Economist Intelligence Unit

The Economist

Reaping the benefits of ICT

Europe's productivity challenge

A report from
the Economist Intelligence Unit
sponsored by Microsoft

Contents

Acknowledgements

Reaping the benefits of ICT: Europe's productivity challenge is an Economist Intelligence Unit white paper, sponsored by Microsoft.

The Economist Intelligence Unit bears sole editorial responsibility for the content of the report. The findings and views expressed in this white paper do not necessarily reflect the views of the sponsor.

Our research for this report drew on three main initiatives.

- We conducted empirical research to investigate the strength of ICT's impact on economic growth, based on a cross-section model of 60 countries.
- We ran a survey of 100 senior executives on the commercial challenges of harnessing ICT to deliver increased productivity and growth. The survey participants include a mix of small and large organisations and was conducted in February and March 2004.
- The author conducted in-depth interviews with a large number of European politicians, business leaders and prominent academics in this field.

The author of the report was Denis McCauley and the editor was Gareth Lofthouse. Laza Kekic of the Economist Intelligence Unit produced the cross-section model that underpins some of the key findings in this report. Mike Kenny was responsible for design and layout.

Our deepest thanks go to all the interviewees and survey respondents for sharing their insights on this topic.

April 2004

Executive Summary

Once again Europe finds itself at a technology crossroads. This time the challenge is not about adopting a revolutionary technology in the mould of the Internet or mobile telephony. The issue now is whether Europe can turn its substantial investment in information and communication technology (ICT) into greater economic gain.

ICT has played a central role in helping the United States to achieve remarkable productivity gains since the 1990s. Sadly, this success in harnessing ICT has not been repeated. Despite high spending and the widespread adoption of sophisticated ICT infrastructure, European countries continue to lag behind on key measures of economic growth and productivity. This leaves Europe's policymakers and business leaders wrestling with two puzzles. First, why hasn't heavy investment in ICT delivered the economic growth and acceleration in productivity experienced in the US? Second, what must be done to ensure that the benefits of ICT flow faster and stronger?

The economic development goals which EU leaders signed up to at their Lisbon summit in 2000 (the "Lisbon agenda") reflect a desire to address these issues, and subsequent EU initiatives have sought to point the way forwards. Progress is slow and uneven, however, and most European countries have yet to see ICT investment translated into faster growth and productivity.

This report explores why Europe struggles to maximise the economic gains from ICT, and seeks to identify the critical success factors that policymakers and managers must address to improve the rewards of ICT. The findings are based on three lines of research.

- First, the Economist Intelligence Unit conducted empirical research to investigate the strength of ICT's impact on economic growth, based on a cross-section model of 60 countries. The report also makes extensive use of the Economist Intelligence Unit's international business environment rankings.
- Second, we conducted a survey of 100 senior executives on the commercial challenges of harnessing ICT to deliver increased productivity and growth. The survey participants include a mix of small and large organisations drawn from 18 industries.
- Third, we conducted in-depth interviews with a large number of European politicians, business leaders and prominent academics in this field.

In addition to the primary research, the report draws on the existing literature published on this topic to provide an overview of the key issues. The findings of this research programme can be summarised as follows:

The link between ICT and growth is strong in developed economies. The Economist Intelligence Unit's cross-section analysis of 60 countries confirms the general view that ICT is strongly linked to economic growth in developed countries. At the same time, the impact of ICT is weak in emerging markets and our analysis suggests this may be because ICT begins to deliver GDP per head growth only after a certain threshold of development is reached. The research also supports the widely held notion that ICT deployment and use will begin to affect economic growth only after an adjustment period.

ICT accounts for much of Europe's lag behind the US in growth performance in recent years. The cross-section analysis indicates that ICT accounted for as much as 0.4 percentage points of the 0.52-point difference between GDP per head growth rates in the US and the euro zone big three (Germany, France, Italy) in 1995-2002. Our forecasts also suggest that Europe is unlikely to close this gap unless significant progress is made in areas such as skills, innovation and competition.

The Nordic countries and Ireland are the most ICT-savvy. These countries compare well with the US in several areas, particularly in generating productivity gains from ICT use in technology sectors. The UK has yet to see the same rewards from ICT in its productivity figures, but its high levels of ICT development and a favourable business environment are grounds for optimism about the future. The performance of other European economies is mixed, with the Netherlands and Austria performing well in some areas, while the south European countries fare worst.

Skills, innovation and competition are crucial to making technology work. The productivity growth gap between the US and Europe is partly down to differences in effectiveness of ICT use. Most European countries have paid insufficient attention to a number of key ICT "enablers"—the complementary factors that allow enterprises to use technology to the fullest. Alarmingly, one-third of companies surveyed for this report admit that 50% or more of their ICT projects fail to meet their initial objectives. In this respect, difficulties in making the necessary organisational and process changes in the workplace are a major impediment to growth in Europe. Weaknesses in managerial skills and technology awareness, and the lack of an innovation culture, hamstring European enterprises in their attempts to put ICT to productive use.

Europe's weaknesses are most acute among small and medium-sized enterprises (SMEs). SMEs fare poorly compared with large firms in access to capital, the fruits of research and development (R&D), high quality networks and information technology (IT) systems, as well as management skills training. SMEs account for over 95% of firms in most European countries; success in encouraging innovation and effective ICT use in this sector will therefore have a large impact on the economy's ability to reap greater economic growth and productivity gains. Big firms have no reason to be complacent, however; ICT-related management skills are lacking here too, and large firms have particular problems in integrating multiple new systems. Europe's large organisations can also be slow to adapt business processes and change the way people work to take advantage of new technology.

Policymakers and business leaders have work to do. Europe's politicians seem to recognise the challenge. But the interviews and survey for this report suggest that if Europe is to have any hope of closing the productivity gap with the US, its policymakers and business leaders must focus their efforts in five areas:

- **Skills**. Europe needs to entrench ICT-related managerial skills in the workforce, both through skills training and changes to educational

curricula. Business leaders in particular must ensure awareness among managers of the potential benefits and risks of new technologies; ICT vendors have a responsibility to build awareness as well.

- **Innovation**. Europe's policymakers must follow through on their pledge to foster an entrepreneurial culture by encouraging new firm creation and risk-taking, for example by reducing the penalties for bankruptcy. At the same time, managers have a responsibility to entrench and reward innovation within their organisations.
- **Competition**. Governments must maintain the assault on barriers to competition, particularly in telecommunications markets. This is particularly critical for the growth of broadband access. Moreover, the benefits of enhanced telecoms competition must be extended to businesses and consumers in the EU accession countries.
- **ICT in the public sector**. The executives we interviewed and surveyed believe the best thing governments can do to promote effective ICT use is to practise what they preach. In particular, they can do much to stimulate demand for (and demonstrate the benefits of) ICT through initiatives to bring public services online. They can also promote and reward innovative behaviour among firms by choosing suppliers that use ICT to deliver improved services and better value for money.
- **Invigorating R&D**. Nurturing R&D centres of excellence to compete with the US is important. Even more critical is the need to invest a greater share of public funds to applied research, and channelling the fruits of university and public R&D to enterprises.

Progress in each of the above areas will create a more conducive environment for innovation in Europe. It will not be easy, particularly for organisations with an ingrained aversion to risk and change. However, countries such as Ireland and Sweden show what can be achieved when governments and businesses find the right ingredients for ICT-led growth.

Introduction

In March 2000, European Union leaders signed up to an economic reforms strategy that seeks no less than to transform the EU "into the world's most competitive and dynamic knowledge-based economy". Known as the Lisbon agenda, the initiative commits Europe's governments to undertake far-reaching reforms in the areas of innovation, liberalisation, entrepreneurship, employment and (this being Europe) social inclusion as well as sustainable development. Yet the backdrop to this initiative was the growing recognition on the part of policymakers and economists that the EU as a whole was falling behind the United States in key measures of economic growth, most crucially that of labour productivity growth. The transatlantic productivity gap has not diminished since the Lisbon summit, even after the intervening economic downturn experienced on both sides of the Atlantic.

Why does the US outpace Europe in productivity growth? In answering this question, many commentators point to America's success in harnessing ICT for economic benefit. US companies were quicker to embrace technological innovation than their European counterparts, and have therefore been quicker to reap the rewards.

The EU sank nearly €1.9 trillion into ICT capital in 1995-2001, an average growth rate of over 19% per year. The optimists believe that this heavy investment in ICT will soon pay off in higher productivity and economic growth. Our own analysis, presented later in the report, supports the hypothesis of a time lag: that is, a period of adjustment before the benefits of new technology begin to materialise in the productivity figures. But it is dangerous to assume it is simply a matter of time before the full rewards of ICT emerge. In fact, the signs are that Europe will continue to lag behind in productivity growth unless it overcomes a number of serious deficiencies in its policy and business environment.

This report has three purposes: to assess the impact of ICT on productivity in Europe; to identify the ICT "enablers"—the complementary factors such as skills development, innovation policy and business environment—in which Europe most seriously underperforms the US; and to focus attention on the areas where policymakers and business leaders can do most to unleash these enablers. For the purposes of the report, ICT is defined as IT hardware, software and services, and telecommunications equipment and services.

Part I of the report assesses the economic impact of ICT, and is primarily based on empirical research conducted by the Economist Intelligence Unit. It includes the results of a cross-section examination of 60 countries, covering the 1995-2002 period, which attempts not only to measure the link between ICT and growth, but also to assess the importance of key ICT enablers in this context. In the discussion, we also compare the relative performance of European countries in relation to indices of ICT infrastructure development and ICT enablers. These help us to identify Europe's fast and slow movers in encouraging effective ICT use.

Part II identifies the ICT enablers that will play a crucial role in Europe's efforts to accelerate growth and productivity. The conclusions draw on findings from the Economist Intelligence Unit's survey of 100 senior business executives, as well as interviews with a wide range of policymakers, business leaders and academics. In part III, the report highlights the key areas where Europe's policymakers and business leaders need to focus their attention in order to unleash the enablers of ICT-led productivity growth.

Part I
The economic impact of ICT

The question of technology's impact on economic growth and productivity has fascinated and perplexed governments, academics and business leaders since the ICT "revolution" began. The millennial bubble bursts and subsequent slowdown in ICT investment may have tempered wilder claims about the economic benefits of ICT, but interest in the subject remains high.

The role of technology in the economy is now a subject of government policy across the globe, and new studies devoted to ICT production, diffusion and its effects appear on an almost weekly basis. There is widespread consensus that ICT does benefit productivity and growth, but exactly how and to what extent remains a matter of debate.

Those that believe ICT has a key role to play in economic growth look to the example of the United States. America's formidable growth since 1995 appears to explode the "productivity paradox", the famous observation of Robert Solow that "You can see the computer age everywhere but in the productivity statistics"* . Most economists believe this productivity surge can be traced in part to the benefits of ICT production and use. Some go further, claiming ICT has delivered fundamental and lasting change in the US economy, leading to a permanent improvement in its growth prospects. The fact that productivity growth has remained strong in the US even after the post-2000 slowdown would seem to reinforce this view.

Doubts remain, however. Some economists believe the traditional growth-accounting studies that paint ICT in such a positive light are flawed. In particular, it is said these studies may have exaggerated the importance of ICT relative to non-ICT sources of growth. Another major problem is that many growth accounting studies assume that buying a new computer instantly has a positive impact on productivity—a notion that seems at odds with most organisations' experience.

The impact of ICT on growth in most European countries remains less certain than in the US. In the larger European countries, output and productivity growth rates have not accelerated, and since the mid-1990s the gap with US productivity levels has actually begun to widen after a long period when Europe appeared to be catching up. How much of this is due to (on average) lower levels of adoption of ICT in Europe is one of the questions that this report sets out to address.

Reassessing the link between ICT and productivity

A new empirical study conducted by the Economist Intelligence Unit takes a different approach to the traditional growth-accounting models referred to above, and sheds new light on the link between ICT and growth. The objective was to test how much GDP growth is influenced by a range of factors including ICT use, ICT enablers such as skills and training, and the quality of the business environment.

