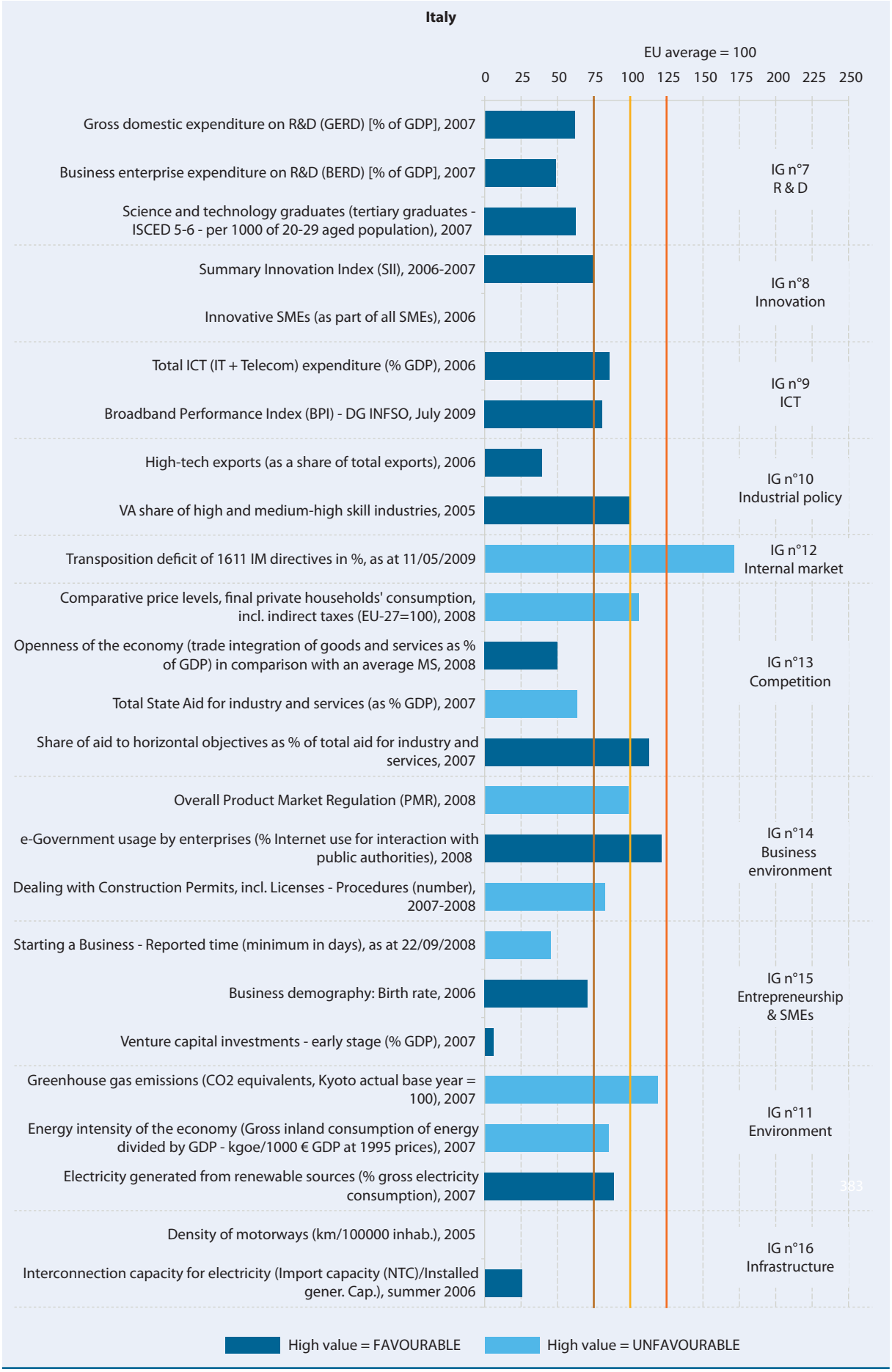

France
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
IG n°14 Business environment
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
Venture capital investments - early stage (% GDP), 2007
IG n°15 Entrepreneurship & SMEs
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
Electricity generated from renewable sources (% gross electricity consumption), 2007
IG n°11 Environment
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

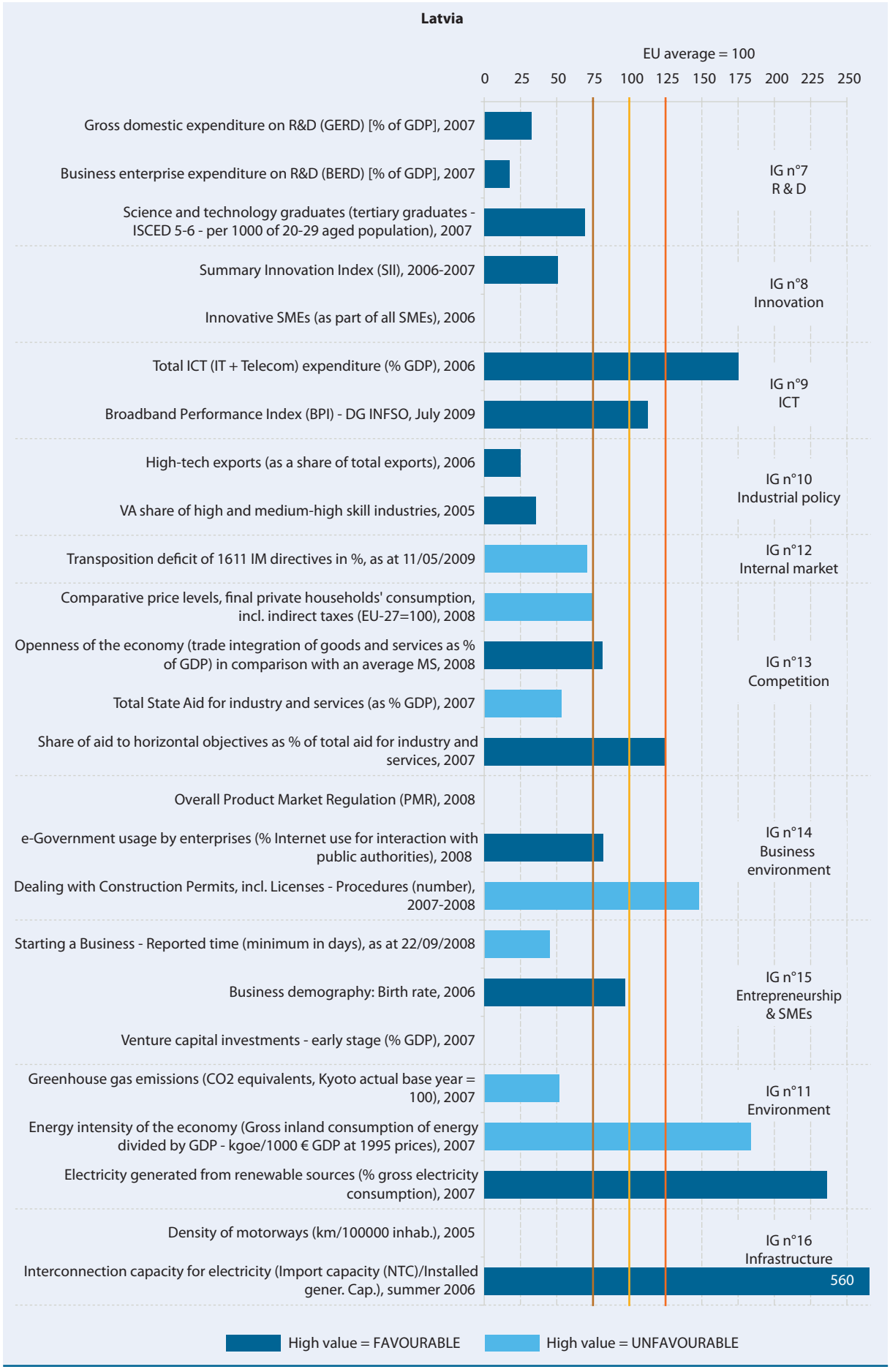

Germany
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
IG n°14 Business environment
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
Venture capital investments - early stage (% GDP), 2007
IG n°15 Entrepreneurship & SMEs
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
Electricity generated from renewable sources (% gross electricity consumption), 2007
IG n°11 Environment
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

