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Wonders will never cease: Prospects for a new economy in Europe

Computers can figure out all kinds of problems,
except the things in the world that just don't add up.
James Magary

Christopher Hurst

Kristian Uppenberg

1. Introduction

The late 1990s saw one of the most rapid diffusions of a new technology seen in history. Within the space of 5 years the number of Internet users reached 50 million. This compares with the 13 years required by TV to reach the same number of users in the 1950s and 1960s, and the 40 years that radio took in the first half of the 20th century.

Coupled with the rapid spread of Internet came a speculative bubble in high-tech companies. Throughout the last five years of the 1990s, some USD 150 billion were raised by US Internet-related companies via venture capital injections and IPOs. It has now become the common view that much of this was a transfer of wealth from foolish investors to the staff of "dot-coms", and the customers and advisors of these companies, rather than investment properly said. However, at the time it seemed that a new industrial revolution was underway.

At the same time, the US economy set its own record, by continuing strong growth long after the "normal" business cycle. Could there be special reasons why new records were being set? It did not take a genius to put these two factors together and to conclude that a "new economy" based upon information technology, and particularly the Internet, had arrived.

Interestingly, more detailed analysis does show a remarkable turnabout in the productivity of the US economy during in the late1990s. There seems to have been something more going on than "irrational exuberance" by investors and the creation of a new pastime of Internet surfing. Section 2 explores this literature in more detail. The focus here, and in the rest of this paper is on the possible consequences of information and communications technologies (ICT) on long-term productivity growth. We largely put to one side the many other possible dimensions of a new economy that have arisen in the public debate, including a less volatile business cycle and higher future corporate profitability. Specifically, we view the core of the matter as whether investment in these technologies can boost medium-to-long-term growth prospects, even if they do nothing to prevent future economic or financial volatility. Just as the surge in stock prices or the wealth-driven consumption boom of the 1990s may have contained little tangible evidence of our definition of a "new economy," so their reversal is equally incapable of refuting it.

The macroeconomic evidence does suggest that ICT has played an important role in boosting US productivity. However, both the size of the impact and the extent to which it is spread through the economy depend upon a number of assumptions. The phenomenon is simply too short-lived for there to be adequate data to definitively identity the impact of ICT investment. Therefore, in Section 3 we turn to microeconomic reasoning on the likely impact of ICT on firms. While comparisons with the great inventions of the past goes too far, the conclusion is that ICT does appear to have the potential

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to make a significant contribution to economic growth over the medium-term, though only when a certain number of conditions are met.

The focus here is on the possible consequences of ICT on long-term growth, rather than the many other possible dimensions of a new economy.

Thus, we turn our attention to Europe and ask where the continent stands in the adoption of these technologies. Section 4 addresses this issue. In general, we find a number of causes for concern. While there are certainly some market segments where European companies perform well, it seems unlikely that EU ICT production will generate the same kind of contribution to overall growth as that seen in the US. For the economy as a whole there is also a question of the optimal structure of investment. Europe is investing relatively more in telecoms than the US, but is spending substantially less on information technology (IT).

However, talking of Europe as one economic mass hides large differences between countries, some of which seem to have as "new" economies as the US. While large regional differences also exist within the US, we believe this topic merits particular reflection in the case of EU, not least because differences among EU regions are largely addressed via transfers of one form or another to support investment - including ICT (1). Section 5 addresses the question of what ICT means for the geographical distribution of economic activity. Will we see the "death of distance" or highly concentrated clusters of economic activity?

Unequal performance within Europe, and between Europe and the US is also due to a number of institutional factors that influence the rate of innovation in an economy and the extent to which it can exploit new ideas to the fullest. Section 6 briefly explores some of these issues, including computer-related skills, the functioning of labour markets, and the financing of innovative start-up companies.

Finally, section 7 concludes with a summary the main lessons we have learnt from this exercise.