To investigate these issues, we estimated a cross-section growth model for 60 countries including 26 developed countries and 34 less-developed countries, covering the 1995-2002 period. Cross-section analysis looks at data for a set of different countries at a single point in time, or over an average time-span (as opposed to times series analysis that takes observations across different points in time for a single country).

The specially designed model has several advantages over many previous empirical studies of

* Solow, 1987

ICT's impact in Europe. First, it enabled us to estimate the impact of ICT on growth differences between countries, for example the US and EU member states. Second, it allowed us to investigate "interaction effects", for example the relationship between ICT and the business environment, or ICT and skills levels. Finally, the model takes into account ICT use as well as infrastructure development, in contrast to traditional models that focus primarily on ICT investment indicators.

Using this model, together with a variety of indices such as the Economist Intelligence Unit's business environment rankings, it is possible to draw a number of conclusions about the economic impact of ICT.

Technology does drive growth—but only after a minimum threshold of ICT development is reached

The cross-section model confirms the link between ICT and GDP per head growth in the 26 developed countries included in the study, including the US and 16 European countries. Countries with high penetration levels for fixed telephone lines, mobile phones, personal computers (PCs) and the Internet appear to achieve the greatest economic benefit from ICT. By contrast, the impact of ICT on GDP per head growth was non-existent and in some cases even negative for the developing countries included in the model.

This raises the question of why ICT should have a positive effect in some countries but not in others. One major reason for this appears to be that technology has a positive impact on GDP per capita growth only after a minimum threshold of ICT development is reached. In other words, ICT penetration and usage needs to attain critical mass before it will make a significant positive impact on a country's economy.

Once countries reach the threshold (indicated by a score of five on our ICT development index—see Appendix A, p.28), increases in ICT development begin to have a positive effect on GDP per capita growth. It is significant that the countries that exceed this development threshold—the US, the four Nordic countries, the UK, Netherlands and Switzerland—also score highest in the Economist Intelligence Unit's index of ICT enablers (see p.11, and Appendix A, p.28), and have registered the fastest labour productivity growth over the 1996-2002 period. The exception is Ireland, which has yet to demonstrate the explosive broadband and mobile communications growth of the Nordic countries; Ireland's economic miracle, has thus far been a unique story of FDI-fuelled ICT production and other factors which have compensated for moderate levels of ICT development.

Labour productivity growth and ICT

Aggregate labour productivity growth and ICT contribution to labour productivity growth, 14 European countries and US, 1990-95 and 1996-2002, in percentage points

1990–1995			1996–2002		
	Labour prod. growth	ICT contribution		Labour prod. growth	ICT contribution
Norway	3.11	0.85	Ireland	3.76	1.90
Sweden	2.95	0.96	Sweden	2.67	1.33
Italy	2.83	1.09	Finland	2.02	1.40
Finland	2.65	0.43	United States	1.74	1.90
Ireland	2.39	0.68	Austria	1.73	0.75
Austria	2.32	0.76	Norway	1.71	0.68
United Kingdom	2.20	0.74	Denmark	1.45	0.59
Germany	2.11	0.52	Germany	1.38	0.67
Denmark	1.99	0.72	Switzerland	1.10	0.43
Belgium	1.90	0.92	United Kingdom	1.08	1.21
Spain	1.22	0.06	France	1.00	0.18
France	1.13	0.23	Belgium	0.78	0.35
United States	1.12	0.71	Netherlands	0.77	0.48
Netherlands	0.63	0.29	Italy	0.56	0.36
Switzerland	-0.03	-0.42	Spain	0.28	0.14

Source: OECD

Along with Ireland, the US recorded the biggest increases in ICT contribution to labour productivity growth in the 1996-2002 period.

There is a time-lag before ICT benefits growth and productivity

For countries with an ICT development index below the threshold level, particularly developing countries, the ICT impact is either non-existent or even negative. Our study identified no link between ICT and GDP per capita growth in the sub-sample of 34 emerging markets, which include the EU accession countries and other main Central and East European countries. This is consistent with the view that there is a considerable time-lag between ICT investment and returns, representing the time it takes for organisations to assimilate and adjust to new technology. During this period the adoption of ICT can even retard productivity growth. At the firm level, this suggests that ICT is no panacea. According to the authors of a 2003 OECD report, firms can over-invest in ICT „either in an effort to compensate for lack of skills or competitive pressure or because they lack a clear market strategy*.

ICT accounts for most of the gap in GDP per head growth between the US and euro zone "big three"

In addition to reinforcing the link between ICT and increased productivity and growth in developed economies such as Europe and the US, the cross-section model suggests ICT is the main factor behind the transatlantic productivity gap. The impact of ICT appears to be substantial: about 0.4 percentage points of the 0.52-point difference between GDP per head growth rates in the US and the euro zone big three (Germany, France, Italy) in 1995-2002 can be attributed to ICT use. The Economist Intelligence Unit's forecasts of GDP growth indicate that Europe is unlikely to close this gap unless significant action is taken.

Education and the business environment are crucial to making technology work

ICT development is only one of the important factors affecting growth. The cross-section model indicates that the quality of a country's business environment, as well as its attention to specific ICT enablers such as education, significantly affect its ability to harness the full benefits of technology. At a firm level, the survey and interviews also highlighted the importance of ICT enablers such as skills, R&D and access to venture capital. Our research suggests that countries that have a highly developed ICT infrastructure, together with a strong performance in most of the ICT enablers, tend to deliver faster economic growth.

European effectiveness in harnessing ICT

The Economist Intelligence Unit's research confirms that most European countries lag significantly behind the US in key measures of ICT investment, use and productivity growth. But figures for the EU as a whole mask stark differences among the 25 members of the post-enlargement Union.

The ICT Development Matrix below illustrates different countries' ability to harness ICT for economic gain. The positioning of countries in the matrix is based on a combination of data and qualitative assessments that reflect each country's level of development of ICT infrastructure and ICT enablers in 2002-03.

Countries that are best positioned to harness ICT effectively appear in the upper-right sector of the matrix. Europe's top performers in terms of infrastructure development and the ICT enablers are the Nordic countries together with the UK. The US outperforms all other countries in the quality of ICT infrastructure. When it comes to the ICT enablers, however, Norway and the UK match the US, whereas Sweden, Denmark and Finland actually outperform

* OECD, 2003

it. Tellingly, it is the Nordic countries along with Ireland that have registered the largest ICT contributions to labour productivity growth in Europe in the 1996-2002 period.

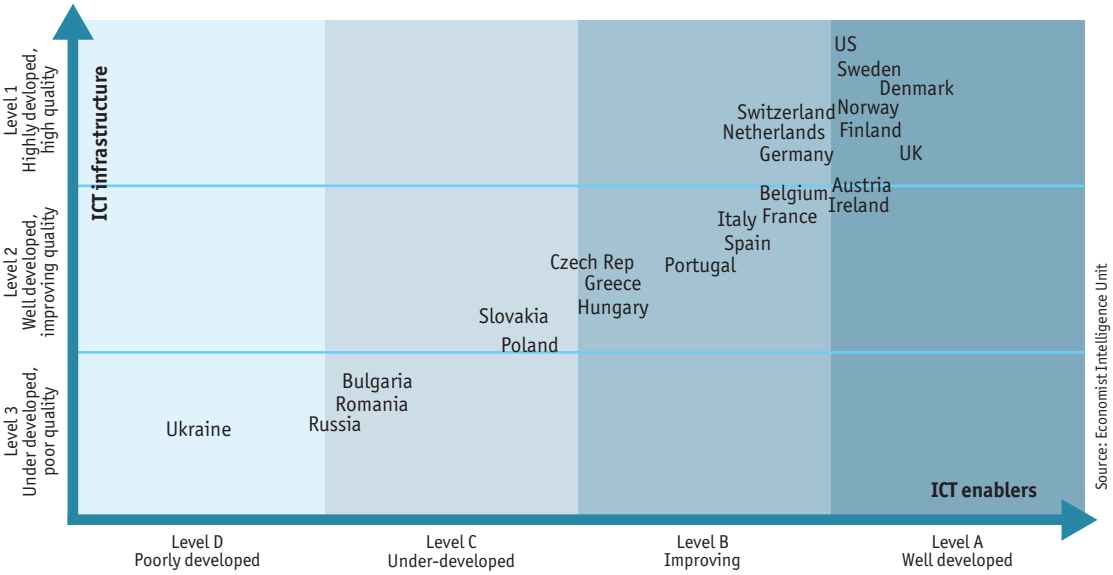
The UK, although among the better performers in our matrix, has been slower to see the results filter through into faster productivity growth. However, several economists believe the UK is on the cusp of an acceleration in productivity growth on the strength of its effective use of ICT. Ireland, by contrast, ranks in the middle of EU countries on ICT infrastructure development but is strong on enablers and also boasts a well-developed ICT-producing sector.

A few countries, including Austria, Switzerland and the Netherlands, appear ready to join the European leaders, but several weaknesses hold them back. The Netherlands, for example, with a very well-developed ICT infrastructure, competitive markets and a positive business environment, is burdened by a relatively poor performance (by EU standards) in skills training and education. France and the Mediterranean rim countries tend to underperform across most infrastructure and enabler categories, but it is the countries of central and eastern Europe that need to make up the most ground.

Our research challenges the assumption that the

Continued on page 14

ICT development matrix



The ICT infrastructure index used here combines six connectivity variables—penetration of traditional fixed lines, broadband access lines, mobile phones, PCs, Internet users and Internet servers per million population—with four qualitative variables: quality of Internet connections and levels of e-business development, of online commerce, and of Internet/web literacy. The ICT enablers index takes into account affordability of Internet access, telecoms market competition, security of the Internet infrastructure, government support for ICT development, laws governing the Internet, ICT skills of the workforce and quality of ICT supporting services. When combined, these indices provide a good measure of a country's readiness to reap the benefits of technology.

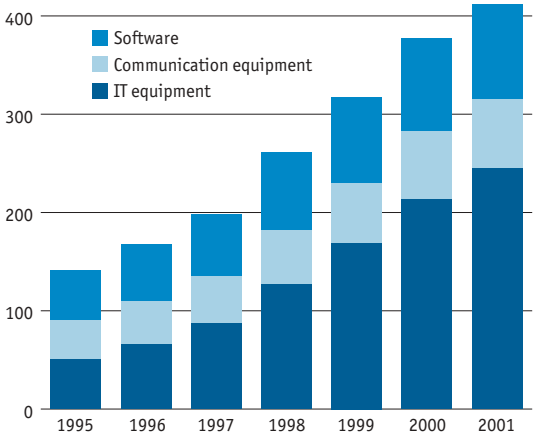
Three ways ICT can boost the economy

1. ICT investment. Investing in ICT goods and services leads to capital deepening, which in turn leads to increases in labour productivity. Economists believe ICT capital investment has made a sizeable contribution to GDP growth in many developed countries in the past decade, accounting for between 0.3 and 0.8 percentage points of GDP per head growth in the OECD in the 1995-2001 period[1].

Across the OECD, the share of ICT investment in total investment has expanded over the past decade, especially in the US, Australia, Canada and the Nordic countries. Other European countries are also investing large amounts of capital in ICT goods and services.[2] ICT gross fixed capital formation in the EU totalled nearly €1.9 trillion in 1995-2001, and expanded at an average rate of 19.5% over the period. However, Europe continues to lag behind in terms of the share of ICT investment in GDP: in the EU in 2001 it accounted for 2.6% of GDP compared with 4.2% in the US. And Europe has a long way to go to catch up to US levels of ICT capital stocks.

Will the high levels of ICT investment that have produced this effect be sustained in the future? Despite a dip since 2000, many economists see ICT investment growth in both the US and Europe remaining buoyant in the medium term—a view our survey supports, with 70% of companies saying they plan to increase investment in the next two years. One notable sceptic is Robert Gordon, an economist who argues that the 1990s boom owed much to transitory factors and that the drivers of demand for ICT goods will be weaker over the next half-decade[3]. On this view, ICT investment growth should still continue, but at a much more moderate pace than in the second half of the 1990s.

ICT investment in the European Union, 1995-2001
(Gross fixed capital formation in 14 EU countries [in constant 1995 prices], billions of Euros)



Source: Marcel Timmer, Gerard Ypma and Bart van Ark, "IT in the European Union: Driving Productivity Divergence?", Groningen Growth and Development Centre, 2003.