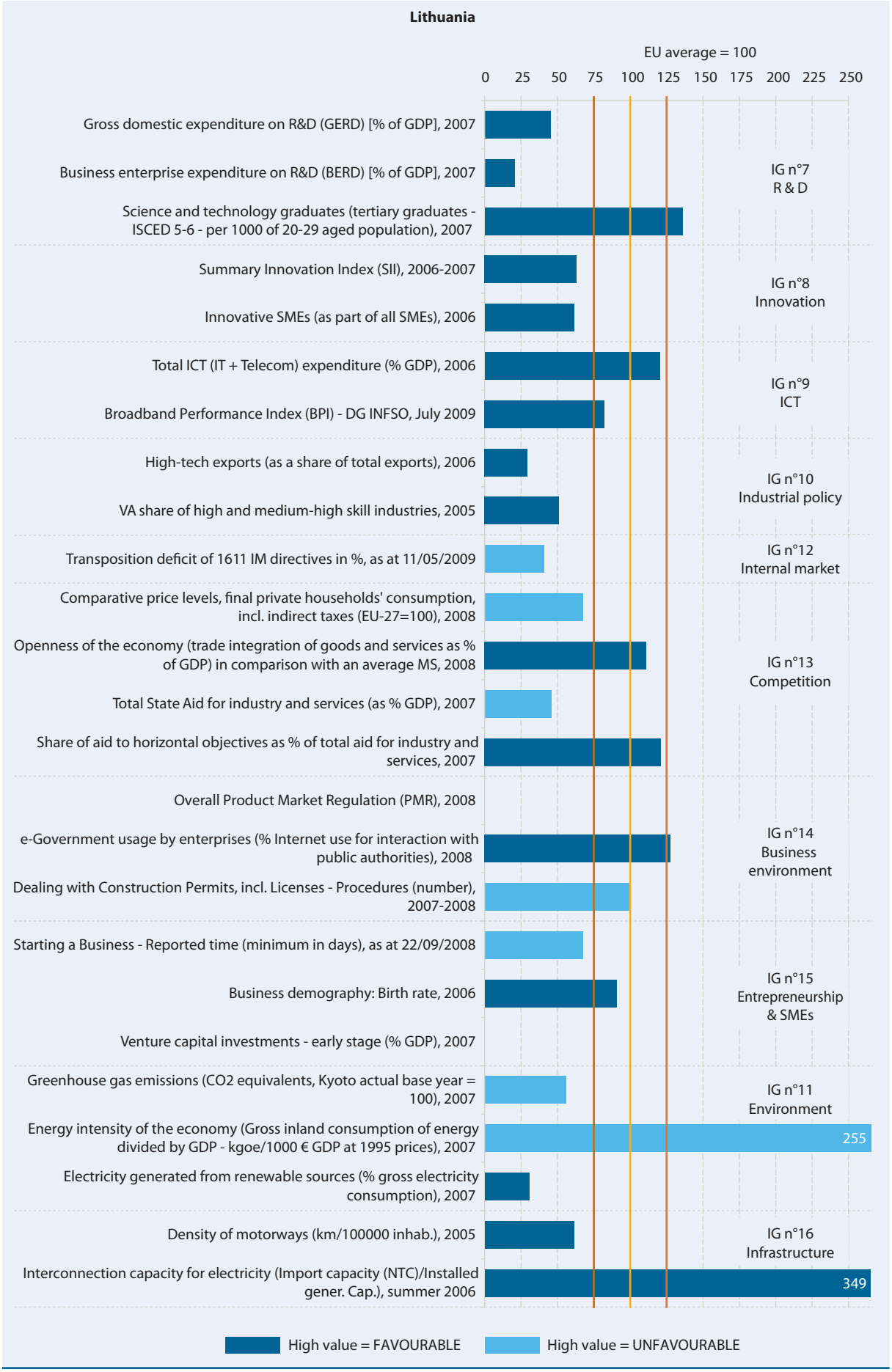

Greece
EU average = 100
0 25 50 75 100 125 150 175 200 225 250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

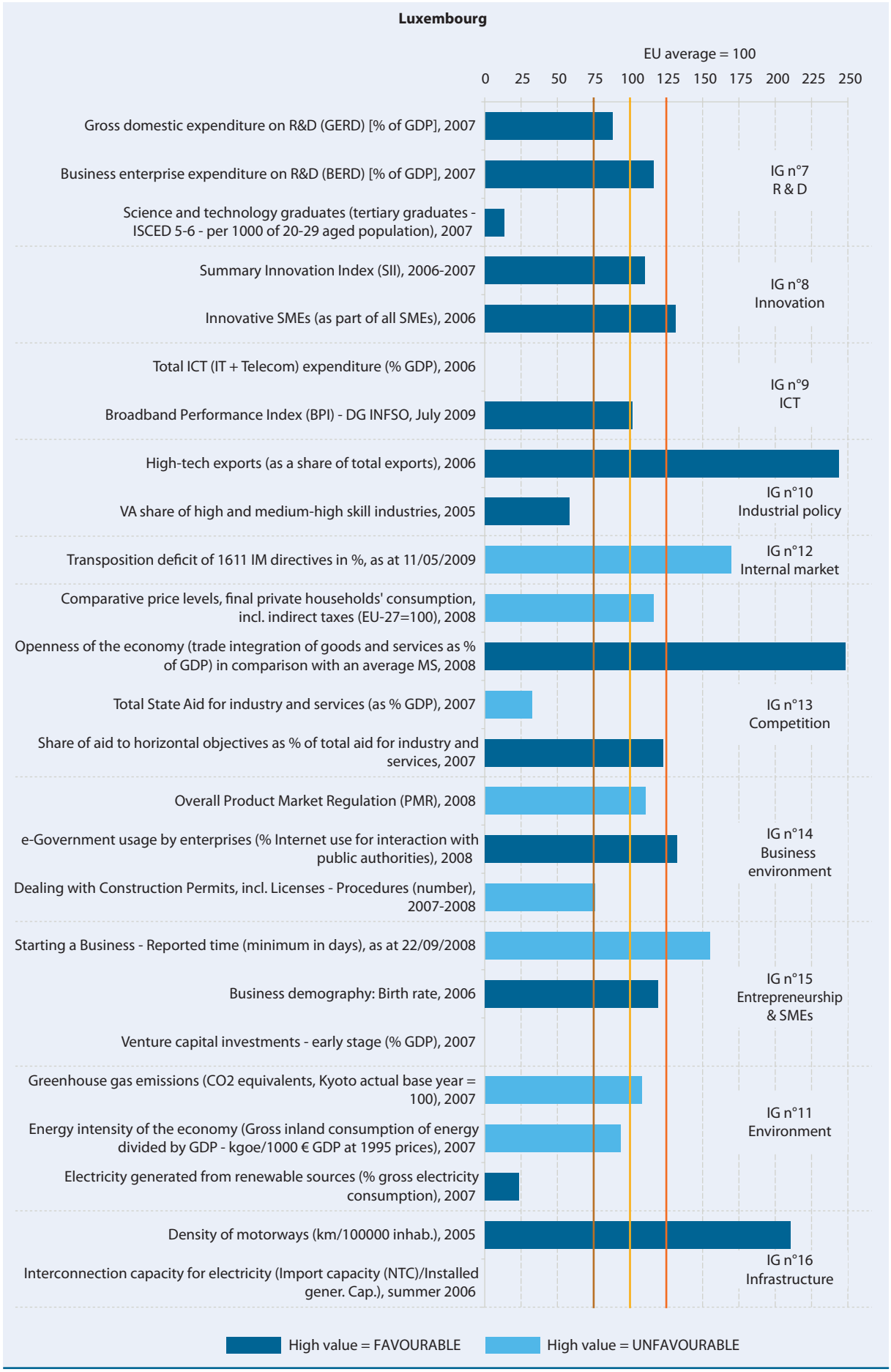

Hungary
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
Electricity generated from renewable sources (% gross electricity consumption), 2007
IG n°11 Environment
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