2. Macroeconomic evidence of a new economy in the United States

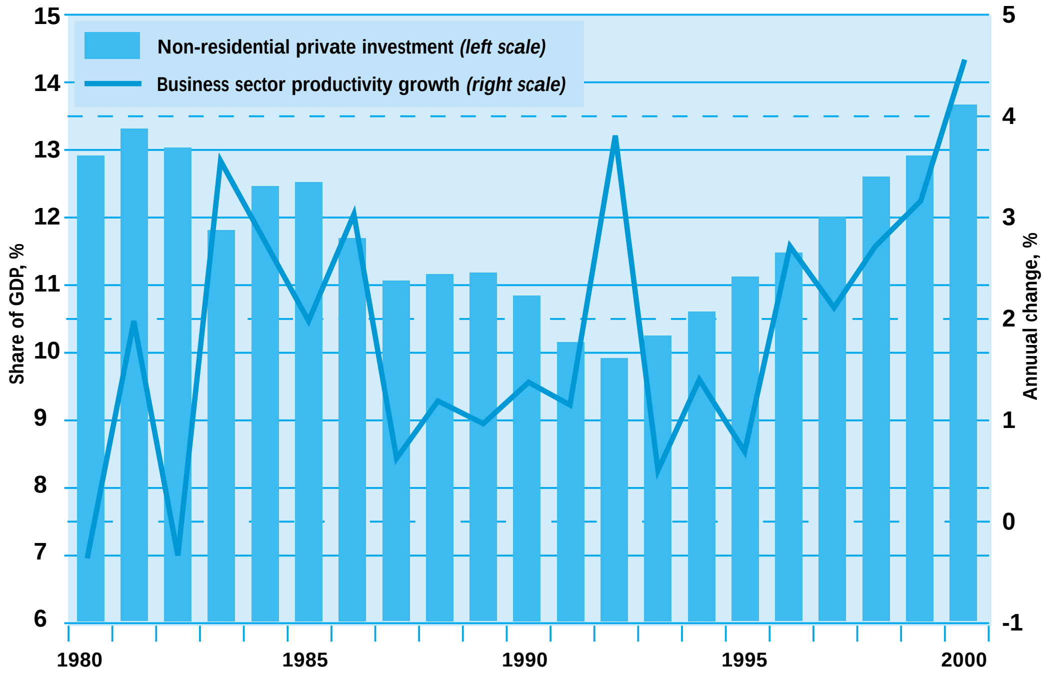
2.1 The growth in US labour productivity in the 1990s

Let us start with a brief recap of the recent performance of the US economy. After an unspectacular recovery from recession at the beginning of the decade, the US economy gained momentum in the second half of the 1990s. Real GDP growth accelerated from 2.4% on average in 1991-95 to 3.9% in 1996-2000. While the low unemployment rate is an impressive feature of the US economy, it is nevertheless not a key element in the acceleration of US growth in recent years. Average annual employment growth did accelerate from 1.0% in 1991-95 to 1.6% in 1996-2000, but this figure remains below the averages for previous decades (2). Rather than employment growth, the key element behind higher economic growth in the second half of the 1990s is output per man-hour worked, i.e. labour productivity. In the business sector of the economy, labour productivity growth accelerated from 1.5% annually in 1991-95 to 3.3% in 1996-2000. The paper by David (this volume), gives some more detail on the evolution of GDP and labour productivity growth in the US in recent decades.

1) See Volume 5, Number 1, of the EIB Papers *for more discussion of European regional development policy.*

2) Average annual civilian employment growth in fact slowed from 2.4% in the 1970s, to 1.8% in the 1980s and 1.3% in the 1990s.

Figure 1. US labour productivity growth in the business sector and private investment as a share of GDP



Source: Council of Economic Advisers (2001)

As suggested by Figure 1, part of this acceleration is the result of an extraordinary rise in private non-residential investment. This increased in nominal terms from around 10% of GDP at the beginning of the decade to 14% in 2000. The link from capital formation to productivity is straightforward, as the instalment of new machinery and equipment makes it possible for any given number of workers to produce more output. If capital formation is expanded at a faster rate than employment, the ratio of capital to labour increases. This is also known as capital deepening.