What are your plans for investment in ICT in the next 2 years?
(% respondents)

Over 100% increase in investment	6
50-100% increase in investment	11
25-50% increase in investment	10
10-25% increase in investment	21
Up to 10% increase in investment	22
Same level of investment	25
Up to 10% decrease in investment	3
10-25% decrease in investment	2
25-50% decrease in investment	0
50-100% decrease in investment	0

2. The impact of ICT production. For the handful of countries with a big ICT-producing sector, production of ICT manufactured goods and services has made a large contribution to GDP growth, according to most studies. The European countries that have benefited most from ICT production are Finland, Ireland and Sweden, which manufacture large quantities of ICT hardware and software. Total factor productivity (TFP) growth, an important measure of ICT's impact on productivity, has also accelerated in each of these countries[4].

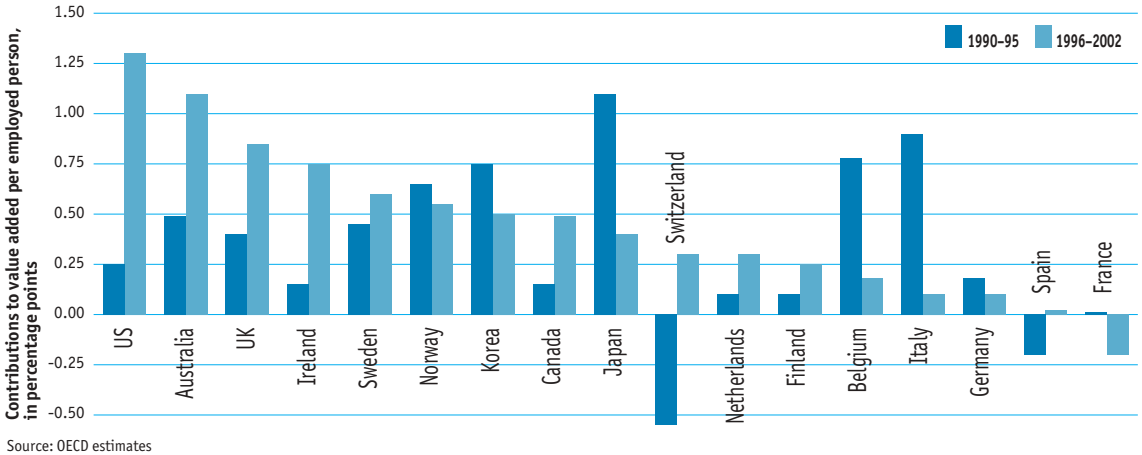
ICT-producing firms are believed to provide additional impetus to productivity growth in other sectors through the transfer of knowledge to customers and suppliers, although this has yet to be proven. Despite this, few economists or policymakers believe governments should intervene to create or boost an ICT-producing sector artificially. Dirk Pilat, an economist at the OECD, argues that only a few firms can compete in this area[5]. Besides, the absence of a strong ICT-producing sector is not thought to be a hindrance to reaping the productivity benefits of ICT throughout the rest of the economy[6].

3. The impact of ICT use. Ultimately, the biggest pay-off from ICT is a sustainable boost to productivity growth throughout the rest of the economy in the ICT-using sectors. This requires greater improvements in workplace efficiency that are more difficult to achieve but also provide longer-term benefits.

Economists studying TFP growth in Europe's ICT-using industries have seen little (if any) sign of an acceleration here. Many economists conclude that this is because of the time-lag between the point where countries invest heavily in ICT and the point where its benefits become apparent in the productivity indicators. Our own empirical study supports the time-lag theory, but also points to other factors, including the level of ICT development and the strength of a variety of ICT enablers in each country.

[1]OECD, 2003 2OECD, 2003; [2]Colecchia and Schreyer, 2001; Bartelsman and Hinloopen, 2002 [3]Gordon, 2002 and 2003 [4]Van Ark et al, 2002 [5]Pilat and Wölfl, 2004 [6]OECD, 2003

Contribution of ICT-using services to aggregate labour productivity growth



Source: OECD estimates

The importance of software in the ICT mix

In the US, software has attracted the largest share of ICT investment since the technology boom began in the early 1990s. By 2000, it accounted for about 14% of total non-residential capital investment in the US, and nearly 40% of overall ICT investment growth[1].

ICT investment in the EU as a whole has been more heavily weighted towards IT and communications infrastructure, where price declines have been steepest. Software nonetheless accounted for one-third or more of ICT investment in the UK, France and the Netherlands in 2000, and substantially more in the Nordic countries[2].

Software investment tends to lag purchases of hardware. This may explain the more rapid growth of software investment relative to total investment in the US, where firms made an early start in deploying IT and networking infrastructure. Assuming that Europe is playing catch-up to the US in overall ICT investment and has invested heavily in hardware since the late 1990s, software vendors can probably look to good times ahead in their European markets. Software markets in western Europe proved relatively resilient during the technology slump of 2000-02, continuing to expand at moderate rates, whereas hardware sales declined. IDC, a technology consultancy, projects that the west European software market will expand at a respectable 6.6% compound annual growth rate over the 2003-07 period to a volume of €57.5bn.

[1]Colecchia and Schreyer, 2002; Ahmad, et al, 2004 [2]Ahmad, et al, 2004

largest and richest economies inevitably lead the way in harnessing ICT. Germany, for example—long the continent's economic powerhouse, a leader in broadband adoption and home of some of its software giants—currently ranks in the middle of EU countries in our ICT development and enabler indices, as well as in labour productivity and other key macroeconomic indicators. By contrast, Ireland has outpaced even the US in ICT-led productivity growth, thanks mainly to a strong ICT-producing sector, even though it is not so long ago that Ireland was among the poorest EU countries in terms of GDP per head. Ireland's success in creating an environment fostering technology-industry expansion is a major factor in its remarkable growth story.

Most observers, subscribing to the time-lag theory, believe the benefits of ICT will eventually materialise in a wider range of European countries. Nevertheless, the majority of European countries seem unlikely to match the US performance in ICT-led productivity growth in the near future. The Economist Intelligence Unit's forecasts suggest that, on current trend, most European countries show no sign of closing the gap in growth with the US.

Part II
What's holding Europe back?

"To reap the benefits of ICT we must invest in the parallel areas of organisational capital—in skills, innovation and R&D."
Erkki Liikanen, EU commissioner for enterprise and the information society.

The empirical studies suggest that ICT has played a central part in the United States' extraordinary productivity growth since the mid-1990s. But it is equally clear that high levels of ICT investment and adoption do not, in themselves, guarantee faster growth and productivity. With the exception of a dip in 2000-02, ICT investment has grown impressively on both sides of the Atlantic, yet most of the EU countries continue to be outpaced by the US economy.

The rewards of ICT depend on a complex interaction between technology and a range of other complementary factors relating to the business environment. To help identify and understand which of these factors are most important, the Economist Intelligence Unit conducted a survey of 100 senior business executives, as well as in-depth interviews with a range of European policymakers and business leaders.

Inevitably our research highlighted a wide range of factors that influence a country's ability to benefit from ICT. Even so, a recurring theme in the survey and interviews has been the need to focus on four key ICT "enablers": ICT-related management skills; more effective R&D; spurs to innovation such as access to venture capital; and, more contentiously, the creation of open and competitive markets. In most of these areas, it is argued that countries like the US and the Nordics have been more successful in creating an environment where innovation can flourish and where the benefits of ICT can be fully realised.

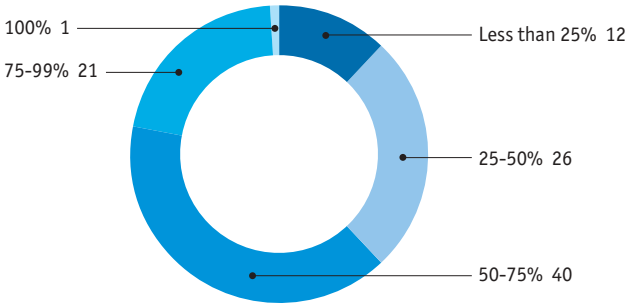
There is no reason for European countries to miss out on the spoils of ICT, provided they embrace innovation wholeheartedly. They have done so before with notable success: take, for example, Europe's shining achievement in developing the Global System for Mobile Communications (GSM) standard, a breakthrough that enabled the growth of the region's highly competitive mobile services and equipment industry. Europe's liberalisation of its telecoms markets, although patchily implemented, has also encouraged competition and made voice, Internet and data communications more affordable to many businesses and households. Boldness and imagination in other key areas will be crucial to Europe's attempts to win further economic rewards from ICT in the future.

Wanted: an innovation culture

Europe has no shortage of technology, but is often said to lack the entrepreneurial spirit that makes US companies more likely to innovate, take risks and embark on new ventures. According to Tarek Ghouri, director of government practice for Nokia Enterprise Solutions, "the technology is available today to create compelling solutions that grow productivity; the main ingredient lacking is imagination at the enterprise level".

That European business suffers from an entrepreneurial deficit and ingrained risk aversion compared to the US is a relatively non-controversial view, accepted by virtually all the studies we have reviewed for this report, and most of the government, industry and academic leaders we interviewed. A Eurobarometer survey sponsored by the European

What proportion of your ICT projects meet their business objectives?
(% respondents)



Commission shows that only 4% of Europeans have set up a business in the past three years, and that almost three times as many Americans are involved in entrepreneurial ventures. The Commission, OECD and others also worry that new European ventures grow too slowly.

Innovation often stems from entrepreneurship and a willingness to take risks. Empirical research indicates that new firms tend to be the most innovative in their markets, and often prod incumbents towards more innovative behaviour as well. However, even Europe's more innovative countries tend to be risk-averse. Martti af Heurlin, deputy director-general of Tekes, Finland's National Technology Agency, says that although Finnish business people are very supportive of innovation, the impulse to create new firms is too weak. It seems would-be entrepreneurs are put off by the prospect of losing the good salaries and the job security they enjoy with their existing large firms.

The European Commission has been sufficiently concerned by this issue to launch a number of initiatives in an attempt to boost entrepreneurship. These are intended to reduce the regulatory and administrative burden for SMEs, to simplify compliance with tax laws, and to ease the legal, financial and cultural pain of bankruptcy. However, most of these issues need to be addressed at the national level, and it remains to be seen how vigorously member states will pursue these initiatives.

What are the biggest internal barriers to maximising the benefits of ICT?
(%; respondents could provide a maximum of two answers)

Lack of ICT knowledge in senior management	38
Business and IT executives not working together effectively	34
Inadequate integration between different technologies in the business	30
Cost constraints	29
Inability to manage and harness data effectively	23
Flawed project planning or implementation	23
Lack of ICT skills in workforce	22
Employee resistance to change	22
Other	3

Skills to reorganise, skills to innovate

Europe is not short of skilled technical workers. Schools and universities produce a steady flow of graduates trained in software programming, network design and other technical aptitudes, and these are well represented in IT departments throughout Europe's private and public sectors (the accession countries being no exception).

Organisations do complain of skills shortages, but finding good technical skills is not the biggest problem. Rather, it is the difficulty in finding managers with the skills and experience to turn technology to business advantage. In our survey, lack of ICT knowledge in senior management and the failure of IT and business management to work together effectively were cited as the two main barriers to maximising the benefits of ICT. These failings have painful repercussions: one in three of the European companies we surveyed says that fewer than half of ICT projects meet their business objectives.

Clearly something is amiss. European managers struggle to turn technology investment into gains in productivity or revenue. The implication is that it is not enough to deploy new enterprise software or a

Case study:

R&D and skills training for Finnish SMEs

Finland's National Technology Agency—in Finnish, Tekes—is the spearhead of Finland's research and development support programmes. Its main focus has been the channelling of €400m per year of government funding to deserving university, company and institute R&D programmes covering all sectors. Much of this is used to fund innovative applications of ICT, with €160m of it going to SMEs. Tekes also facilitates stronger links between research institutes and companies to encourage the smoother transfer of knowledge between the public and private sectors.