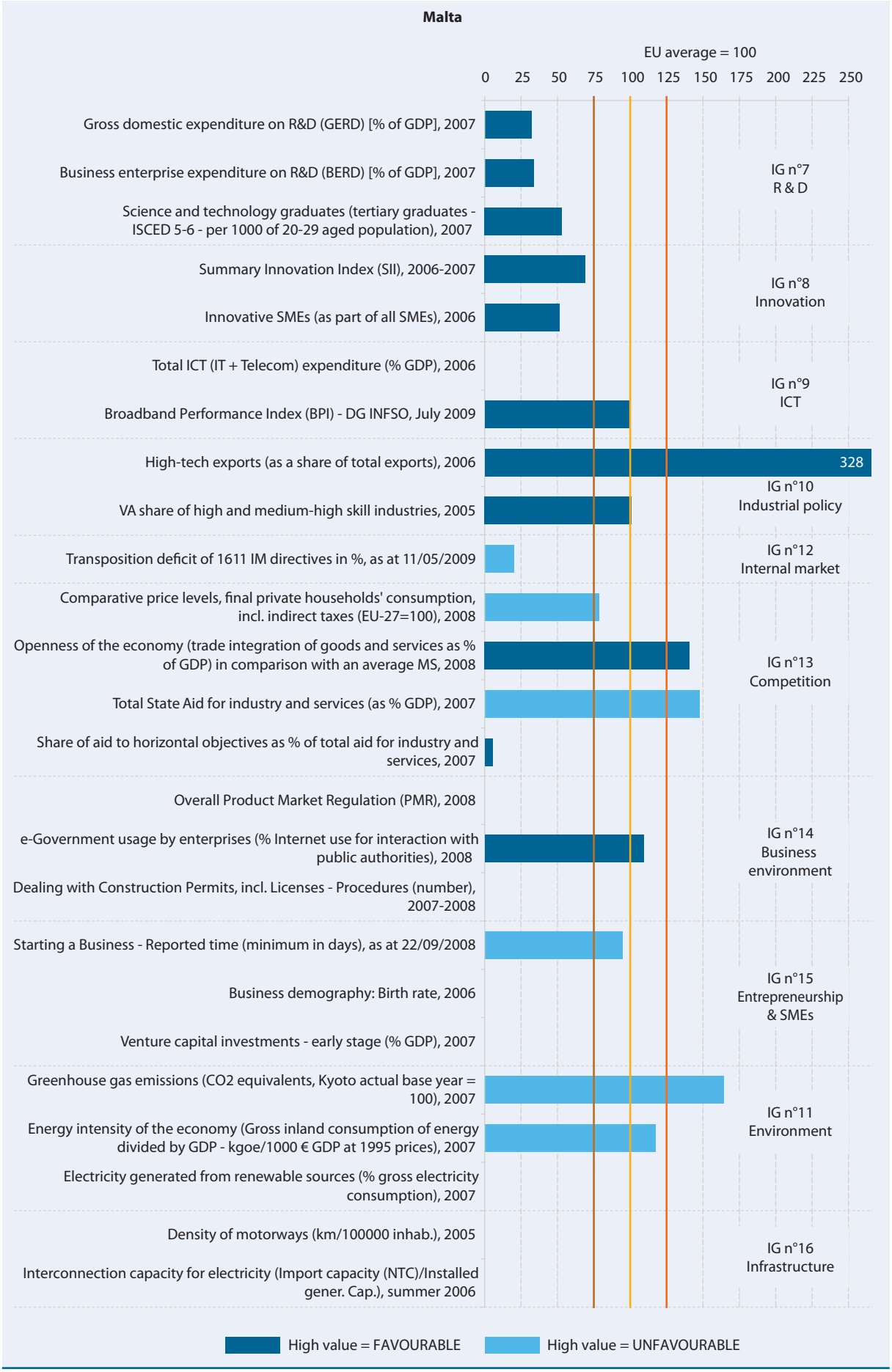

Ireland
EU average = 100
0 25 50 75 100 125 150 175 200 225 250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

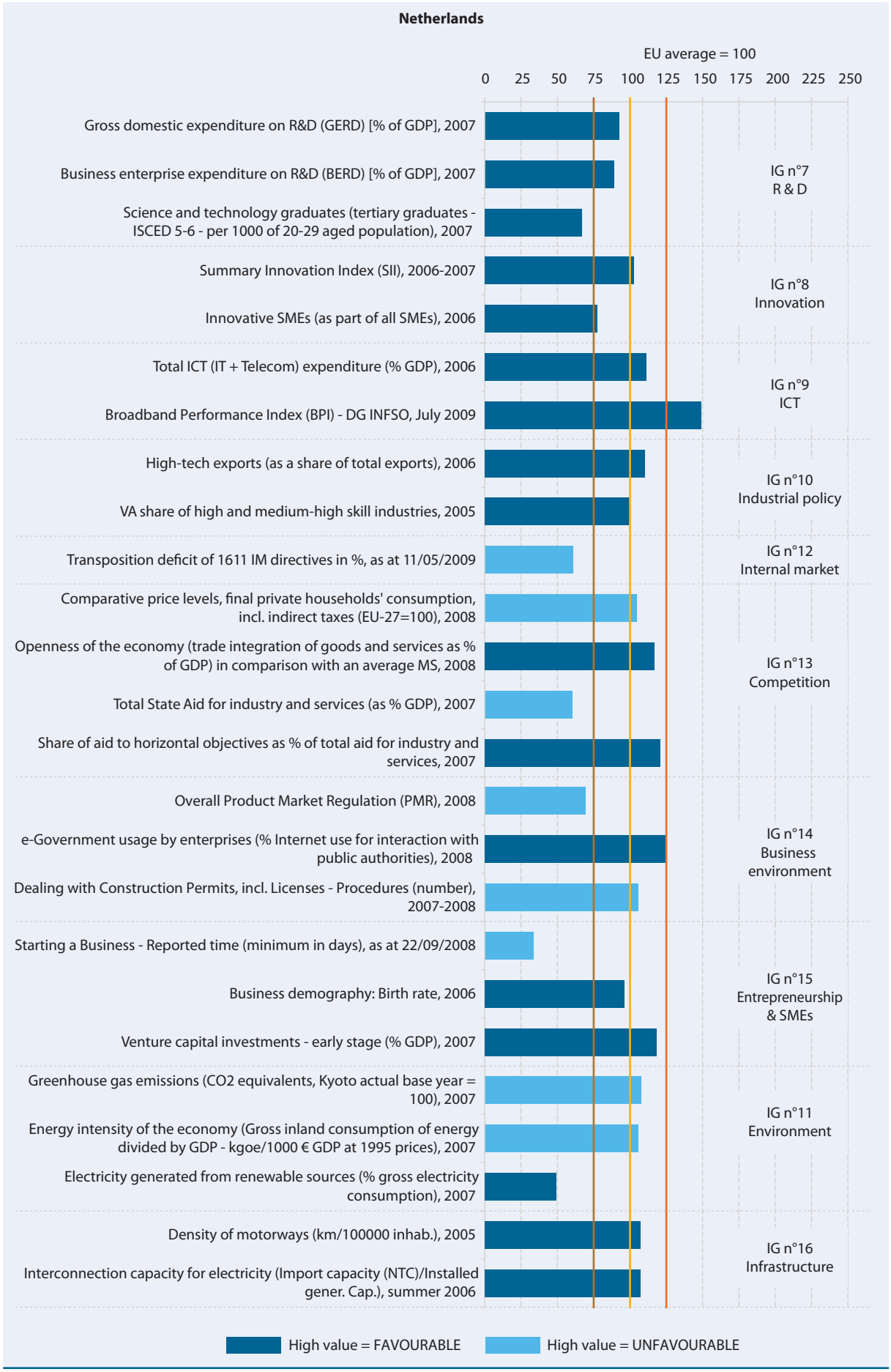

Italy
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

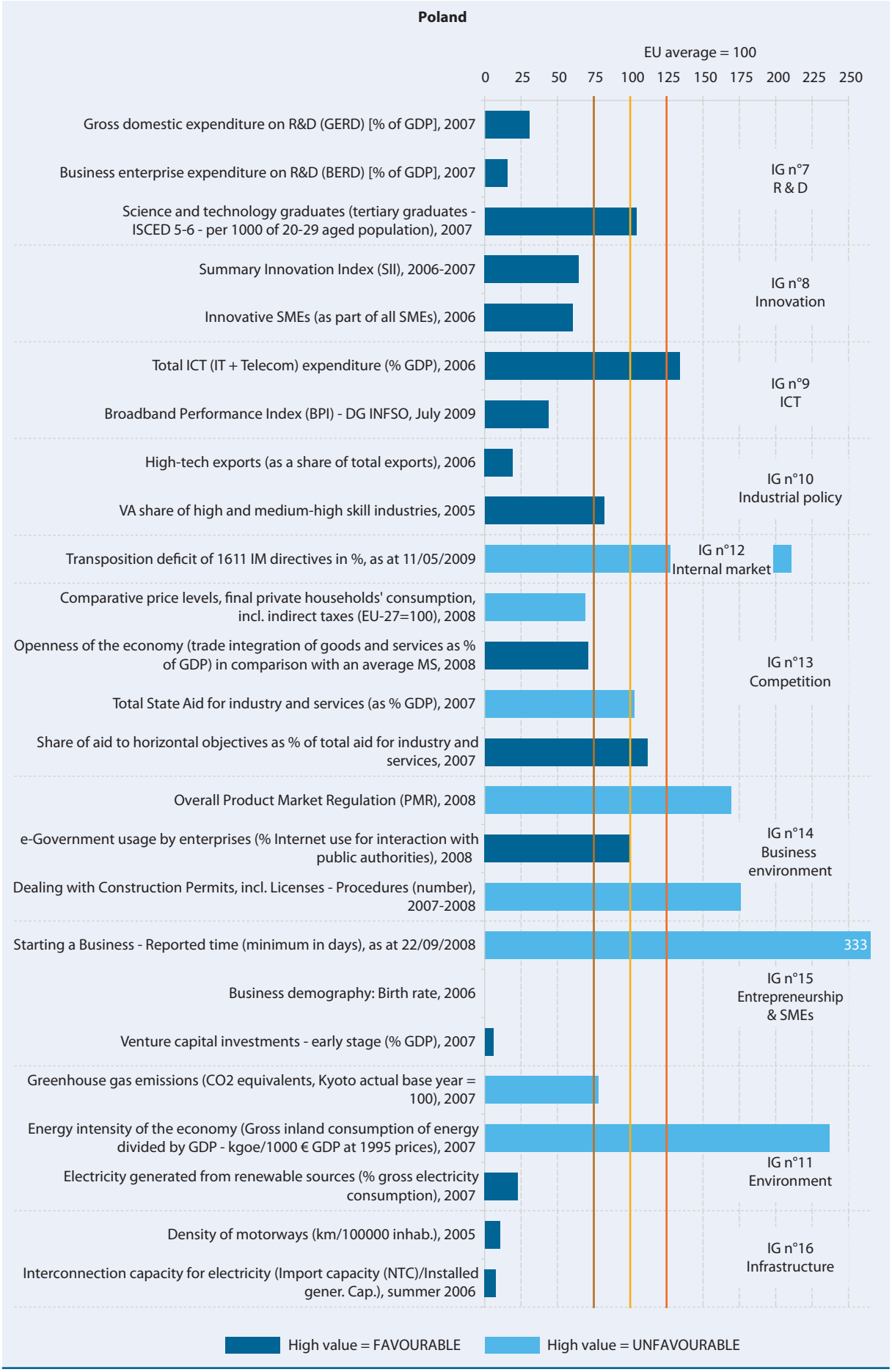

Latvia
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
IG n°11 Environment
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
IG n°16 Infrastructure
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
560
High value = FAVOURABLE
High value = UNFAVOURABLE