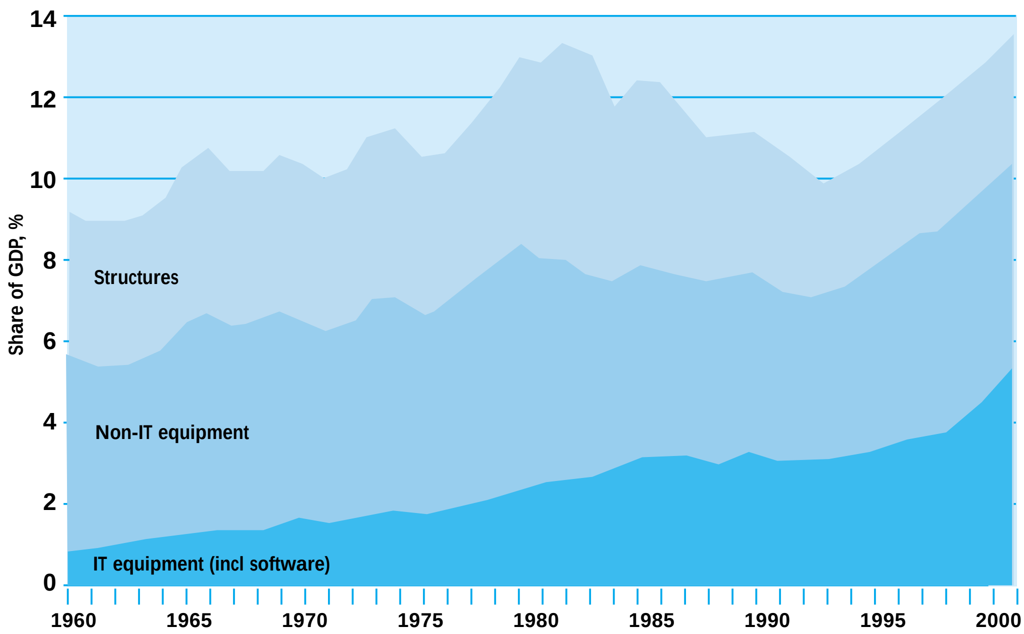
Part of the acceleration in US labour productivity growth is the result of an extraordinary rise in private non-residential investment. IT has accounted for much of this.

Figure 2 shows that investment in IT (as reported by the US Bureau of Economic Analysis - note that following normal US practice here we talk mainly of IT, excluding some communications) has accounted for most of the increase in non-residential investment in recent years (3). Thus, much of the capital deepening in this period must also have been due to IT equipment.

These two pieces of evidence are key to the notion that there is something "new" about the US economy in the second half of the 1990s; however, they are not enough to justify talk of a new economy, since an investment boom can also be fuelled by temporary factors. For example, the replacement of computer systems due to the Y2K bug may have stimulated IT investment. More generally, the 1990s has seen a shift from wages towards corporate profits which, combined with higher leverage, has fuelled corporate investment. Whether these factors will be sustained in the medium-term remains uncertain. A stronger sign that the US economy's growth potential has permanently improved lies rather with total factor productivity (TFP).

3) The figure shows a nominal ratio. In real terms, the rise in both total and IT investment is more dramatic as a result of the decline in the price on IT equipment. This is discussed further in a later section.

Figure 2. The structure of business investment in the US



Source: Council of Economic Advisers (2001)