In addition to its work in R&D, Tekes recently launched a programme to encourage productive use of ICT in SMEs. According to Mr af Heurlin, the €1m programme is designed to address the ICT skills gap of Finnish SMEs. The gap is felt not so much in technical expertise as in managers' ability to capitalise on ICT investments for commercial benefit. Tekes provides funding that enables SMEs to receive ICT-related management training directly from Tekes itself or from approved agencies. Between 30 and 50 small-scale projects are expected to receive funding in 2004.

data network and ensure that it operates properly. Today's managers need to be able to understand a technology's impact on the business, and have the skills and leadership qualities required to transform the business around it.

Stephen Timms, the British minister of state for energy, e-commerce and postal services, believes that ICT technical skill levels are no longer a barrier to growth in the UK, but is concerned about the shortage of ICT-related managerial skills, particularly in SMEs. "Managers require a higher level of insight and understanding about how to use technology to achieve some level of business transformation," he says. Erkki Ormala, Nokia's director of technology policy, also acknowledges the skills gap among Europe's managers, and says Europe's risk-averse business culture does not encourage managers to innovate.

The more familiar a firm is with changing structures and processes, the more likely that it will benefit from

How important are the following aspects of the business environment in enabling your company to benefit from ICT?
(%; respondents could rate from 1-5, where 1=extremely important and 5=unimportant)

	1 Extremely important	2	3	4	5 Unimportant
1. A deregulated and competitive telecoms sector	37	33	19	8	3
2. Government policies to promote diffusion of technology among consumers	29	33	26	10	2
3. Availability of finance to fund innovation and new ventures	32	35	25	5	3
4. Robust legal framework and law enforcement to protect online trade	39	24	27	6	4
5. Effective laws to protect intellectual property	34	27	23	9	6

ICT and earn a return on its investment. Firm-level studies conducted in Germany and the Netherlands* reveal a strong link between companies' willingness to introduce process innovations and their likelihood of generating productivity gains from ICT investments.

Reorganising the workplace to adapt to new technology can involve anything from automating manual processes to overhauling product design, production or logistics systems. For some managers, ICT investments trigger a decision to spin off a new entity, or to leave and start a new firm themselves. Conceiving and implementing such changes requires both knowledge and innovative behaviour. At the risk of adopting yet another management fad, this suggests that Europe's managers must take on board the lessons of change management and accept that rethinking structures and processes around new technology needs to become routine practice.

Open markets, unfettered competition

Our cross-section analysis of 60 countries appeared to confirm a strong link in developed economies between the quality of the business environment and the economic impact of ICT. Generally speaking, the more open and stable the business environment, the more likely that ICT use will make a contribution to growth. In addition, competition in ICT-producing markets drives advances in technology and also pushes prices down, encouraging the wider diffusion of technology. Strong competition in the economy as a whole encourages other companies to use technology to innovate with their products, services, work processes and organisational structures.

A clear example of the benefits of open competition can be seen in Europe's liberalisation of its telecoms markets, initiated in the late 1990s across the EU and later in the accession countries. Operating under European Commission guidelines, European governments deregulated the long-distance and leased-line market, then local access markets, to new competitors; ensured restriction-free entry by providers big and small to Internet service markets; and embarked on initiatives to give alternative operators access to incumbents' last-mile networks. Although some countries have achieved more than others, these actions have usually resulted in significantly lower costs of telephony and data services for end-users, as well as wide-scale deployment of broadband access networks.

Which of the following government initiatives are most beneficial for fostering a strong ICT-producing sector?
(%; respondents could provide a maximum of three answers)

Initiatives to encourage technology transfer from universities	29
Government leading the way in innovative use of ICT	35
Encouragement of foreign direct investment in ICT sector	23
Policies to promote competition in the ICT sector	35
Schemes to promote access to higher bandwidth services	34
Promotion of common technology standards	36
Availability of good ICT education in primary and secondary schools	33
Availability of specialist high tech qualifications in further and higher education	10
Policies to redress under-representation of women in ICT jobs	2
Financing schemes for ICT-related investment	22
Policies to promote labour mobility	9
Policies to attract ICT skilled immigrants	10
Other	1

Which of the following government initiatives are most important to promote the diffusion of ICT in a country?
(%; respondents could provide a maximum of three answers)

Government schemes to promote universal access to PCs and Internet	41
Development of e-democracy	15
Government innovation in providing online services to citizens	44
Policies to promote competition in the ICT sector	34
Regulation to protect consumer interests	19
Schemes to promote access to higher bandwidth services	36
Promotion of common technology standards	32
Availability of good ICT education in primary and secondary schools	43
Other	0

• OECD, 2003

Restrictive product-market regulation is another area where innovation can be stifled. A study prepared for the Commission* makes the case that relatively light product-market regulation in the US has helped to boost productivity growth there, whereas EU countries' far more stringent product-market regimes have held growth back. Erkki Liikanen, EU commissioner for enterprise and the information society, believes that it is critical for member governments to review their product-market regimes and reduce administrative burdens on product competition.

Bart van Ark, an economist from the University of Gröningen, believes restrictive product markets discourage innovation and ultimately the effective use of ICT. Although Mr Van Ark is sceptical about catch-all solutions, he argues that some industry-specific measures would bring clear benefits. In the retail industry, for example, extending shop opening hours and harmonising zoning laws would encourage competition and innovative behaviour in this intensive ICT-using sector.

A common thread running through the interviews is the need to encourage companies to do business across Europe, be they ICT producers or users. "Firms must be allowed to achieve European scale," asserts Arthur Weyns, vice-president and chief strategy officer for Philips Consumer Electronics. The current variation of competition and other regulations in different member states are often counterproductive, claims Mr Weyns, partly because public officials' perspectives remain local, not European. Under this view, the more harmonisation of regulations at the European level, the better.

The issue of labour-market regulation is more contentious. Many economists argue that Europe's labour-market regulations are too restrictive and that they deter companies from reorganising the workplace. Policymakers and economists diverge, however, on the link between labour regulations and productivity growth, and on the desirability of policy initiatives to effect change. If nothing else, the relationship between labour regulations and ICT-led productivity growth will need to be explored more fully before politicians at either the EU or national level will feel confident enough to propose far-reaching changes.

A commitment to open markets and unfettered competition is clearly a factor in encouraging successful innovation, but not everyone sees it as a priority. In our survey, most managers were much more concerned about getting technology to meet business needs, or about overcoming problems integrating IT into the organisation, than about further liberalisation of Europe's ICT markets.

Innovative ventures need venture capital

In the US, venture capital provides a valuable catalyst for the emergence of new, innovative businesses. By contrast, Europe's venture-capital industry remains small and underdeveloped. Although overall private equity investment levels in Europe approach those across the Atlantic, the amount channelled into early-stage financing is substantially less in Europe than in the US (in 2002, 10.6% in Europe compared with 21.1% in the US, according to PwC).

The lack of venture capital is a strong disincentive to innovation and enterprise. Germany, for example, boasts some of Europe's more prolific R&D programmes with close ties to business (see below), but limited access to venture capital can make it difficult for technology start-ups to find funding. Eike Röhling, director-general of technology policy in the federal Ministry of Economics and Labour, cites the shortage of venture capital as one of the key barriers to innovation in his country.

Funding for university and research institute spin-offs is another area where Europe compares

*For example, Van Ark and O'Mahony, 2003

unfavourably with the US. The UK, Ireland and the Netherlands are more likely to nurture such equity funding channels: the European Venture Capital Association ranks the UK and Ireland as boasting the most conducive tax and legal system for private equity funding in Europe, whereas Germany, Denmark and Austria fall at the bottom of the list. In most of Europe, would-be innovators usually have to seek financial support elsewhere.

The amount of equity capital available for new and early-stage ventures in Europe is beginning to increase and, according to the European Venture Capital Association, expectations for 2004 are more optimistic than has been the case over the past two years. Still, fundraising for venture capital remains difficult in Europe. Industry veterans point out that European venture-capital firms are extremely selective in their investments, partly because they had their fingers burnt in the dot.com crash, but also because they have limited confidence in entrepreneurs' business models and management teams (back to the skills gap).

Case study:

Bridging the R&D gap

The Catholic University of Louvain in Belgium (UCL, by its French acronym) provides a good, if all too rare, example of European efforts to bridge the university-company divide in research and development. In its own research as well as the science parks that it funds, the university stresses the importance of applied research that can be put directly to use by companies. UCL's sizeable in-house research institute (4,000 staff, including 200 PhDs, and 200 laboratories) proactively seeks and wins contracts with companies from the region as well as elsewhere in Europe and abroad, specialising in bio-tech, environmental and IT technologies. A handful of large firms, such as Lilly, Pfizer and Abbott, and a much larger number of mid-sized firms directly employ staff working in UCL laboratories on corporate projects.

UCL, with its links in the Wallonia region and beyond, is among a handful of successful R&D clusters in Europe with strong corporate relationships. The most prominent besides UCL are the Fraunhofer Society of research institutes across Germany, Sophia Antipolis in France and Cambridge in the UK.

Reinvigorating R&D

The other major part of the innovation equation—for ICT-producing and -using firms alike—is research and development. Public and private-sector R&D expenditure in the EU is not small: €182bn in 2002, according to Eurostat, compared with €309bn spent in the US. Even so, the EU figure amounts to less than 2% of GDP, compared with 2.8% in the US and nearly 3% in Japan. The unfavourable comparison prompted the European Commission to set targets for boosting this figure to 3% by 2010.

Little product innovation takes place without firms either using in-house research (this applies mainly to large firms) or gaining access to the results of third-party research. In Europe as in the US, a substantial volume of R&D work is conducted by universities and independent research institutes. In contrast to the US, however, links in Europe between university-based institutes and businesses remain weak.

Our own research and other studies reveal numerous complaints relating to R&D activity in Europe, ranging from a misallocation of public funds (too much being channelled into pure research and too little into applied R&D) to universities' distrust of corporate clients or institutes' inability to attract and retain talented researchers. All this combines to limit the impact of R&D on firm innovation in Europe. Another problem is that Europe's SMEs have limited access to the fruits of R&D, which prevents them from reaping the rewards of technological innovation.

Finland shows that some European countries are

attempting to extend the benefits and R&D to smaller businesses (see the case study on Tekes). Ireland must also be considered an R&D success story. Having made the decision two decades ago to develop a strong ICT production base, the Irish government has ploughed large public funds into R&D. One example is Science Foundation Ireland, a fund established in 2000 which will inject €635m into ICT and biotech research over the next seven years. The country has also invested great efforts into improving research collaboration between universities and industry. Danny O'Hare, chairman of Ireland's Information Society Commission, says the focus on R&D ensures talented researchers are attracted into Ireland's universities and institutes, and that to some extent the "brain drain" of scientific talent to the other side of the Atlantic is being reversed.

Security, standards and intellectual property

In each of the areas discussed above, most European countries compare unfavourably with the US. In other areas, European companies need to address the same ICT challenges that thwart innovation the world over. Of these, three issues stand out as requiring particular attention from Europe's policymakers and business leaders.

The first is security. A large and growing proportion of Europe's business transactions are now conducted through digital channels. Ensuring minimum, enforced standards of network security as well as trust in payment systems, digital identities and digital contracts is vital to encourage more business leaders to offer ICT-enabled services, and to give users (employees, suppliers and customers) the confidence to use them. Elie Simon, president EMEA of Sun Microsystems, believes regulators must seek to develop unified security standards to protect Europe's network infrastructure. Challenges in developing effective, common authentication protocols are another obstacle to e-business adoption for large and small firms alike.

At the regional level, the European Commission and major systems vendors are trying to co-ordinate "cyber-security" efforts. This includes schemes to build awareness among firms of security threats and of options for dealing with them. When it comes to security threats such as viruses, SMEs are thought to be particularly vulnerable as they tend to have fewer resources available to handle problems if they arise.

Second is the issue of common standards, the lack of which is cited as a main external concern by 37% of the executives we surveyed. Common standards remove much of the risk associated with investing in competing technologies. Europeans fondly recall the development of the GSM standard, and the rewards that accrued to consumers and mobile industry firms from its universal adoption on the continent. Today, new digital broadband, mobile, wireless and other technology platforms are emerging together with a plethora of competing standards. In many cases, uniformity of standard on the GSM model will not be feasible, but a technology's ability to connect seamlessly with others remains crucial.