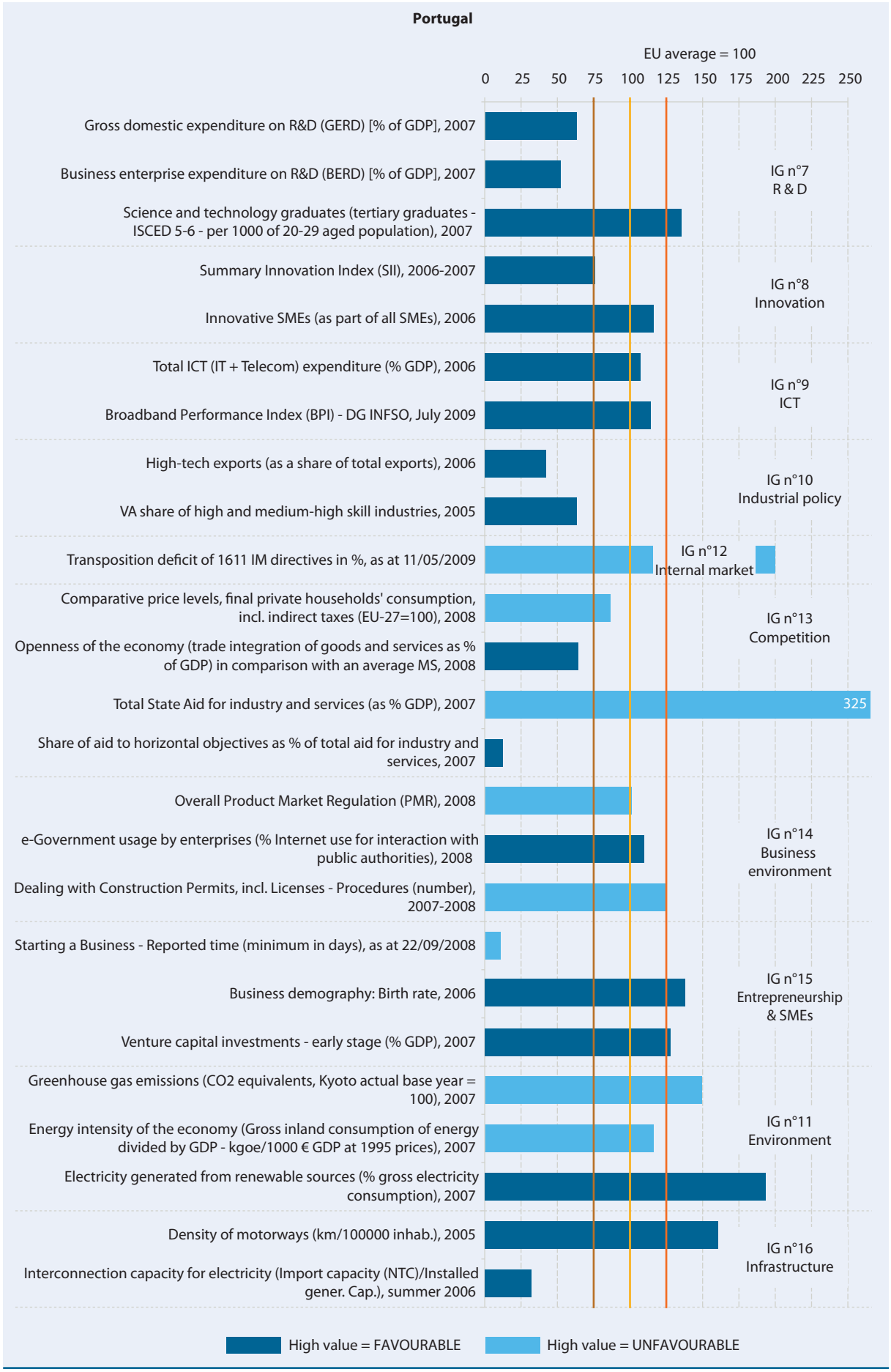

Lithuania
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
IG n°7 R & D
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
Summary Innovation Index (SII), 2006-2007
IG n°8 Innovation
Innovative SMEs (as part of all SMEs), 2006
Total ICT (IT + Telecom) expenditure (% GDP), 2006
IG n°9 ICT
Broadband Performance Index (BPI) - DG INFSO, July 2009
High-tech exports (as a share of total exports), 2006
IG n°10 Industrial policy
VA share of high and medium-high skill industries, 2005
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
IG n°11 Environment
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
255
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
IG n°16 Infrastructure
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
349
High value = FAVOURABLE
High value = UNFAVOURABLE

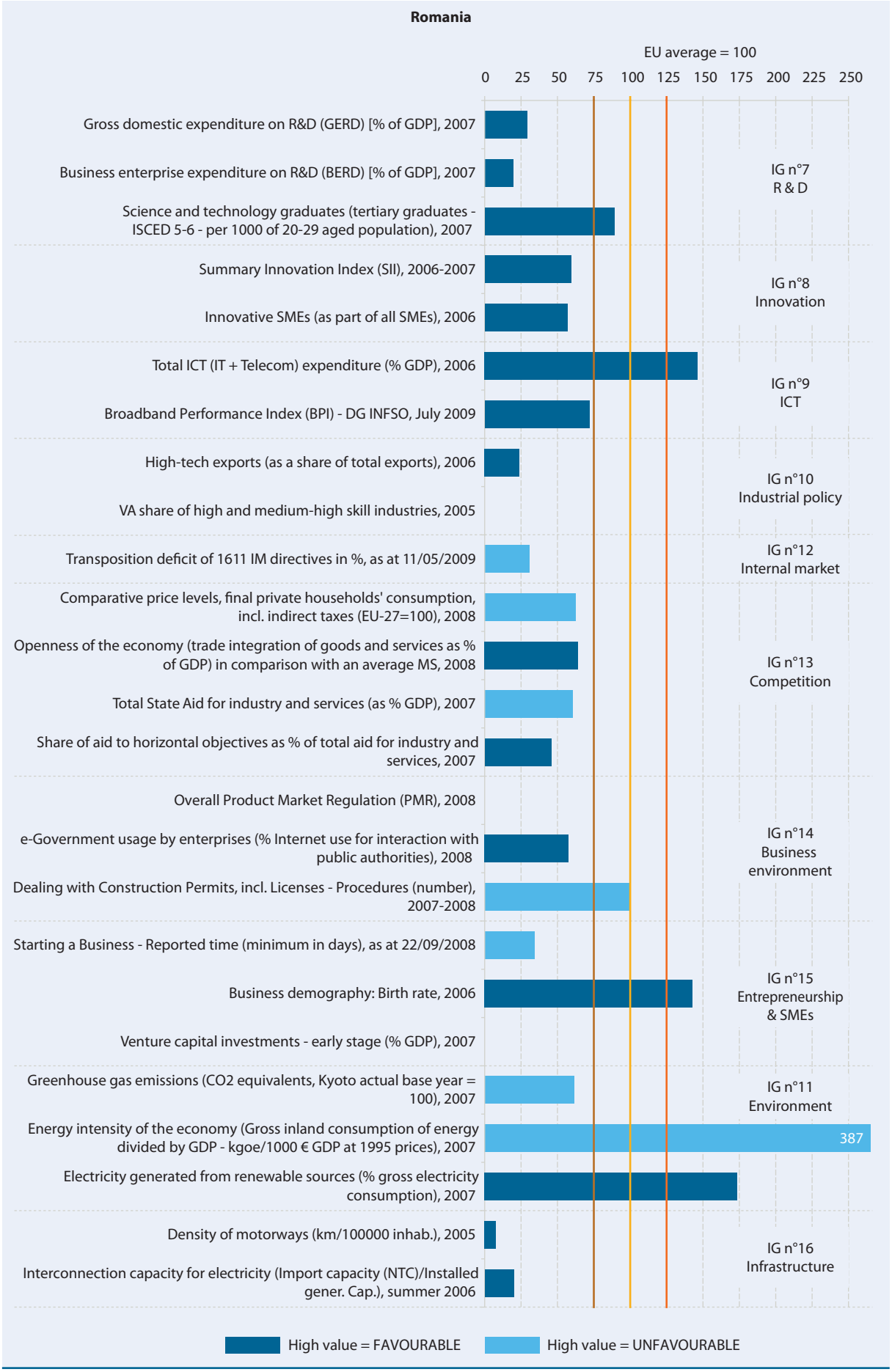

Luxembourg
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
Total State Aid for industry and services (as % GDP), 2007
IG n°13 Competition
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