2.2 Sources of US labour productivity growth

The surge in total factor productivity in the late 1990s

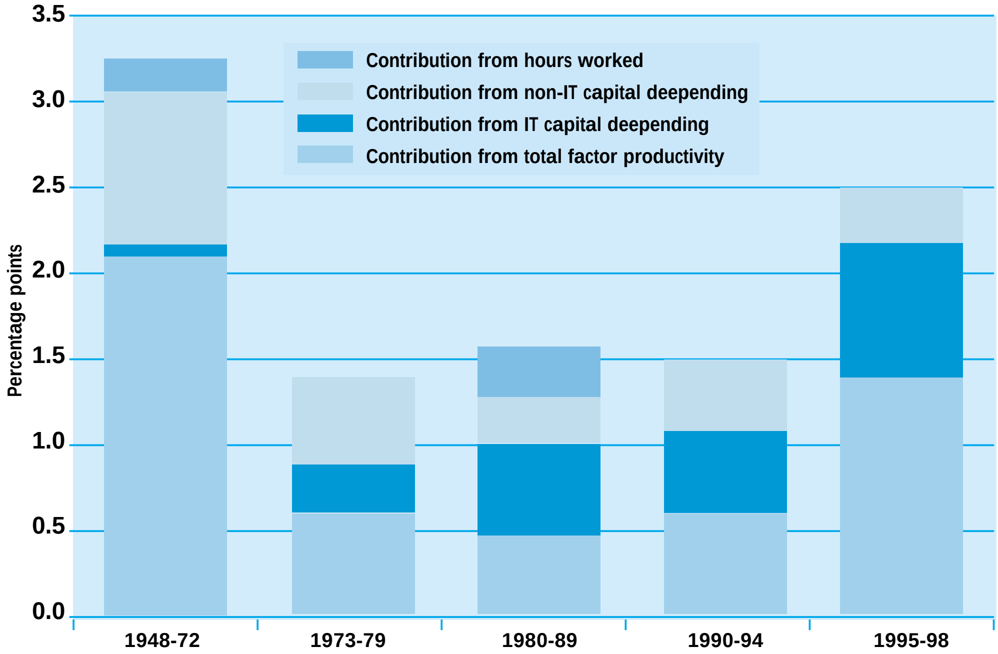
In the neoclassical growth model, output is a function of capital, labour and TFP. Since all these variables except TFP can be observed, the growth equation can, under some simplified assumptions, be inverted to produce TFP as a residual (see Quah, and Vanhoudt and Onorante, both in this volume). By definition, TFP is that part of output that cannot be directly inferred from increases in the quantities of capital and labour inputs, and thus refers to the quality of these inputs and how well they are being used in the economy. There are many ways in which a better utilisation of factors of production can be attained. For example, a more skilled labour force is likely to make more productive use of any given amount of hours worked. New knowledge from R&D is likely to increase TFP growth in a similar way. So long as human capital and knowledge are not included specifically as factors of production in the growth equation, they will instead boost the TFP residual.

Economists seem to have reached an uneasy consensus that the increased production and diffusion of ICT is a key element behind the rebound in TFP growth in the late 1990s.

Figure 3 shows the results of one such growth accounting exercise. It documents more explicitly how US labour productivity growth has very much been an IT capital deepening story, while the contribution from capital deepening in other equipment and infrastructure peters away to nothing throughout the 1990s. Figure 3 also shows how the long period of poor TFP growth from 1973 onwards was suddenly reversed in the mid-1990s. Although the historical puzzle around the post-1973 slowdown has remained unresolved, the rebound since 1995 does appear to have an explanation. Economists who have investigated the matter seem to have reached an uneasy consensus that the increased production and diffusion of IT is a key element.

A handful of papers have taken centre stage in this debate in the past year, the main results of which we report in Table 1. While adopting somewhat similar growth-accounting approaches, there are also some important differences that make comparisons less than straightforward. For example, Oliner and Sichel (2000), use data for private non-farm business GDP, while Jorgensen and Stiroh (2000), use data for private domestic output. Still, the two papers come to similar explanations for the increase in productivity: IT capital deepening dominates that of other equipment and structures. However, TFP growth is even more important than capital deepening, and this comes from both IT producing and using sectors. A third study by the Council of Economic Advisers (2001), concludes even more strongly that IT capital deepening and TFP growth in IT using sectors are by far the main factors at play. These results are encouraging for those who believe that IT is revolutionising the way economic activity is conducted, since it suggests that IT leads to positive spillovers throughout the economy.

Figure 3. US labour productivity growth, by source



Source: US Bureau of Labor Statistics

However, at the opposite end of this debate, a fourth paper by Gordon (2000), attributes the entire contribution of TFP to the acceleration in productivity in the IT-producing sectors of the economy. This implies that it is only the manufacture of computers that has benefited from great technical advances, with little evidence of positive spillovers from the use of IT in the rest of the economy.