Mark MacGann, chairman of the European Information, Communications and Consumer Electronics Technology Industry Association (EICTA), underscores the importance of industry and government adhering to international, open standards for device and platform interfaces in order to ensure full interoperability. The latter will not only improve managers' ability to achieve technology integration at the enterprise level, but more importantly it will maximise end-users' access to the benefits of the information society. Arthur Weyns of Philips stresses that agreements on standards must be crafted and led at the European level; too wide a scope is still given to local interpretation, and too many

standards-related initiatives stop at national borders.

Third, strong intellectual property (IP) safeguards are also critical to creating an innovation culture, and are viewed by a majority of the executives we surveyed as "important" or "extremely important" to enabling firms to benefit from ICT. Along with other aspects of a country's legal system, reliable IP protection forms an important component of a positive business environment, and Europe has generally compared favourably in this area with the US and other developed countries.

This is the context for an ongoing debate involving the European Commission, the European Parliament, industry groups, entrepreneurs and software developers around the ability to patent software. Many large ICT companies (including Microsoft, the sponsor of this report) favour the extension of patents to cover software as a way to strengthen IP protection across Europe and thereby create greater incentive for innovation. For their part, independent software developers view software patents as a weakening of copyright protection, and thus no less of a threat to innovative activity in this field. At the time of writing, the revised European Commission directive appeared to weaken the applicability of patents to software.

Part III
Unleashing the enablers of growth

Europe's challenge is to create a business environment where innovation can thrive and where the benefits of ICT are readily available at all levels of the economy. Creating that environment—and ultimately delivering increased productivity growth—requires co-ordinated action on the part of policymakers and business leaders. Public-private partnerships have been very effective in the past in helping to redress other European challenges in the technology field: examples include successful co-operation to unify mobile standards or pilot broadband projects. Similar collaboration between business and government will be crucial in the future if Europe is to address its deficits in skills, innovation and R&D.

The eEurope 2005 plan (the part of the Lisbon agenda concerned with creating a knowledge-based economy in Europe) and other initiatives signify a desire in the EU to remove the barriers to innovation and growth. But a danger remains that efforts to encourage ICT innovation will be dissipated across a flood of initiatives. Instead, Europe's policymakers and business leaders need to focus their attention on action that is most likely to "unleash the enablers" of ICT-led productivity growth. In this spirit, we conclude this study with five imperatives for innovation in Europe.

As may be expected, these concentrate on those areas where Europe as a whole compares least favourably with the US. In making our recommendations, we freely admit to skirting areas where the links to ICT-led productivity growth are more contentious. The central example is labour-market regulation, which most economists believe is too restrictive in most of Europe. Despite this, many policymakers (as well as executives judging from our survey) do not see labour-market reform as a priority. Certainly they will have enough to busy themselves with while this particular debate is resolved.

Five imperatives for policymakers and business leaders

1. Entrench ICT-related managerial skills in the workforce. Governments have a number of jobs to perform in propagating the necessary skills to use ICT effectively. One targets the workplace, where public agencies can directly organise or support third-party initiatives to improve managerial and employee skills in ICT use. This is particularly relevant to staff in SMEs, where such skills are most in need. Taking the longer view, governments should also entrench ICT-related training at all levels of the educational system, and ensure that tertiary institutions offer relevant ICT-related management training in the appropriate programmes. Danny O'Hare, chairman of the Irish Information Society Commission, says Ireland's success in harnessing ICT stems partly from efforts by the government, business and universities first to identify critical skill gaps, and then to change the educational system to address them.

Business leaders need to invest in skills training for their own managers and staff, and provide incentives to encourage staff to undertake this training outside the workplace. The organisations that will be most successful in harnessing ICT will train their staff not only how to use new technology, but also in more challenging areas such as how to deploy technology for competitive advantage. In particular, managers will need to understand better the benefits, risks and

commercial impact of new technology. Firm-level analysis provides ample evidence that, if not used properly, new systems or networks can have a harmful impact on workplace productivity. It is therefore incumbent on executives to ensure, through training and other mechanisms, that their managers are fully aware of the potential benefits of an ICT investment, as well as the specific workplace factors that may complicate it, before a purchase is made.

ICT vendors carry a special burden of responsibility in this context. Vendors must make every effort to ensure that customers are not only aware of the benefits of a newly deployed technology, but also of the potential pitfalls. Such behaviour may not be enforceable by industry watchdogs, but it is good corporate practice and certainly in the interest of building long-term customer relationships. It is to be hoped that business managers will increasingly demand this behaviour from their suppliers.

2. Stimulating innovation and enterprise.
Policymakers are aware that restraints on entrepreneurship sap innovation and constrain productivity growth. Progress in meeting the goals of the European Commission's entrepreneurship plans would be a good step towards enhancing innovation and productivity growth. The following areas in particular merit attention.

- Ensuring a greater flow of funding to SMEs. The EU and national governments should work with the financial sector to support the expansion of Europe's venture-capital industry. This includes not only structural measures to encourage the rebirth of secondary technology- capital markets, but also the support of consultancy and skills training for small firms in business planning.
- Taking practical measures to encourage new firm creation and risk-taking. Reducing the complexity of tax compliance, streamlining the approval and registration of ownership changes, and lowering penalties for bankruptcy would all remove significant barriers to the creation of new firms.

It remains for the European Commission, member governments and other players to translate these broad objectives into specific actions, and ultimately, to drive their implementation at national and local levels. But it is up to business leaders to take advantage of this more supportive environment to encourage risk-taking and innovation in their organisations. This is easier said than done, of course, but there are numerous tools that managers can use to create a more positive environment for innovation. These include the creative use of teams, quality circles and other mechanisms to promote employee involvement in decision-making; greater information-sharing; a more imaginative use of monetary incentives and other rewards; employee participation in job design; and modifying criteria for promotion to reward new ideas and innovation. Training in change management can also help to ensure that organisations are both willing and able to adapt to new challenges and exploit technology's potential to the full.

3. Redouble the assault on barriers to competition.
We've highlighted the benefits that telecoms market liberalisation has brought to European businesses and consumers in the form of reduced costs and better services. Connectivity is no longer a major barrier to effective ICT use, at least in western Europe. But policymakers must continue to promote competition in the telecoms industry, for two main reasons.

- First, to prevent the rebuilding of virtual monopolies in broadband access markets. Even after liberalisation, Europe's incumbent telcos control the critical "last-mile" networks. Fortunately, most have used this dominance to aggressively roll out digital subscriber line (DSL)

Case study:

e-government... from the East

Having spent about 1% of the state budget on public-sector IT development over the last ten years, Estonia has one of the most ICT-savvy governments not only in central Europe but in Europe as a whole. The national government already conducts much of its business online: ministers review new legislation, make comments and vote online using flat-screen computer terminals. Digital documentation has replaced paper in preparations for cabinet sessions, and an Internet-based system has been launched to enable cabinet meetings to be conducted online.

Meanwhile, an e-democracy website (dubbed "Today, I'm Deciding") has been in place for citizens for several years. The portal allows Estonians to comment on draft bills and submit their own ideas for legislation. Integrating this and its various other services on one platform, in March 2003 the government launched the Citizen's IT Centre, a portal designed to provide a one-stop shop for existing and new services. The portal allows individuals and firms to complete and digitally sign government forms, such as passport applications, over the web.

broadband networks and services, but they have simultaneously managed to restrict competitors' access to the last mile. In the longer term, competition in the provision of broadband services must become entrenched to ensure that businesses and households gain and retain access to sufficient bandwidth at affordable prices.

- Second, the benefits of competition must be extended to the EU's new members. Csaba Csapodi, director-general in Hungary's Ministry of Informatics, stresses that connectivity and cost—of IT systems as well as telecoms services—remain barriers to productive ICT use in accession countries. Liberalisation, and later local loop unbundling (LLU), helped to kick-start broadband adoption in the EU. With the possible exception of Estonia, no such catalyst has emerged in central Europe. Pressure on incumbents coupled with incentives for competition will provide a catalyst for broadband adoption.

4. Practise what you preach. Government can play two important roles as as an ICT user. The first is by demonstrating the benefits of ICT use through concerted e-government and e-health initiatives to bring public services online. In the second, in order to promote and reward innovative behaviour, governments should become "smart purchasers", favouring those suppliers that use ICT to offer innovative services and better value for money. By dint of its sheer weight in the economy, this type of government procurement can help to aggregate demand for new products and services.

Patrick de Smedt, chairman of Microsoft EMEA, puts "leading by example" at the top of his prescriptions for policymakers. He argues that governments that directly invest in ICT, for example by offering e-health services, can do much to build awareness of ICT benefits among SMEs and the broader public. His view is widely shared by other business leaders we interviewed and surveyed for this report. Such initiatives form a central plank of the eEurope 2005 action plan, and many EU governments—including a few accession countries—have made considerable progress in bringing services online.

As the public sector transacts more of its business

online, it will be incumbent on its suppliers in the private sector to keep pace. The eEurope 2005 action plan calls for most public procurement to be conducted electronically by the end of 2005, and some countries are moving faster towards this goal than others. In the UK, for example, any firms that want to work with local authorities will have to be able to do business online by 2005. This requirement underscores the importance of ICT-related skills training and awareness programmes, particularly ones targeted at smaller firms.

5. Encourage more effective R&D activity.
Governments account for a large portion of R&D spending in Europe—32% in 2002 according to Eurostat's most recent figures—and through their indirect stewardship of universities have considerable influence on how research institutes operate. Nurturing European centres of R&D excellence that can compete for contracts and researchers with the US leaders requires long-term action in numerous areas. However, shorter-term initiatives that can yield benefits for European firms include:

- boosting the portion of R&D funds earmarked to applied rather than pure research;
- supporting public-private mechanisms enabling SMEs collectively to access the results of university or other R&D;
- encouraging universities to establish closer ties with companies for R&D purposes; and
- actively sponsoring pilot projects to demonstrate the benefits of R&D.

Better support for technology-specific pilot projects features highly on business leaders' wish lists for government action, judging by our survey and interviews. Such projects help bring together important ingredients in the innovation mix—including venture capital, secure networks and skills training—in powerful demonstrations of the role that ICT can play in business and society. Elie Simon, president EMEA for Sun Microsystems, places great store in the concept of "niche ecosystems". These ecosystems bring together research excellence and business experience to turn innovative ideas into commercially successful products.

Many large companies in Europe are eager to farm out research to university-based institutes, but some need to be more flexible on issues of intellectual property ownership and reward-sharing to keep universities interested. For their part, the universities need to show no lesser degree of flexibility. Also, large firms such as Nokia, Ericsson and Philips have been extremely supportive of community-based pilot projects and often play prominent roles in them.

The buck stops with the managers

In the preceding pages we have suggested ways in which European policymakers and business leaders need to remain on the offensive. It is hoped that the results of their efforts will be a much more positive environment for the efficient use of ICT. But ultimate responsibility for using ICT more effectively to improve workplace productivity lies with the executives and staff of European organisations, public and private sector alike. It is up to managers to exploit the fruits of the initiatives discussed above and translate them into more productive use of their ICT assets: the productivity buck stops here.

Appendix A
Empirical analysis: background and explanation

The Economist Intelligence Unit conducted a cross-section empirical analysis of 60 countries covering the years 1995-2002. This is the period in which a structural break in productivity trends for some countries has been hypothesised, linked with the use and production of ICT goods and services. The year 1995 is also significant as the approximate time when the world wide web began to emerge as a mass information medium. In addition some of the most important indicators of ICT diffusion, such as Internet use, are not relevant or available for earlier periods. The dependent variable in all our regressions is average annual growth in real GDP per head during this timeframe.