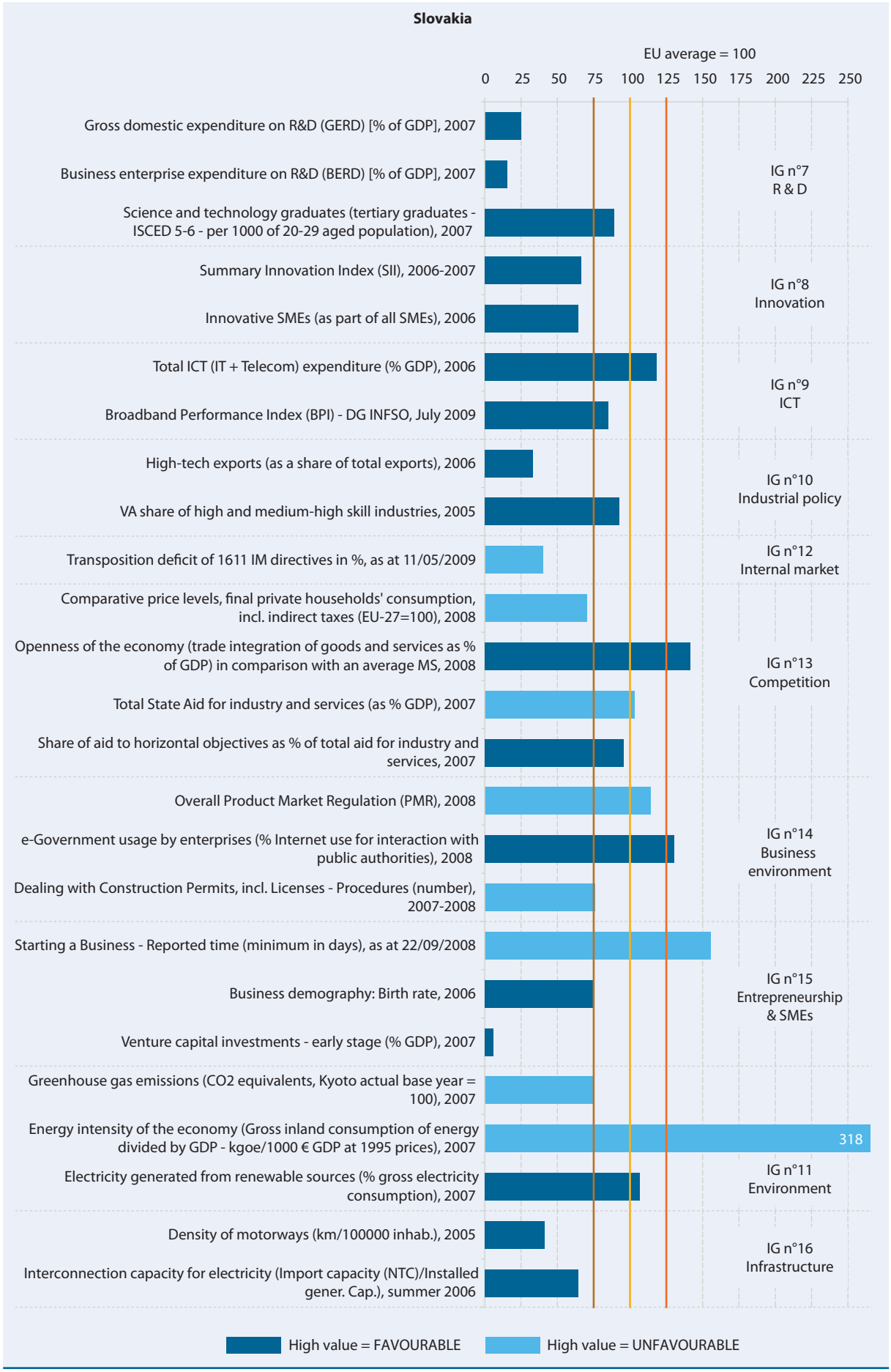

Malta
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
328
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

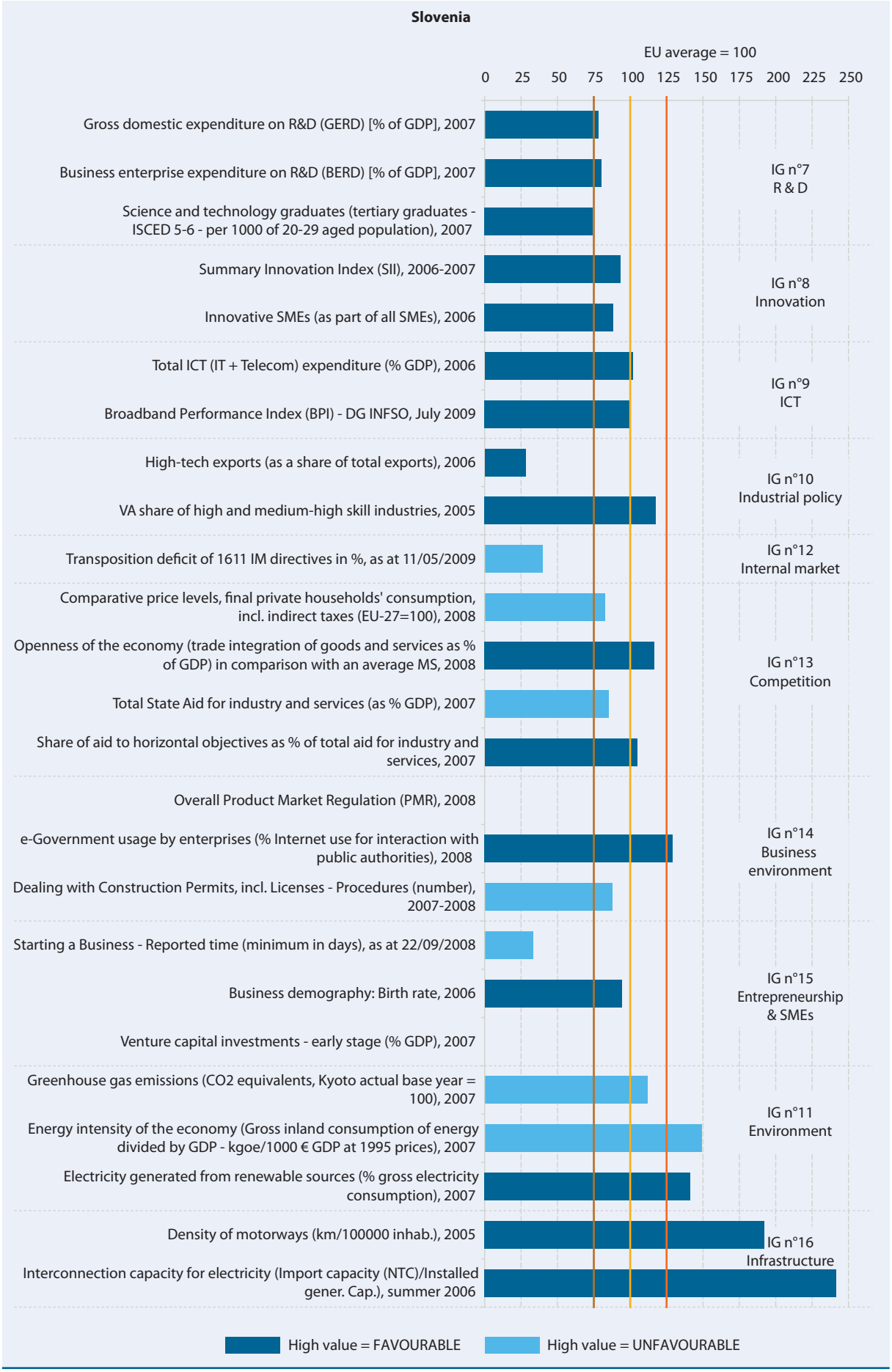

Netherlands
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
Total State Aid for industry and services (as % GDP), 2007
IG n°13 Competition
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
IG n°14 Business environment
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
Venture capital investments - early stage (% GDP), 2007
IG n°15 Entrepreneurship & SMEs
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
Electricity generated from renewable sources (% gross electricity consumption), 2007
IG n°11 Environment
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