The stark contrast between Gordon's results and those of the other papers largely stem from how the data is adjusted for cyclical fluctuations. The growth accounting framework assumes the economy is always working at full output. However, this is clearly not the case as the economy moves through the business cycle (4). This can be corrected by averaging data over long periods -

4) David (this volume) provides the additional insight that ICT could have boosted the pro-cyclical nature of productivity growth, both by improving inventory management during the cyclical upswing, and because the sector itself is associated with substantial economies of scale.

long enough to capture an entire business cycle. The problem is that the break in the pattern of productivity is only observable for a relatively short period after 1995. Neither Jorgenson and Stiroh nor Oliner and Sichel have taken cyclical factors into consideration in their analyses. Gordon, on the other hand, has assumed that the current business cycle displays a pattern similar to earlier expansions. Following this assumption, he concludes that as much as 0.5 percentage points of the acceleration in labour productivity growth is cyclical. The Council of Economic Advisers also accounts for cyclical fluctuations, but with a methodology that yields more upbeat conclusions than Gordon. Unfortunately, this controversy is likely to remain unresolved until the economic expansion has fully run its course, the truth probably lying somewhere in between (5).

Table 1. Sources of the acceleration of US labour productivity growth in percentage points

	Jorgenson & Stiroh 1990-95/ 1995-98	Oliner & Sichel 1990-95/ 1995-99	Council of Economic Advisers 1973-95/ 1995-00	Gordon 1972-95/ 1995-99
Acceleration in labour productivity growth	0,9	1,0	1,6	1,3
of which:				
Capital deepening	0,3	0,5	0,4	0,3
- IT capital deepening	0,2	0,5	0,6	n.a.
- Non-IT capital deepening	0,1	0,0	-0,2	n.a.
Labour quality	-0,1	-0,1	0,0	0,1
Total factor productivity	0,7	0,7	1,2	0,3
- Production of IT goods	0,2	0,3	0,2	0,3
- Other sectors	0,5	0,4	1,0	0,0
All other factors, including cyclical adjustments	n.a.	n.a.	0,0	0,6

Source: Council of Economic Advisers (2001); Gordon (2000); Jorgenson and Stiroh (2000); Oliner and Sichel (2000). Differences are due to rounding

Measurement problems

Apart from cyclical factors, a number of measurement issues also risk distorting the picture.

Apart from cyclical factors, a number of measurement issues also risk to distort the picture. Productivity estimates are calculated using real output and input data, i.e. nominal figures deflated by a price index. This exercise is straightforward for products that do not change much over time, but becomes problematic when the rate of quality improvement is rapid. To address these problems, the United States has since 1996 applied quality-adjusted - or “hedonic” - pricing when deflating nominal IT output and investment to obtain real volumes (see Vanhoudt and Onorante, this volume). Instead of deflating nominal computer output data by an average computer price index, the hedonic price deflator is adjusted for changes in a number of performance-related characteristics, such as

5) The quarterly variation in business cycles is large enough to support all sorts of patterns; however, the smoothed business cycle in the US in the 1990s does show a different pattern from the historical average (see, for example, Schweitzer, 1998).

memory size and speed. As a result of rapid technical progress in the manufacturing of semiconductors, this hedonic price index has been falling at a rapid pace (at over 25% annually) in recent years. When this price index is used to deflate nominal IT output, real output growth is boosted accordingly. Since the amount of labour going into the manufacture of computers is growing at a much lower pace, such rapid growth in real output also generates high labour productivity growth.

Given that the usefulness of computers is determined by their computing capacity, the shift to hedonic pricing has improved the accuracy of how the real economy is measured. Nevertheless, there are unresolved questions as to how well the technical performance of computers reflects their economic value. For example, if computers are at least partially used for tasks that do not depend on their improved capacity (such as word processing and e-mail), then the shift to hedonic pricing may exaggerate investment. In other words, the future revenue stream from computer purchases may not be related to quality of the equipment bought. Vanhoudt and Onorante (this volume) show how changing from an average price index to hedonic index boosts both investment and estimates of TFP growth. On the other hand, quality improvements in in-house software are not treated in a hedonic way, so the benefits of improvements here are not captured.

In fact, this debate soon arrives at more general measurement issues. For example, both Jorgensen and Sichel (2000) and the US Commerce Department's *Digital Economy 2000* show that typically IT intensive service sectors displayed much lower productivity growth in the 1990-97 period than less IT-intensive service industries. Here again measurement issues may be at play. Triplett and Bosworth (2000), for example, argue that IT investment may have created new forms of output that are not properly identified. In banking, for instance, ATM machines have made bank transactions easier and more readily available, while debit and credit cards have reduced the need to use cheques. To the extent that measures of bank output focus on traditional transactions, such as the number of cheques processed, bank output - and hence productivity - is being underestimated (6).