Examining post-1995 growth and its relationship to ICT in a cross-section context complements previous empirical studies, but also has several advantages:

- The standard growth accounting framework that is usually employed to measure the contribution of ICT to growth in individual countries is not conducive to isolating the all-important impact on total productivity of ICT as a general purpose technology.
- A cross-section framework offers the opportunity of controlling for other factors that affect growth (and thereby helps avoid the risk of confusing the role of ICT with other variables). This framework allows us to assess whether ICT and growth are linked across a large and more heterogeneous sample of countries.
- The Economist Intelligence Unit's approach also has advantages over existing cross-section studies, in that most of these have focused on ICT investment across countries. Despite the considerable work that has gone into making the ICT investment measures comparable across countries, a number of question marks about the comparability of these investment figures remain. We used instead a "physical" indicator of ICT endowments (use and infrastructure), based on a composite index of various ICT indicators.
- The EIU model allows us to estimate the impact of ICT on growth differences between countries—for example between the US and EU. The framework was also used for medium-term growth forecasting, and to investigate if "threshold effects" operate – that is whether ICT only has an impact on growth once a certain minimum level of ICT development is achieved.
- The model allowed us to investigate possible inter-action effects—for example between ICT and government policies or ICT and skill levels. In addition, the EIU's business environment model enables us to investigate the role of various policy and business environment variables (measured by a synthetic index covering labour, product and financial markets) and their possible interaction with ICT.

The Economist Intelligence Unit's model is well-behaved in that in the full 60-country sample all the standard determinants of growth, and necessary control variables from the point of view of identifying an ICT effect, are shown to have a significant impact. The equations explain a very high percentage of the inter-country variation in growth; in the case of the developed countries in particular, the percentage was much higher than is usual in cross-section estimates. This greatly boosts confidence in our findings about

the role of ICT.

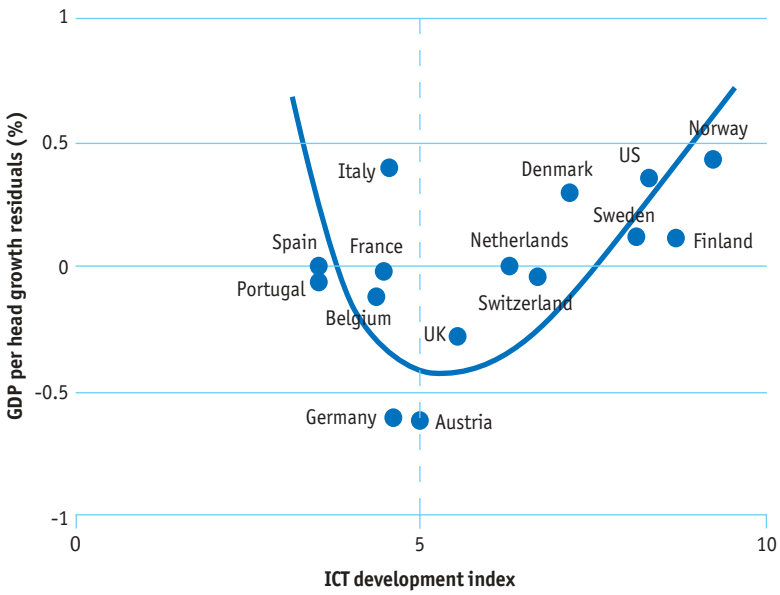
The explanatory variables in the initial specification of a standard "neo-classical model" (equation 1 in table 1) include initial income levels, investment shares, demographic variables (rate of growth of total population and rate of growth of population aged 15-65), and a measure of educational endowments/human capital. To increase the explanatory power of the framework—and also to have more control variables before assessing the impact of ICT—we also introduce other variables that have been used in previous empirical studies. These include a dummy variable for major oil-producing countries, a measure of the openness of economies, a measure of real exchange-rate variability and our composite index of the quality of the business environment and micro-economic policies. (Further explanations of these variables are provided following table 1).

Only one outlier is identified in the sample—Ireland (for which we introduce a dummy variable)—that is the variables in the model only explain a small proportion of the very high growth achieved in Ireland during this period.

Given the possible reverse causality between growth and ICT development, we use an ICT composite variable of ICT at the start of the period, rather than a contemporaneous ICT measure (that is, one averaged over the 1996-2002 period) or a measure of ICT at the end of the period. This variable is found to have a statistically significant positive impact on growth once all the other variables are controlled for (equation 3 in table 1).

This is a significant result because the ICT variable may not have survived in such a multi-variable setting. The results also suggest that schooling, ICT and the quality of the business environment are inter-related, though no evidence is found for any explicit interaction effect between ICT and policy variables or ICT with skill levels.

ICT development and GDP per head growth residuals, Europe and the US, 1996-2002



This chart relates ICT development to growth in GDP per head, after non-ICT growth determinants have been controlled for. The y axis represents the residuals (predicted growth minus actual growth) in a regression equation that relates growth in GDP per head to non-ICT variables.

The implied relationship between ICT and growth is non-linear, graphically described by a U shape. This means that at low levels of ICT development (the downward sloping part of the curve), the various costs and disruptions caused by the introduction of ICT outweigh the benefits—any increases in ICT are actually associated with a decline in the rate of growth. Above a certain level of ICT development (the upward-sloping part of the curve), network effects from a minimum mass of ICT in the economy and the experience derived from earlier ICT development mean that the benefits of increasing ICT outweigh any costs—increases in the ICT index are clearly associated with increased growth. The threshold in the chart where ICT development begins to have a positive effect on growth in GDP per head is indicated by a dotted line.

Source: Economist Intelligence Unit

Developing countries

It is possible, as much of the literature on this subject argues, that the relationship between ICT and growth is very different in developed and developing countries. For this reason we split our sample into two: a developed country group (26 countries) and an emerging markets sample (34 countries). Countries with per head GDP at purchasing power parity (PPP) of more than US$11,000 in 1995 are assigned to the

Table 1

	Equation 1 Coefficients	t Stat	Equation 2 Coefficients	t Stat	Equation 3 Coefficients	t Stat
Constant	1.7204	0.6386	2.8405	1.4070	11.0409	3.5639
Ln GDP pc	-0.9022	-2.5293	-0.9697	-3.6772	-2.0894	-5.6645
INV	0.1771	4.3269	0.1350	4.3517	0.1151	4.2097
POPg 15-65	1.0840	2.5327	1.4608	4.1441	1.7805	5.6249
POPg total	-1.5760	-3.2168	-2.0889	-5.4315	-2.7549	-7.3175
SCHOOL	0.6274	3.3684	0.4606	3.3591	0.2468	1.8528
Ireland			4.9350	4.6164	4.7512	5.0394
OIL			1.2485	2.7090	1.6337	3.9810
OPEN			2.3304	4.3296	2.4352	4.8861
REER			-8.6141	-3.5945	-7.3643	-3.4990
BUSENV					0.4076	2.1835
Ln ICT1					1.3911	2.3808
R2	0.437		0.712		0.783	
N	60		60		60	

Ln GDP pc—natural logarithm of GDP per head in 1995 at PPP, US$.

INV—average share of fixed investment in GDP (at current prices) in 1996-2002.

POPg 15-65—average annual rate of growth of population aged 15-65.

POPg total—average annual rate of growth of total population.

SCHOOL—the mean years of schooling of the adult population in 1995. Available direct measures of years of schooling have been shown to be deficient in various respects. There are also many missing country values. We thus construct a proxy measure for mean years of schooling that is comparable across countries, on the basis of primary, secondary and tertiary enrolment ratios (primary in 1985 and secondary and tertiary in 1990). To construct this estimate, direct measures of the mean years of schooling for countries for which they are available are regressed on enrolment ratios. The resulting equation is used to derive our estimate of mean years of schooling of the adult population for all countries in the sample.

Ireland—dummy variable for Ireland.

OIL—dummy variable taking value of 1 if a country is a major oil exporter; 0 otherwise. Over the long term, the relationship between growth and oil dependence has been found to be negative. However, this need not be the case in the short and medium term. Indeed, in our sample, spanning a seven-year period, the relation is found to have been significantly positive. There were 10 major oil producers in the sample.

OPEN—Updated Sachs-Warner index of openness: a country is rated as an open economy according to the following four criteria: (1) average tariff rates below 40%; (2) average quota and licensing coverage of imports of less than 40%; (3) a black-market exchange-rate premium that averaged less than 20%; and (4) no extreme controls (taxes, quotas, state monopolies) on exports. If a country satisfies all the criteria it is assigned a 1; if not a 0. The vast majority of the countries in the sample—53—were rated as open.

REER—the standard deviation of annual percentage changes in the real effective exchange rate, 1996-2002. This variable captures the effect of exchange rate and financial crises suffered by some countries during this period.

BUSENV—an index constructed by the Economist Intelligence Unit of the business environment (on a 1-10 scale) based on indicators grouped in the following categories: policy toward private enterprise, financing conditions, the tax regime, the macroeconomic environment and labour markets. The overall index is a simple average of the five category sub-indexes.

ICT1—is a composite indicator of ICT for 1995-96, the start of the growth period under investigation. It is constructed on the basis of data for:
1. Fixed telephone lines penetration (lines per 100 population).
2. Mobile phones penetration (per 100 population).
3. Personal computers (number per 100 population).
4. Internet users (per 100 population).

Each indicator is transformed into an index scaled 1-10 (using minimum and maximum values of the indicator in our country sample). The composite ICT infrastructure/use index, on a 1-10 scale, is a simple average of the 4 component indexes.

Table 2

	1		2		3	
	Coefficients	t Stat	Coefficients	t Stat	Coefficients	t Stat
Constant	17.1387	3.0515	21.2354	3.4749	24.9549	5.1393
Ln GDP pc	-2.1840	-3.6787	-2.6461	-4.0388	-2.1148	-3.9894
INV	0.0682	2.3232	0.0711	2.4937	0.0703	3.1788
POPg 15-65	2.1199	3.4445	2.0015	3.3262	1.5819	3.2841
POPg total	-2.9603	-3.9237	-2.8601	-3.8956	-2.2675	-3.8183
BUSENV	0.1965	1.3845	0.1611	1.1542	0.3249	2.7556
Ireland	4.3531	8.7674	4.5476	9.1157	4.6139	11.9140
SCHOOL	0.4520	4.6828	0.4130	4.2494	0.4275	5.6651
Ln ICT			0.6167	1.4737	-11.3163	-3.3080
Ln ICT* Ln ICT					3.3112	3.5041
R2	0.903		0.909		0.945	
N	26		26		26	

developed country sample.

The results of the regression for the developing countries confirm the view that ICT and growth are unrelated at lower levels of development; the ICT variable is not found to be related to growth in the developing country sample. The estimated equation for the developing groups explain a similar, high proportion of the variation in growth in 1995-2002 as in the full-country sample (80%), with all the basic explanatory variables achieving high statistical significance.

Developed countries

The 26 developed country equations explain an even higher share of 1995-2002 growth for those countries than the results for the full 60-country sample—an extremely high 95% in equation 3 of table 2, which is very unusual in cross-section investigations. It is also surprising given the smaller sample, and much less variation in key variables than in the full sample.

ICT is found to have a significant impact, but in non-linear, quadratic form (equation 3 in table 2). The square of the ICT variable is significant and has a positive impact, while the ICT variable itself has a negative impact on growth. This indicates a threshold effect — increases in ICT start to have a positive effect on growth only above a threshold level of development of ICT.

The importance of the education variable is very strong, whereas it was not significant in the developing country sample.

Sources of growth

We can use our results to estimate that about 0.4 percentage points of the difference in growth between the US and euro zone big 3 (France, Italy and Germany) was due to ICT—which is comparable to other findings. The growth advantage that the euro zone economies had in terms of lower initial GDP per head (the catch-up potential) and higher investment rates is roughly cancelled out by the effects of the US's superior business environment and schooling. This leaves the ICT variable accounting for the major part of the 0.52 percentage point difference in average growth.

Forecasting

We can also use our framework to generate medium-term forecasts (using equation 3 of table 3). To do this we use the EIU's forecasts of investment shares in GDP in 2004-08, the starting level of GDP per head (in 2003, expressed in 1995 PPPs), UN and EIU forecasts for the demographic variables, and forecasts of the

Table 3 Sources of differences in average growth in GDP per head between US and Eurozone big 3 (Germany, France, Italy), 1995-2002

Initial GDP pc	-0.62
INV	-0.24
DEMOGRAPHY	0.08
BUSENV	0.47
SCHOOL	0.69
ICT	0.43
Estimated difference in growth	0.80
Actual difference in growth rates	0.52
Unexplained residual	-0.28

average quality of the policy and business environment in 2004-08 from the EIU's business environment rankings model.