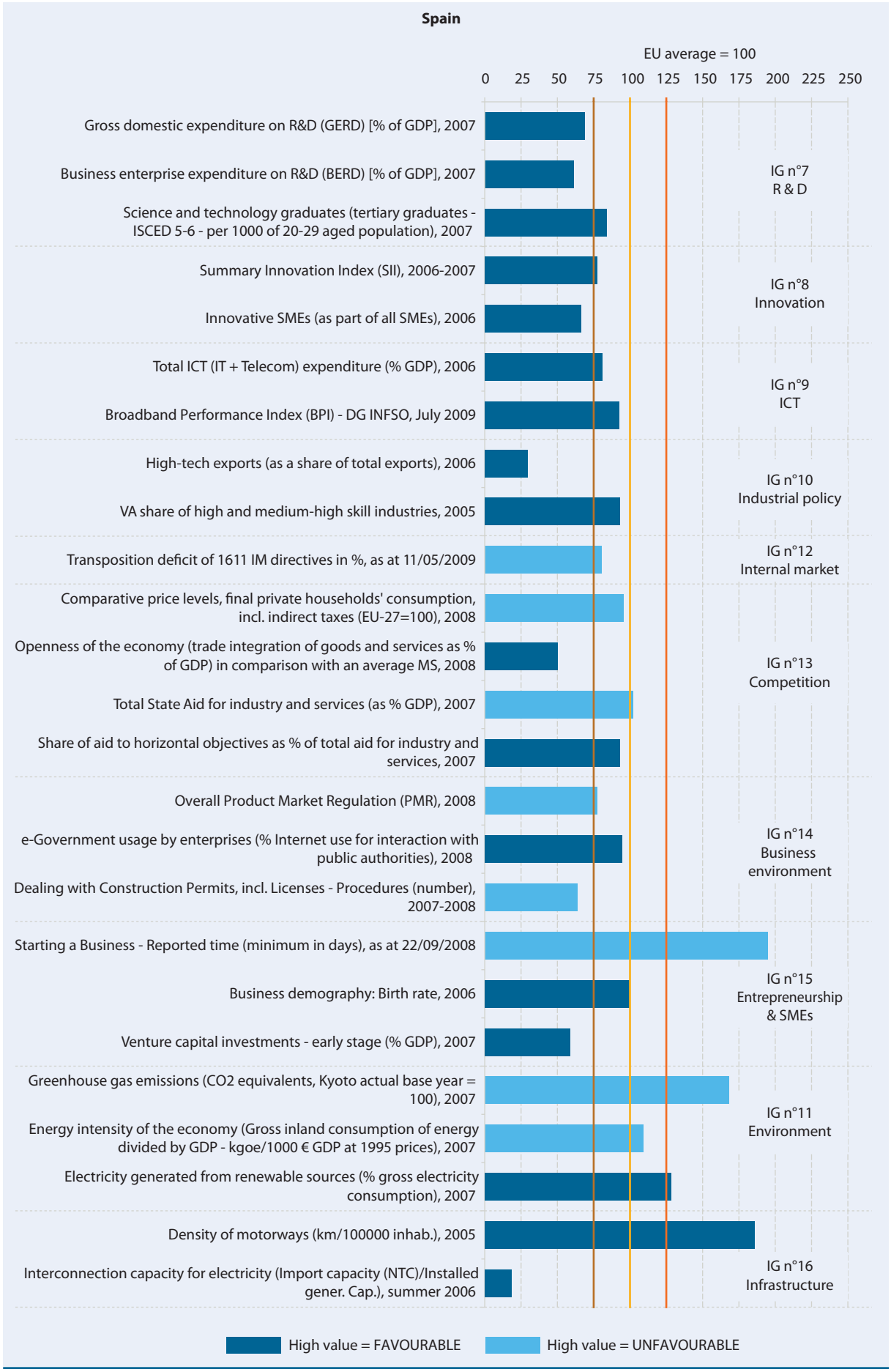

Poland
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
IG n°7 R & D
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
Summary Innovation Index (SII), 2006-2007
IG n°8 Innovation
Innovative SMEs (as part of all SMEs), 2006
Total ICT (IT + Telecom) expenditure (% GDP), 2006
IG n°9 ICT
Broadband Performance Index (BPI) - DG INFSO, July 2009
High-tech exports (as a share of total exports), 2006
IG n°10 Industrial policy
VA share of high and medium-high skill industries, 2005
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
333
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
Electricity generated from renewable sources (% gross electricity consumption), 2007
IG n°11 Environment
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

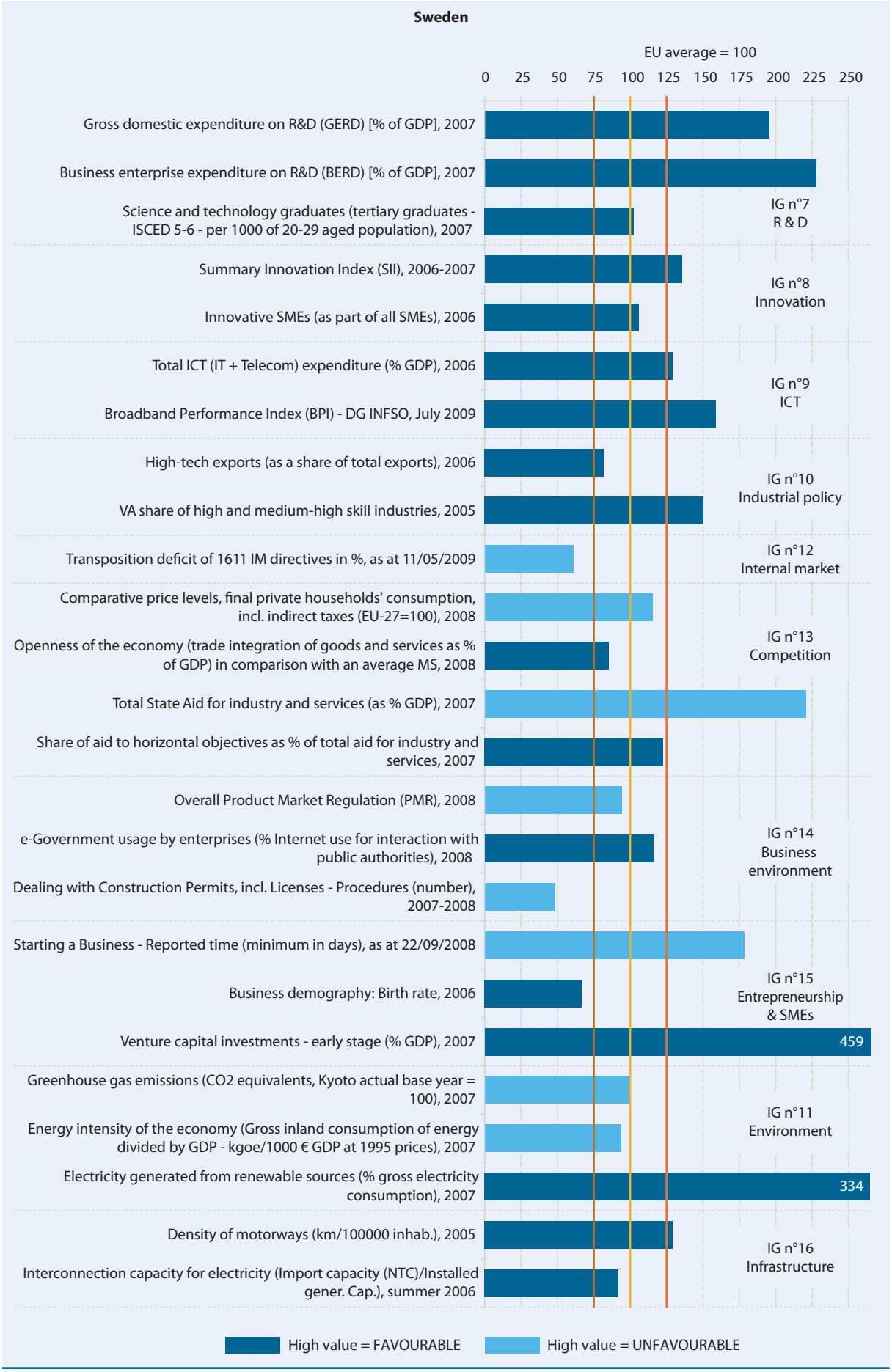

Portugal
EU average = 100
0 25 50 75 100 125 150 175 200 225 250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
325
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
IG n°14 Business environment
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
Venture capital investments - early stage (% GDP), 2007
IG n°15 Entrepreneurship & SMEs
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