David (this volume), also argues that the personal computer aided a shift towards "mass customisation" and an increase in the number of new products in the 1980s. As official government price indices tend to miss the rapid fall in prices that occur early in the life of new products, there may have been a transitory downward bias in measured productivity growth between the mid-1970s and early 1990s (when this process seems to have come to a halt).

These questions are a useful reminder of just what a synthetic and indicative number GDP actually is. But where does that leave us as regards the existence, or not, of a new economy?

If higher TFP growth is restricted to computer production, then there must be some unease that quality-based price indexing is overstating the value of computers.

2.3 A final word from the macroeconomic data

Firstly, there is little doubt that capital deepening from computer investment played an important role in boosting US labour productivity. Secondly, there is broad agreement that the US economy experienced an increase in total factor productivity in the late 1990s. However, this can be whittled away to increased productivity in the production of computers alone under one set of assumptions,

6) The US Commerce Department has tried to circumvent these measurement issues by excluding a number of hard-to-measure sectors. They then find in the remaining sectors that ITintensive services do exhibit higher productivity growth. The problem is that many of the excluded sectors are exactly those highly IT-intensive sectors where we would like to know what has happened (such as finance).

or boosted to an even larger and broad-based improvement under another set. If the gains are restricted to computer production, then there must be some unease that hedonic, quality-based, price indexing is overstating the value of computers that are being bought.

At the same time, the Council of Economic Advisers' more detailed sectoral analysis finds a notable acceleration in labour productivity growth in wholesale and retail trade (5 and 4 percentage points, respectively). These are sectors where companies have invested heavily in IT in recent years, accompanied by a wave of reorganisation and restructuring. Can it really be that IT investment has not been a critical factor in increasing productivity here? The next section turns to microeconomics and company experience to see if more insights can be gained at this level of analysis.

3. How has IT influenced firms?

3.1 The pay-off from IT investment

Many reasons for the US slowdown in overall productivity growth after 1973 have been advanced, including the oil shocks, inadequate public investment and a declining skill level in the work force. A curious factor was that computer investment - in mainframe computers in the 1970s, followed by the PC revolution in the 1980s - did not have a measurable positive impact on productivity growth until the mid-1990s.

David (1990, 1991, and this volume), suggests that the initial inability of computers to affect productivity growth could be because long adjustment periods are needed for an economy to fully benefit from a revolutionary new technology (7).

Long adjustment periods are needed for an economy to fully benefit from a revolutionary "general purpose technology". The example of the electrical dynamo illustrates this.

David uses the example of the electrical dynamo to illustrate this. Before the dynamo, factories run by the steam engine were constrained by the fact that production had to be concentrated in the engine's immediate vicinity. This imposed limitations on the productivity of the manufacturing process. Production and assembly of components often could not be organised sequentially, leading to costly waiting periods, large stocks and the constant reallocation of intermediate goods within the factory. The electrical dynamo revolutionised production by allowing a larger number of smaller engines to be scattered throughout the factory. The great productivity gains from introducing the dynamo thus came not from the fact that electrical engines were necessarily faster or stronger than steam engines, but that they facilitated more efficient organisation of the work. Unsurprisingly, it took decades for factories to be reorganised and for the full gains to be realised, but there was an overall surge in productivity growth once a certain critical mass was passed (8).

David argues that there are parallels between the interconnection of electric motors through wired grids - and the associated transformation of manufacturing practices - and the interconnection of computers via communications networks. That the capacity to process information has a major

7) Bresnahan and Trajtenberg (1995), have introduced the concept of "general purpose technologies" in this context.

8) Though the electrical generator was introduced by Edison in 1881, older technologies continued to dominate factories well into the early 1900s. In fact, the new electric power technology only gained momentum after the First World War, when major investment in power plants and transmission capacity produced rapid efficiency gains in electricity generation. The impact on productivity growth from around 1920 and onwards was substantial. David estimates that the acceleration in labour productivity growth in the US manufacturing industry, from 1.5% annually in 1899-1914 to 5.1% in 1919-29, was largely accounted for by higher TFP growth.

impact on business structures fits in with a long line of research on transaction costs as the determinant of optimal organisations (Williamson, 1981). For example, it has been argued that the traditional hierarchical business structure that emerged in the early 20th century was a way of minimising the number of communications links within an organisation (Malone, 1987, and Radner, 1993). Thus, the substantially lower cost of information and communications has increased the scope to outsource some activities, and has shifted the optimal organisation from one of vertical command towards laterally linked groups (see, for example, Lipsey, 1999).