The ICT index that we use for the forecasts (ICT2) is different from the ICT index used for estimating growth in 1995-2002. ICT variables are time-specific, and cannot be easily compared over time, given technological change. Thus we construct a more sophisticated measure of ICT use and infrastructure for 2002-03 (ICT2), which we use in our forecasting exercise. To accomplish this we use some of the EIU's

Table 4	ICT1 1995-96	Rank	ICT2 2002-03	Rank	ICT "enablers" index 2002-03	Rank	SCHOOL 2003	Rank	BUSENV 2004-8	Rank
Australia	6.52	6	7.51	12	9.49	3	11.1	3	7.35	20
Austria	4.98	16	6.62	17	9.00	12	9.6	17	7.79	13
Belgium	4.49	19	6.38	19	8.58	15	11.0	5	7.71	17
Canada	6.27	7	7.65	9	9.22	6	9.9	14	8.27	9
Denmark	7.58	5	8.25	3	9.54	1	10.2	11	8.84	4
Finland	8.85	2	7.60	10	9.20	7	11.4	1	8.54	7
France	4.52	18	5.97	22	8.41	19	9.8	15	7.65	18
Germany	4.73	17	7.07	15	8.71	13	9.1	20	7.73	15
Greece	3.45	26	4.77	26	7.08	26	9.0	21	6.59	26
Hong Kong	6.12	10	7.82	7	9.22	5	7.3	26	9.06	1
Ireland	4.45	20	6.21	21	9.02	11	9.8	16	8.24	11
Israel	5.13	15	6.37	20	8.41	18	9.0	22	7.27	22
Italy	4.00	22	5.94	23	8.21	22	8.9	23	6.89	25
Japan	5.77	13	6.56	18	7.93	23	9.2	19	6.98	24
Netherlands	5.94	12	7.76	8	8.36	20	10.3	9	8.41	8
New Zealand	6.08	11	6.82	16	8.42	17	10.2	11	8.18	12
Norway	9.41	1	7.91	5	9.13	8	10.7	7	7.74	14
Portugal	3.52	25	4.92	25	7.73	25	9.5	18	7.20	23
Singapore	6.18	9	8.06	4	9.07	10	7.6	25	8.73	5
South Korea	4.01	21	7.53	11	8.31	21	11.0	4	7.34	21
Spain	3.52	24	5.55	24	8.57	16	10.3	8	7.54	19
Sweden	8.36	4	8.48	2	9.44	4	11.4	2	7.73	16
Switzerland	6.26	8	7.83	6	8.71	13	8.7	24	8.91	3
Taiwan	3.86	23	7.09	14	7.91	24	10.0	13	8.27	10
UK	5.50	14	7.37	13	9.52	2	10.3	9	8.95	2
US	8.50	3	8.64	1	9.12	9	10.8	6	8.66	6

Table 5

Growth rates of real GDP per, annual average 2004-08, %

	Actual 1995-2002	Forecast 2004-08
Australia	2.65	2.62
Austria	1.98	2.00
Belgium	1.94	2.83
Canada	2.70	2.09
Denmark	2.00	2.80
Finland	3.52	3.36
France	1.99	1.83
Germany	1.33	1.46
Greece	3.14	2.20
Hong Kong	1.61	1.04
Israel	0.35	1.13
Italy	1.52	1.03
Japan	0.88	0.47
Netherlands	2.24	2.34
New Zealand	1.95	2.97
Norway	2.39	2.80
Portugal	2.41	2.53
Singapore	1.28	1.72
South Korea	3.87	3.96
Spain	2.95	2.70
Sweden	2.58	3.52
Switzerland	0.91	1.79
Taiwan	3.36	2.99
UK	2.41	2.45
US	2.14	2.12
EU-15	2.07	2.07

'e-readiness' qualitative indicators. The ICT2 measure consists of the four connectivity variables used for ICT1 and six other measures: the number of Internet servers per million population, broadband penetration and four qualitative variables from the e-readiness rankings, based on a 1-5 scoring system. The qualitative variables are transformed to a 1-10 scale, so that all ten indicators that make up ICT2 are on a 1-10 scale. (ICT2 is a simple average of the ten indicators). The four qualitative indicators assess the quality of Internet connections, the development of e-business, the development of online commerce and the exposure of the population to the Internet ("Internet literacy").

We also construct an index of 'ICT enablers' (on a 1-10 scale), indicators that are likely to be closely associated with or conducive to ICT development. These include:

- Affordability. The cost of 20hrs of Internet access, as of national income
- A qualitative indicator of competition in the telecoms market.
- A qualitative indicator of the security of the Internet infrastructure.
- An indicator of the government's role (government encouragement and financing for ICT, and extent of censorship).
- An indicator of laws covering the use of the Internet.
- An indicator of the ICT skills of the workforce.
- A measure of the quality of ICT supporting services.

Forecasts of average annual growth in GDP per head for 2004-08 are presented in Table 5. Forecast average EU-15 and US growth is the same as in 1995-2002, which suggests that the EU will not resume the long-term, pre-1995 trend of narrowing the gap with the US in average income levels. About 0.5 percentage points of the difference between US growth and growth in slower-growing, major euro zone economies is again attributable to ICT. Although the forecast EU average in 2004-08 is exactly equal to the 1995-2002 actual figure, there will be greater variability in individual EU economies' performance – with some countries accelerating their growth, which in part is related to ICT developments.

Appendix B: Bibliography

Ahmad, Nadim, Paul Schreyer and Anita Wölfl, 2004, "ICT Investment in OECD Countries and Its Economic Impacts", Chapter 4 of Forthcoming OECD Report.

Bartelsman, Eric and Jeroen Hinloopen, 2002, "Unleashing Animal Spirits: Investment in ICT and Economic Growth", *mimeo*.

Bartelsman, Eric, Andrea Bassanini, John Haltiwanger, Ron Jarmin, Stefano Scarpetta and Thorsten Schank, 2002, "The Spread of ICT and Productivity Growth – Is Europe Really Lagging Behind in the New Economy?", Fondazione Rodolfo DeBenedetti, *mimeo*.

Basu, Susanto, John Fernald, Nicholas Oulton and Sylaja Srinivasan, 2003, "The Case of the Missing Productivity Growth: Or, Does Information Technology Explain Why Productivity Accelerated in the US but not the UK?", NBER Working Paper, No. 10010.

Brynjolfsson, Erik and Lorin Hitt, 2000, "Beyond Computation: Information Technology, Organizational Transformation and Business Performance", *Journal of Economic Perspectives*, 14, p.23-48.

Colecchia, Alessandra and Paul Schreyer, 2002, "The Contribution of Information and Communication Technologies to Economic Growth in Nine OECD Countries", OECD Economic Studies, No. 34.

Colecchia, Alessandra and Paul Schreyer, 2001, "The Impact of Information and Communications Technology on Output Growth", Paris: OECD, STI Working Paper 2001/7.

Daveri, Francesco, 2001, "Is Growth an Information Technology Story in Europe Too?", IGIER Working Paper No. 168.

European Commission, 2003, "European Competitiveness Report 2003," Commission Staff Working Document

Gordon, Robert, 2003, "Five Puzzles in the Behavior of Productivity, Investment and Innovation", *Global Competitiveness Report 2003-2004*, World Economic Forum.

Gordon, Robert, 2002, "High-Tech Innovation and Future Productivity Growth: Does Supply Create Its Own Demand?", *Global Competitiveness Report 2002-2003*, World Economic Forum.

Gust, Christopher and Jaime Marquez, 2002, "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices", International Finance Discussion Papers, No. 727, Board of Governors of the Federal Reserve System.

Huveneers, Christian, 2003, "ICT Diffusion and Firm-level Performance: Case Studies for Belgium," Brussels: Federal Planning Bureau Working Paper 8-03.

Jorgenson, Dale, Mun Ho and Kevin Stiroh, "Lessons for Europe from the U.S. Growth Resurgence", CESifo Economics Studies, Vol. 49, 1/2003, pp 27-47.

Kegels, Chantal, Mary van Overbeke and Willem Van Zandweghe, 2002, "ICT contribution to economic performance in Belgium: preliminary evidence – Revision of WP 7-02," Brussels: Federal Planning Bureau Working Paper 8-02.

OECD, 2003, "ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms", Paris: OECD.

Oulton, Nick, 2001, "ICT and Productivity Growth in the United Kingdom", Bank of England Working Paper, No. 140.

Pilat, Dirk and Anita Wölfl, 2004, "ICT Production and ICT Use – What Role in Aggregate Productivity Growth", Chapter 5 of Forthcoming OECD Report.

Piatkowski, Marcin, 2003. "The Contribution of ICT Investment to Economic Growth and Labor Productivity in Poland 1995-2000", Warsaw: Tiger Working Paper Series No. 43.

Solow, Robert, 1987, "We'd Better Watch Out", *New York Times Book Review*, No. 36 (July 12).

Timmer, Marcel, Gerard Ypma and Bart van Ark, 2003, "IT in the European Union: Driving Productivity Divergence?", Research Memorandum GD-67, Groningen: Groningen Growth and Development Centre.

Triplett, Jack and Barry Bosworth, 2002, "'Baumol's Disease' Has Been Cured: IT and Multifactor Productivity in U.S. Service Industries," Paper Prepared for the Texas A&M Conference, The New Economy: How New?, How Resilient?

Van Ark, Bart and Mary O'Mahony, editors, 2003, "EU Productivity and Competitiveness: An Industry Perspective; Can Europe Resume the Catching Up Process", European Commission, Directorate General Enterprise.

Van Ark, Bart, 2003, "The Productivity Problem of the Dutch Economy: Implications for Economic and Social Policies and Business Strategy", Research Memorandum GD-66, Groningen: Groningen Growth and Development Centre.

Van Ark, Bart, Robert Inklaar and Robert McGuckin, 2002, "Changing Gear: Productivity, ICT and Services: Europe and the United States", Research Memorandum GD-60, Groningen: Groningen Growth and Development Centre.

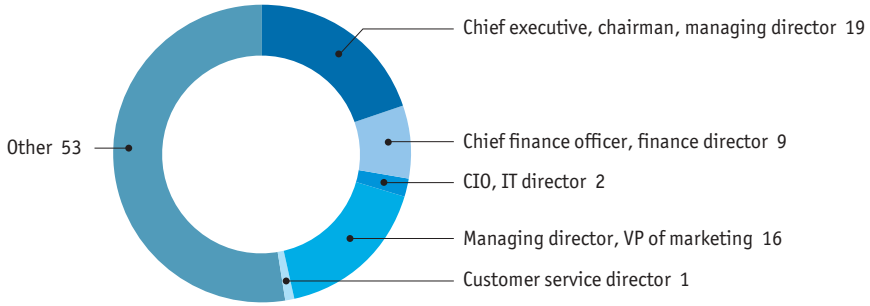
Zhen-Wei Qiang, Christine, Alexander Pitt and Seth Ayers, 2003, "Contribution of Information Communication Technologies to Growth", Washington, D.C.: World Bank Working Paper No. 24.

Appendix C: Survey results

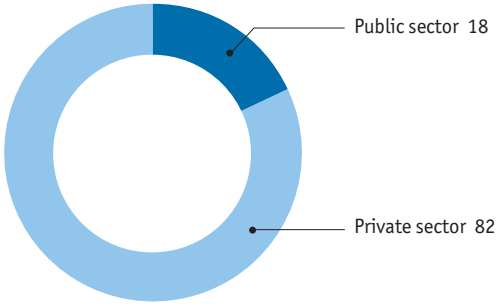
What role does information and communication technology (ICT) play in improving corporate productivity? How do European countries compare with other global markets in providing an attractive environment for ICT investment and innovation? This survey, which is by the Economist Intelligence Unit and sponsored by Microsoft, seeks to answer these crucial questions.