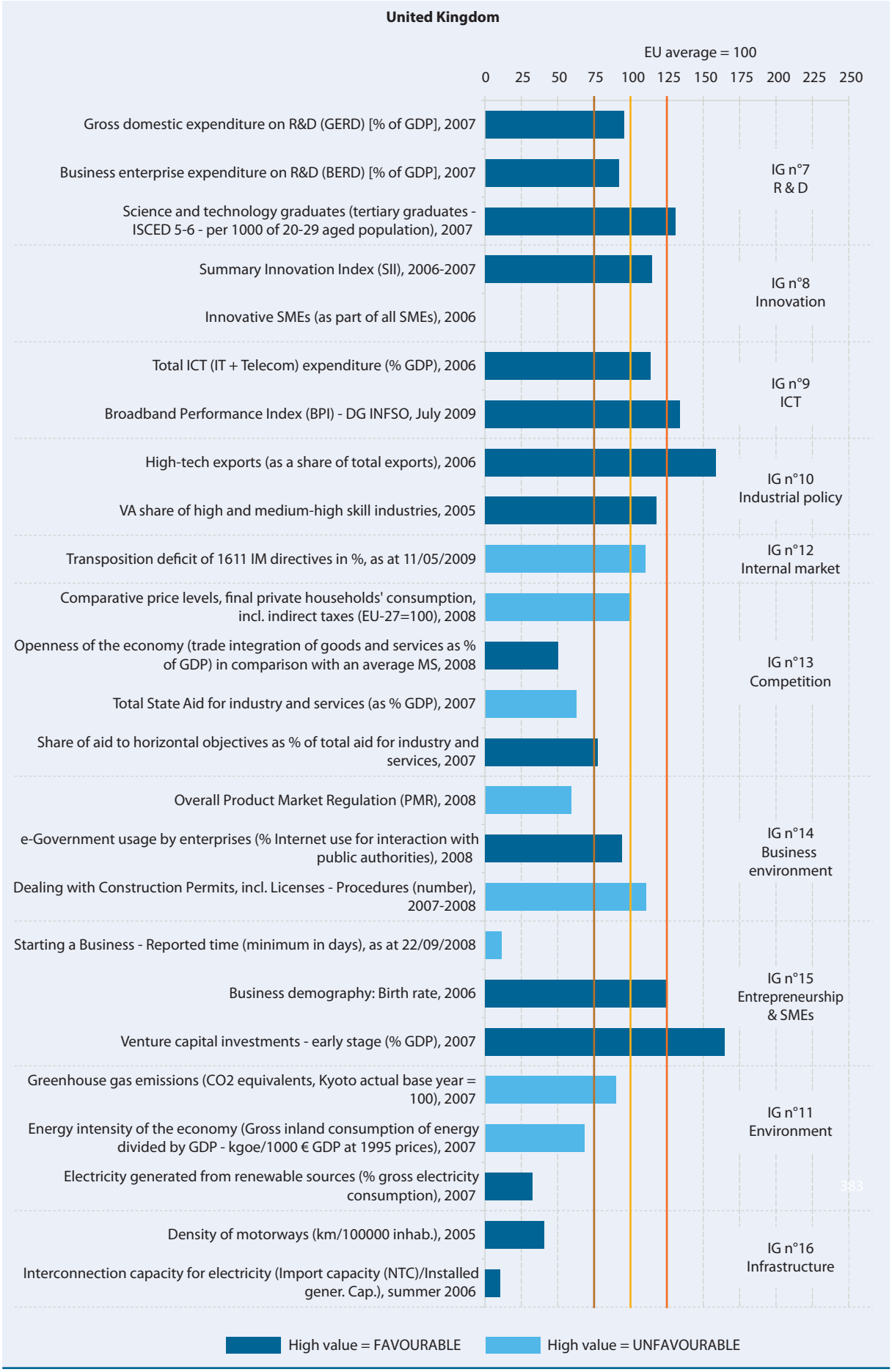

Romania
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
IG n°13 Competition
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
IG n°14 Business environment
Business demography: Birth rate, 2006
Venture capital investments - early stage (% GDP), 2007
IG n°15 Entrepreneurship & SMEs
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
387
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE


Slovakia
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
IG n°7 R & D
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
Summary Innovation Index (SII), 2006-2007
IG n°8 Innovation
Innovative SMEs (as part of all SMEs), 2006
Total ICT (IT + Telecom) expenditure (% GDP), 2006
IG n°9 ICT
Broadband Performance Index (BPI) - DG INFSO, July 2009
High-tech exports (as a share of total exports), 2006
IG n°10 Industrial policy
VA share of high and medium-high skill industries, 2005
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
318
Electricity generated from renewable sources (% gross electricity consumption), 2007
IG n°11 Environment
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE


Slovenia
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
IG n°16 Infrastructure
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
High value = FAVOURABLE
High value = UNFAVOURABLE


Spain
EU average = 100
0 25 50 75 100 125 150 175 200 225 250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE


Sweden
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
459
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
334
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE


United Kingdom
EU average = 100
0
25
50
75
100
125
150
175
200
225
250
Gross domestic expenditure on R&D (GERD) [% of GDP], 2007
Business enterprise expenditure on R&D (BERD) [% of GDP], 2007
Science and technology graduates (tertiary graduates - ISCED 5-6 - per 1000 of 20-29 aged population), 2007
IG n°7 R & D
Summary Innovation Index (SII), 2006-2007
Innovative SMEs (as part of all SMEs), 2006
IG n°8 Innovation
Total ICT (IT + Telecom) expenditure (% GDP), 2006
Broadband Performance Index (BPI) - DG INFSO, July 2009
IG n°9 ICT
High-tech exports (as a share of total exports), 2006
VA share of high and medium-high skill industries, 2005
IG n°10 Industrial policy
Transposition deficit of 1611 IM directives in %, as at 11/05/2009
IG n°12 Internal market
Comparative price levels, final private households' consumption, incl. indirect taxes (EU-27=100), 2008
Openness of the economy (trade integration of goods and services as % of GDP) in comparison with an average MS, 2008
IG n°13 Competition
Total State Aid for industry and services (as % GDP), 2007
Share of aid to horizontal objectives as % of total aid for industry and services, 2007
Overall Product Market Regulation (PMR), 2008
e-Government usage by enterprises (% Internet use for interaction with public authorities), 2008
IG n°14 Business environment
Dealing with Construction Permits, incl. Licenses - Procedures (number), 2007-2008
Starting a Business - Reported time (minimum in days), as at 22/09/2008
Business demography: Birth rate, 2006
IG n°15 Entrepreneurship & SMEs
Venture capital investments - early stage (% GDP), 2007
Greenhouse gas emissions (CO2 equivalents, Kyoto actual base year = 100), 2007
Energy intensity of the economy (Gross inland consumption of energy divided by GDP - kgoe/1000 € GDP at 1995 prices), 2007
IG n°11 Environment
Electricity generated from renewable sources (% gross electricity consumption), 2007
Density of motorways (km/100000 inhab.), 2005
Interconnection capacity for electricity (Import capacity (NTC)/Installed gener. Cap.), summer 2006
IG n°16 Infrastructure
High value = FAVOURABLE
High value = UNFAVOURABLE

Information on the indicators:

– Gross domestic expenditure on R&D (GERD), and
– Business sector R&D expenditure

Source: EUROSTAT. Short description: Both indicators are expressed in a percentage of GDP. R&D is defined according to the Frascati Manual (OECD).

– Tertiary graduates in Science and Technology

Source: EUROSTAT. Short description: The indicator includes new tertiary graduates in a calendar year from both public and private institutions completing graduate and post graduate studies compared to an age group that corresponds to the typical graduation age in most countries. It does not correspond to the number of graduates in these fields who are available in the labour market in this specific year. The levels and fields of education and training used follow the 1997 version of the International Standard Classification of Education (ISCED97) and the Eurostat Manual of fields of education and training (1999). Expressed as per 1000 of population aged 20-29 years.

– Summary Innovation Index (SII)

Source: European Innovation Scoreboard. Short description: The SII is a composite indicator summarising the various indicators of the European Innovation Scoreboard. It gives an "at a glance" overview of aggregate national innovation performance. More information can be obtained at: http://www.proinno-europe.eu/EIS2008/website/docs/EIS_2008_Final_report.pdfInnovative SMEs as % of all SMEs

– Innovative SMEs

Source: EUROSTAT (Community Innovation Survey). Short description: SMEs (which are enterprises up to 249 persons employed) are considered as innovative if they introduce new or significantly improved products (goods or services) to the market or if they implement new or significantly improved processes. All types of innovating SMEs are considered in the nominator, namely product innovators, process innovators, as well as SMEs with only on-going and/or abandoned innovation activities.

– ICT expenditure as a percentage of GDP

Source: EUROSTAT. Short description: Annual data on expenditure for IT and telecommunication hardware, equipment, software and other services as a percentage of GDP.

– Broadband performance index

Source: European Commission (Directorate General Information Society). Short description: Close monitoring of broadband markets, taking into account all relevant variables, is crucial to provide a fair, reliable picture of how the broadband market is evolving in each Member State and in the European Union. The Broadband performance index benchmarks the overall performance of the Member States on a range of factors, which include speeds, rural coverage, affordability, innovation and other socio-economic dimensions. Specific information on the components of the index may be obtained at: http://ec.europa.eu/information_society/eeurope/i2010/docs/future_internet/swp_bpi.pdf

– High-tech exports

Source: EUROSTAT. Short Description: This indicator is calculated as share of exports of all high technology products in total exports. High technology products are defined as the sum of the following products: Aerospace, computers, office machinery, electronics, instruments, pharmaceuticals, electrical machinery and armament. The total exports for the EU do not include the intra-EU trade.

– Value added share of high an medium-high industries

Source: EU KLEMS and own estimates of Directorate General Enterprise and Industry National Accounts and Structural Business Statistics of Eurostat. Short description: High-tech industries are defined according to their notable value of R&D intensity. High-tech manufacturing comprises, for example, manufacturers of pharmaceuticals and medicinal products, communication equipment and computers whereas high-tech knowledge-intensive services cover activities relating to post and telecommunications, computer and related activities, as well as research and development. More information may be found at the following website:

http://www.EU KLEMS.net/,http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-EM-08-001/EN/KS-EM-08-001-EN.PDF

– Member State transposition deficit

Source: European Commission, Internal Market Scoreboard. Short description: the percentage of Internal Market Directives for which the implementation deadline has passed are not currently written into national law. More information can be found in: *http://ec.europa.eu/internal_market/score/index_en.htm*

– Comparative price levels

Source: EUROSTAT. Short description: the ratio compares the price levels of final consumption by private households including indirect taxes of each Member State to the EU average. Comparative price levels are the ratio between Purchasing power parities (PPPs) and market exchange rate for each country. PPPs are cur-

rency conversion rates that convert economic indicators expressed in national currencies to a common currency, called Purchasing Power Standard (PPS), which equalises the purchasing power of different national currencies and thus allows meaningful comparison.