A number of empirical studies do identify a positive correlation between IT investment and firm profits. For example, Brynjolfsson and Yang (1999), show (9) that the stock market values investment in IT capital by a factor of 10. This finding does not imply that there is a 10-to-1 payoff from IT investment, but rather that the firm that has a dollar of computers typically has another nine dollars of related intangibles assets. In line with this, Bresnahan, Brynjolfsson and Hitt (2000) show that skills, education, and greater use of delegated decision-making raises the value of IT investment. Thus, it is the combination of IT investment, organisational innovation and human capital investments that create the intangible assets that the stock market values so highly (10). One consequence of this is that IT may be a skill-biased technical change in the sense that the demand - and hence the wages - of skilled workers will increase relative to the unskilled. We return to this topic in Section 6 when institutional issues are briefly reviewed.

It is the combination of IT investment, organisational innovation, and human capital that creates the intangible assets that the stock market values so highly.

3.2 So what about the Internet?

The previous observations would suggest that it is a coincidence that the productivity gains from IT became visible at the same time (i.e. after 1995), that Internet use took off. These gains were instead the result of intra-firm organisational changes following IT investment in earlier periods.

Still, the Internet, as a major step in the diffusion of the interconnected computer network through the economy, is fully consistent with the model of the new economy set out above. The OECD (2000a) suggests that especially in business-to-business (B2B) relations, e-commerce technologies offer affordable solutions for many ubiquitous processes such as distribution, sales, after-sales service and inventory management. Importantly, such solutions are likely to become more cost-effective the more of a firm's suppliers and customers go on-line. To be effective, e-commerce technologies need to be applied all along the business value chain in an integrated fashion.

Though the figures are still very tentative, a number of estimates do show the potential for considerable reductions in costs across a wide range of sectors. For example, Goldman Sachs (1999), have estimated B2B e-commerce cost savings for the US economy, ranging from less than 15% in heavy industry, to 20-30% in services and traditional manufacturing and above 30% in electronics. Litan and Rivlan (2000), also report on a series of studies on cost savings from the use of the Internet. One of these studies uses the computer company Cisco Systems as a benchmark for manufacturing, and estimates that annual cost savings of between 1 and 2 percent per annum should be possible over the next 5 years for the manufacturing sector as a whole.

9) With data for the Fortune 1000 firms over the 1987 to 1994 period.

10) To return to measurement issues, Brynjolfsson and Hitt (2000), suggest that macro-level studies may have severely underestimated the benefits from investing in computers as intangible assets are poorly accounted for in the national accounts.

Even though over one-half of US households now have Internet access, the volume of business-to-consumer (B2C) e-commerce has remained relatively small, with about 1 percent of retail sales in the US taking place via the Internet. The additional profits from these B2C transactions with respect to traditional retail outlets are also likely to be relatively modest (11). Indeed, Gordon (2000), suggests that much of the higher spending on web sites by traditional retailers is simply motivated by the need to keep their customers from going to online competitors - a zero-sum game with no aggregate gains. On the other hand, there do seem to be a number of services where shifting large number of routine transactions from paper to a web based technology offers the potential for significant savings. Examples include insurance claims, tax payments, basic customer enquiries and the like. And part of the success of Dell Computers comes from the use of the web to attract customer orders, and to provide advice and technical support. From this, Dell has developed a customer-driven build-to-order business model that gives as much as 10 percent advantage over rivals in terms of production costs (Brynjolfsson and Hitt, 2000).

The Internet will considerably aid the spread of new business models for supply-chain management throughout the economy.

The extent to which the Internet will generate wealth through the creation of completely new information-related goods and services remains to be seen. However, it seems safe to say that the Internet will considerably aid the spread of new business models for supply-chain management throughout the economy. It will act as an important catalyst for many of the changes we have mentioned before.