Demographics

Which of the following job titles describes your role best?
(% respondents)



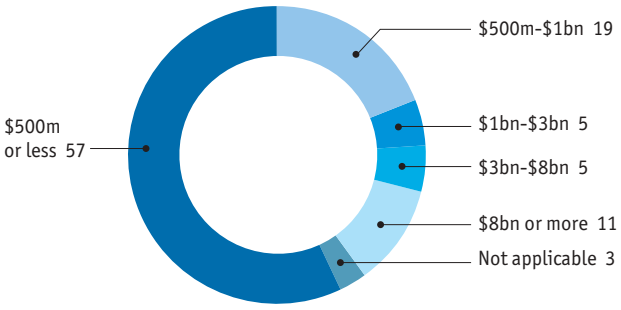
Is your organisation in the public or private sector?
(% respondents)



4. Please tell us what industry or sector your organisation is in.
(% respondents)

Financial services	16
Telecoms, software and computer services	14
Professional services	12
Construction and real estate	8
Healthcare, pharmaceuticals and biotechnology	8
Automotive	4
Chemicals and textiles	3
Education and training	3
Electronic and electrical equipment, household goods and products	3
Transport	3
Travel and tourism	3
Engineering and machinery	2
Food, beverages and tobacco	2
Leisure, entertainment, media and publishing	3
Mining, oil and gas	2
Retailing	1
Civil service	1
Social services	0
Aerospace and defence	0
Agriculture	0
Utilities	0
Other	10

What is your organisation's annual turnover?
(% respondents)



The business environment

How would you rate the overall sophistication of ICT infrastructure in the following countries?
(% respondents)

	1 Excellent	2 Average	3 Below average
1. Belgium	41	53	6
2. Cyprus	4	46	50
3. Czech Republic	6	45	48
4. Estonia	9	27	64
5. France	61	35	4
6. Germany	74	22	4
7. Hungary	6	59	35
8. Ireland	61	38	1
9. Italy	25	67	7
10. Latvia	0	37	63
11. Lithuania	0	27	73
12. Malta	4	43	53
13. Netherlands	79	17	4
14. Poland	5	52	43
15. Slovakia	5	27	68
16. Slovenia	7	41	53
17. Spain	28	65	6
18. Sweden	85	14	1
19. United Kingdom	81	14	5
20. USA	82	14	5
21. India	33	31	36
22. China	12	33	55

Which of the following countries have the highest levels of ICT literacy as an average across the whole population?
(% respondents)

	1 Very high	2 High	3 Low
1. Belgium	28	63	9
2. Cyprus	4	30	66
3. Czech Republic	5	42	53
4. Estonia	8	30	62
5. France	35	55	11
6. Finland	78	18	4
7. Germany	56	42	2
8. Hungary	5	61	34
9. Ireland	50	43	7
10. Italy	22	63	15
11. Latvia	7	28	65
12. Lithuania	3	28	69
13. Malta	0	37	63
14. Netherlands	66	34	0
15. Norway	78	18	4
16. Poland	4	61	35
17. Slovakia	1	38	61
18. Slovenia	5	33	62
19. Spain	23	64	13
20. Sweden	84	15	1
21. Switzerland	73	26	1
22. United Kingdom	70	28	2
23. USA	74	22	3
24. India	28	32	40
25. China	10	34	56

How important are the following aspects of the business environment in enabling your company to benefit from ICT?
(% respondents)

	1 Extremely important	2	3	4	5 Unimportant
1. A deregulated and competitive telecoms sector	37	33	19	8	3
2. Government policies to promote diffusion of technology among consumers	29	33	26	10	2
3. Availability of finance to fund innovation and new ventures	32	35	25	5	3
4. Robust legal framework and law enforcement to protect online trade	39	24	27	6	4
5. Effective laws to protect intellectual property	34	27	23	9	6

What are the biggest internal barriers to maximising the benefits of ICT?
(%; respondents could provide a maximum of two answers)

Lack of ICT knowledge in senior management	38
Business and IT executives not working together effectively	34
Inadequate integration between different technologies in the business	30
Cost constraints	29
Inability to manage and harness data effectively	23
Flawed project planning or implementation	23
Lack of ICT skills in workforce	22
Employee resistance to change	22
Other	3

What are the main external barriers to maximising the benefits of ICT?
(% respondents)

Technology too often badly matched to business needs	37
Lack of commonly adopted technology standards	37
Poor ICT infrastructure	29
Lack of visibility of total cost of ownership for technologies	22
ICT skills shortage	21
Pace at which technologies become obsolete	21
Poor after-sales services from ICT vendors	16
Lack of incentives to foster innovation and ICT investment	14
Restrictive working practices	14
Publicity ramifications of automating jobs	5
Other	2

Which of the following government initiatives are most beneficial for fostering a strong ICT-producing sector?
(% respondents)

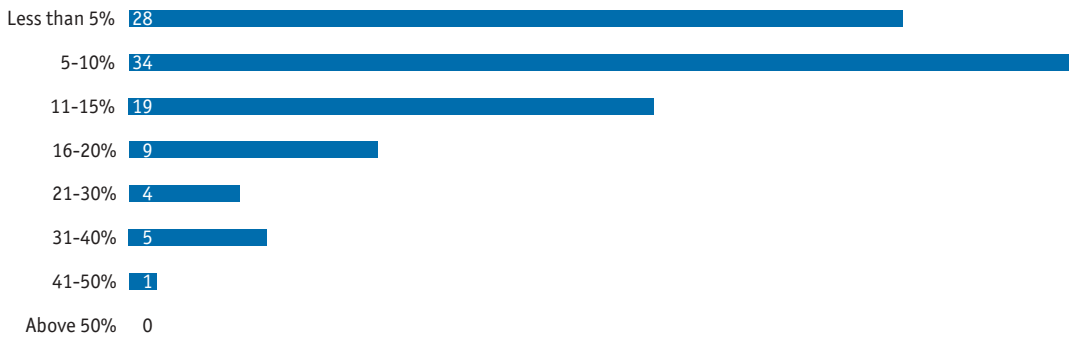
Promotion of common technology standards	36
Policies to promote competition in the ICT sector	35
Government leading the way in innovative use of ICT	35
Schemes to promote access to higher bandwidth services	34
Availability of good ICT education in primary and secondary schools	33
Initiatives to encourage technology transfer from universities	29
Encouragement of foreign direct investment in ICT sector	23
Financing schemes for ICT-related investment	22
Availability of specialist high tech qualifications in further and higher education	10
Policies to attract ICT skilled immigrants	10
Policies to promote labour mobility	9
Policies to redress under-representation of women in ICT jobs	2
Other	1

Which of the following government initiatives are most important to promote the diffusion of ICT in a country?
(% respondents)

Government innovation in providing online services to citizens	44
Availability of good ICT education in primary and secondary schools	43
Government schemes to promote universal access to PCs and Internet	41
Schemes to promote access to higher bandwidth services	36
Policies to promote competition in the ICT sector	34
Promotion of common technology standards	32
Development of e-democracy	15
Regulation to protect consumer interests	19
Other	0

Harnessing ICT in business

What proportion of your organisation's overall budget did you invest in ICT in the last 12 months?
(% respondents)



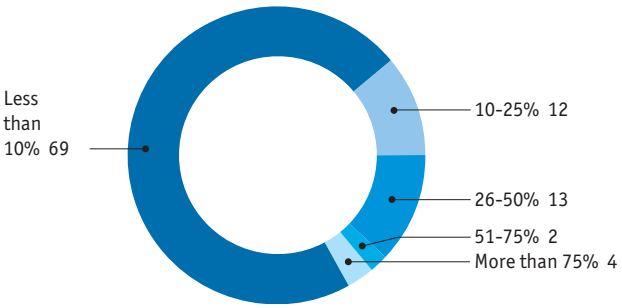
What are your plans for investment in ICT in the next 2 years?
(% respondents)

Over 100% increase in investment	6
50-100% increase in investment	11
25-50% increase in investment	10
10-25% increase in investment	21
Up to 10% increase in investment	22
Same level of investment	25
Up to 10% decrease in investment	3
10-25% decrease in investment	2
25-50% decrease in investment	0
50-100% decrease in investment	0

What proportion of the following business processes are automated in your company?
(% respondents)

	1 Under 10%	2 10-25%	3 25-50%	4 51-75%	5 75-100%
1. Sales transactions	35	15	19	12	19
2. Back office	8	20	26	28	18
3. Supply chain processes	21	23	31	14	10
4. Customer servicing	24	22	23	21	9
5. Production	21	29	20	18	13
6. Procurement	20	25	29	14	12
7. Management reporting	6	7	39	24	24

What proportion of your products or services are sold online?
(% respondents)



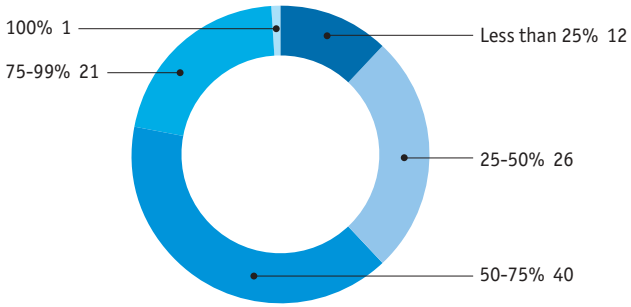
What are the most important factors in your decision to invest in a new technology?
(% respondents)

Functionality and performance	60
Flexibility to adapt to changing requirements	36
Initial cost of technology	28
Simplicity of deployment and management	26
Cost of ownership/maintenance	22
Reliability	21
Open, standards based technology	15

Which of the following are important in your selection of solutions providers for ICT?
(% respondents)

Quality of solutions	80
Price of solutions	67
Long term relationship with provider	49
Global provider	34
Local provider	24
Brand reputation	22
Ability to provide turnkey solutions	21

What proportion of your ICT projects meet their business objectives?
(% respondents)



Which of the following types of ICT initiative have done the most to increase productivity in your business?
(% respondents)

Improved management information	51
Communication and collaboration between employees	48
Customer relationship management	33
Integration of existing data/technologies	33
Remote/mobile working	23
Enterprise resource planning	21
Technologies for knowledge capture and dissemination	21
Outsourcing of IT services	20
Supply chain integration	19
Online sales and marketing channels	14

Which of the following offer the greatest opportunity for productivity gains in the next 3 years?
(% respondents)

Improved management information	47
Customer relationship management	41
Communication and collaboration between employees	32
Supply chain integration	31
Integration of existing data/technologies	29
Technologies for knowledge capture and dissemination	25
Remote/mobile working	23
Online sales and marketing channels	21
Enterprise resource planning	16
Outsourcing of IT services	14

On average how long does it take your company to achieve return on investment from ICT projects?
(% respondents)

Less than 6 months	6
6-12 months	17
12-18 months	33
18 months to 2 years	30
3-4 years	13
5 years or over	1

What management strategies do you use to maximise the value of ICT?
(% respondents)

We monitor the performance of IT department and service providers against service level agreements	53
We use targets and metrics to measure return on investment from ICT initiatives	40
We measure total cost of ownership for our key technology platforms	32
We formally review our ICT suppliers on a regular basis	29
We offer incentives to encourage innovation at all levels of the business	26
We operate schemes to encourage remote and flexible working	25
Senior management is regularly briefed on emerging disruptive technologies	20

How do you measure the benefits of ICT in your organisation?
(% respondents)

Impact on productivity	55
Impact on profitability	40
Return on investment models	32
Impact on customer retention	23
Speed to market	21
We don't use measures to evaluate ICT benefits	15

Whilst every effort has been taken to verify the accuracy of this information, neither The Economist Intelligence Unit Ltd. nor the sponsors of this report can accept any responsibility or liability for reliance by any person on this white paper or any of the information, opinions or conclusions set out in the white paper.

LONDON
15 Regent Street
London
SW1Y 4LR
United Kingdom
Tel: (44.20) 7830 1000
Fax: (44.20) 7499 9767
E-mail: london@eiu.com

NEW YORK
111 West 57th Street
New York
NY 10019
United States
Tel: (1.212) 554 0600
Fax: (1.212) 586 1181/2
E-mail: newyork@eiu.com

HONG KONG
60/F, Central Plaza
18 Harbour Road
Wanchai
Hong Kong
Tel: (852) 2585 3888
Fax: (852) 2802 7638
E-mail: hongkong@eiu.com