– Openness of the economy

Source: EUROSTAT data and DG Enterprise and Industry calculations. Short description: the indicator compares the sum of total (i.e. intra and extra-EU) external trade of goods and services of each country as % of GDP with the total (i.e. intra and extra-EU) external trade of goods and services of an average EU-Member State.

– State aid

Source: EUROSTAT. Short description: The numerator is the sum of all State aid granted to specific sectors (agriculture, fisheries, manufacturing, coal, transport except railways and other services), State aid given on an ad-hoc basis to individual companies e.g., for rescue and restructuring, and State aid for horizontal objectives such as research and development, safeguarding the environment, energy saving, support to small and medium-sized enterprises, employment creation, the promotion of training and aid for regional development. The denominator is GDP.

– Share of aid to horizontal objectives as % of total aid for industry and services

Source: European Commission, State Aid Scoreboard, autumn 2008 update. Short description: State aid for horizontal objectives, i.e. aid that is not granted to specific sectors, is usually considered as being better suited to address market failures and thus less distortive than sectoral and ad hoc aid. R&D&I, safeguarding the environment, energy saving, support to SMEs, employment creation, the promotion of training and aid for regional economic development are the most prominent horizontal objectives pursued with State aid.

– Overall product market regulation

Source: OECD. Short description: the new "integrated product market regulation indicator" enhances and brings together previously separate economy-wide and sectoral indicators into a single, more comprehensive measure of product market regulation. Detailed information on this composite index can be obtained at the following website: http://www.oecd.org/dataoecd/29/41/42779045.pdf

– e-Government usage by enterprises

Source: EUROSTAT. Short Description: Percentage of enterprises using the internet to interact with public authorities (i.e. having used the Internet for one or more of the following activities: obtaining information, downloading forms, filling-in web-forms, full electronic case handling).

– Dealing with Licenses – number of procedures

Source: World Bank, Doing Business project. Short description: the World Bank Doing Business project provides measures of business regulations and their enforcement so as to make their business environment comparable. This particular indicator records all procedures necessary to build a standardised warehouse. These procedures include submitting all relevant project-specific documents (for example, building plans and site maps) to the authorities; obtaining all necessary clearances, licenses, permits and certificates; completing all required notifications; and receiving all necessary inspections. Doing Business also records procedures for obtaining all utility connections. Procedures necessary to register the property so that it can be used as collateral or transferred are also counted. More information can be obtained from: *http://www.doingbusiness.org/*

– Starting a business – number of days

Source: European Commission, DG Enterprise and Industry. Short description: the data are obtained through the network of National Start-up Coordinators. According to the Spring European Council conclusions 2006, Member States should establish, by 2007, a one-stop-shop, or arrangements with equivalent effect, for setting up a company in a quick and simple way. Member States should take adequate measures to considerably reduce the average time for setting up a business, especially an SME, with the objective of being able to do this within one week anywhere in the EU by the end of 2007 (start-up fees should be as low as possible).

– Birth rates

Source: Eurostat. Short description: the indicator covers enterprise births of year n, as a percentage of the population of active enterprises of year n. Data on enterprise births are obtained from the statistical business registers. Using a specific methodology, genuine enterprise births are distinguished from creations or cessations which may reflect only changes in ownership, activity or legal form.

– Venture capital investments –early stage

Source: EUROSTAT. Short description: Venture capital investment is defined as private equity raised for investment in companies; management buyouts, management buy-ins and venture purchase of quoted shares are excluded. Data are broken down into two investment stages: Early stage (seed + start-up) and expansion and

replacement (expansion and replacement capital). Here, only early stage investments are considered, as a percentage of GDP.

– Total greenhouse gas emissions

Source: EUROSTAT. Short description: Emissions of the 6 greenhouse gases covered by the Kyoto Protocol are weighted by their global warming potentials (GWPs) and aggregated to give total emissions in CO2 equivalents. The total emissions are presented as indices, with the base year = 100. In general, the base year is 1990 for the non-fluorinated gases (CO2, CH4 and N2O), and 1995 for the fluorinated gases (HFC, PFC and SF6). Data exclude emissions and removals due to land use change and forestry (LUCF).

– Energy intensity of the economy

Source: EUROSTAT. Short description: This indicator is the ratio between the gross inland consumption of energy and the GDP for a given calendar year. It measures the energy consumption of an economy and its overall energy efficiency. The gross inland consumption of energy is calculated as the sum of the gross inland consumption of five energy types: coal, electricity, oil, natural gas and renewable energy sources. The GDP figures are taken at constant prices to avoid the impact of the inflation, base year 1995 (ESA95). The energy intensity ratio is determined by dividing the gross inland consumption by the GDP. Since gross inland consumption is measured in kgoe (kilogram of oil equivalent) and GDP in 1 000 EUR, this ratio is measured in kgoe per 1 000 EUR.

– Electricity generated from renewable sources

Source: EUROSTAT. Short description: This indicator represents the electricity produced from renewable energy sources as a percentage of gross electricity consumption for a given calendar year. It measures the contribution of electricity produced from renewable energy sources to the national electricity consumption. Electricity produced from renewable energy sources comprises the electricity generation from hydro plants (excluding pumping), wind, solar, geothermal and electricity from biomass/wastes. Gross national electricity consumption comprises the total gross national electricity generation from all fuels (including auto-production), plus electricity imports, minus exports.

– Density of motorways

Source: EUROSTAT. Short description: This indicator represents the density of motorways in terms of km per 100000 inhabitants.

– Interconnection capacity for electricity

Source: European Regulators' Group for Electricity and Gas (ERGEG). Short description: This indicator represents for each country the import capacity (net transport capacity) as % of all installed generation capacities.

ANNEX – List of background studies to the European Competitiveness Report 2009

Some parts of the European Competitivenss Report 2009 are based on, or use, material prepared by a consortium led by WIFO, the Austrian institute for economic Research:

Chapter 1 – "Competitiveness Report and the crisis" has benefited from helpful comments and suggestions from Jozef Konings, Josefina Monteagudo, Dominique Simonis, Ian Vollbracht and Stephen White. The discussion on the EU-US differences in R&D benefited substantially from comments by colleagues at the Research Directorate-General.

Chapter 2 – "EU and BRICs: Challenges and Opportunities for European competitiveness" is based on the background study "EU and BRICs: Challenges and opportunities for European Competitiveness and Cooperation" by Peter Havlik, Roman Stöllinger, Olga Pindyuk, Gábor Hunya, Bernhard Dachs, Carolina Lennon, Marcos Poplawski Ribeiro, Jayati Ghosh, Waltraut Urban, Vasily Astrov and Edward Christie under the responsibility of the Vienna Institute for International Economic Studies (wiiw) and the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

Chapter 3 – "Migration, skills and productivity" is based on the background study "Migration, skills and productivity" by Peter Huber, Michael Landesmann, Catherine Robinson and Robert Stehrer, and also with Robert Hierländer, Anna Iara, Mary O'Mahony, Klaus Nowotny and Fei Pong. The study is coordinated by WIIW in Vienna and carried out in collaboration with WIFO and NIESR.

Chapter 4 – "Training, education and productivity" is based on the background study "Training, education and productivity" by Fiona Carmichael, Marco Ercolani, Lili Kang, Yasheng Maimaiti, Mary O'Mahony, Fei Peng and Catherine Robinson.

Chapter 5 – "Regulation, ICT and productivity" is based on the background study "ICT, Regulation and Productivity: an analysis using EU KLEMS" by Ana Rincon-Aznar, NIESR.

European Commission

European Competitiveness Report 2009
Luxembourg: Publications Office of the European Union

2009 — 211 pp. — 21.0 x 29.7 cm

ISBN 978-92-79-12982-7
doi: 10.2769/21563

Price (excluding VAT) in Luxembourg: EUR 12.00

How to obtain EU publications

Publications for sale:

- via EU Bookshop (http://bookshop.europa.eu);
- from your bookseller by quoting the title, publisher and/or ISBN number;
- by contacting one of our sales agents directly. You can obtain their contact details on the Internet (http://bookshop.europa.eu) or by sending a fax to +352 2929-42758.

Free publications:

- via EU Bookshop (http://bookshop.europa.eu);
- at the European Commission's representations or delegations. You can obtain their contact details on the Internet (http://ec.europa.eu) or by sending a fax to +352 2929-42758.

European Competitiveness Report 2009

European competitiveness is at the centre of this yearly publication of the European Commission. Its main focus is on recent developments in EU productivity growth, the key driver of competitiveness in the long-run. The 2009 edition of the European Competitiveness Report looks at the possible implications of the economic downturn, in particular for productivity, and for some of the determinants of future EU competitiveness: the evolution of the BRIC countries (Brazil, Russia, India and China); the role of high-skilled migration; the extent to and conditions under which training can boost productivity; and the role of product and labour market regulations in influencing Information and Communication Technologies (ICT) investment.

NB-AK-09-001-EN-C

European Competitiveness Report 2009

European Commission • Enterprise and Industry

ISBN 978-92-79-12982-7

Publications Office

Price (excluding VAT) in Luxembourg: EUR 12.00