3.3 A few conclusions from the firm level on the benefits of IT

US firms have been investing heavily in IT in the last few years. To argue that this is nothing more than part of a high-tech bubble (12) appears to be taking new economy scepticism to the extreme. Could it really be the case that such huge IT spending is only the result of a herd instinct of managers to own the latest computer fad? While there may certainly have been inappropriate spending in some instances, firm-level studies show that large cost savings are possible from the use of IT. These benefits do not come from doing the same thing faster, but from using IT as the basis for organisational change and the introduction of new business models.

The comparison between this process and the introduction of electricity raises the hackles of IT sceptics (see, for example, Gordon, 2000), and it is perhaps too much to put IT in the same league as the great inventions of the past. As TFP growth in the US economy in the “era of electricity” (that is, from 1919 to 1929) was of the order of 2 percent per annum, it is also clear that it would be truly remarkable if the new economy were to deliver more than this on a sustained basis. Still, if the benefits from IT-motivated business restructuring are significant, and this effect diffuses steadily through the bulk of the economy, then there would be a sustained period of robust total factor productivity growth. For us, this is sufficient to be described as a new economy phenomenon, even though the impact on growth must eventually disappear when the entire economy is working with best practices (13).

11) To illustrate this point, Oliner and Sichel (2000), use the estimated 10% price difference on CDs between traditional and on-line retailers as a rough indication for the efficiency gains from e-commerce. Multiplying these savings with total online sales, they find that the total cost reductions amounted to only 0.2% of output in the nonfarm business economy in 1999.

12) For example, Stephen Roach, the Chief Economist of Morgan Stanley Dean Witter has put it in these terms: “Blind acceptance of every tantalising twist of the ITproduct cycle quickly became the norm in business circles. There was no rhyme or reason to ITbudgeting... America’s binge on information technology outstripped any conceivable productivity pay back”. (Financial Times, 15.02.2001).

13) In other words the <u>permanent</u> increase in TFP growth required by Vanhoudt and Onorante (this volume), is perhaps too demanding a condition.

It is interesting to note that it is the US computer production industry itself that has been a leader in developing new IT related business models to manage supply and reduce inventory costs. As such, at least part of the productivity gains in US computer manufacture may be a sign of things to come elsewhere in the economy.

4. Prospects for a new economy emerging in Europe

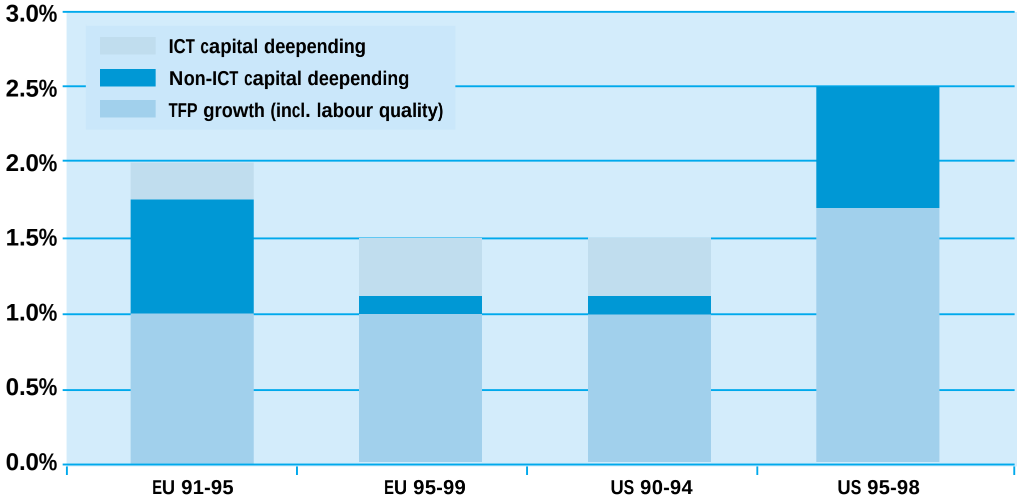
4.1 European productivity growth in the 1990s

In stark contrast to the rebound in the United States, Europe has seen continued deceleration of productivity growth during the 1990s.

How well has Europe done when compared to the American powerhouse? Unfortunately, and in stark contrast to the rebound in the United States, Europe has seen continued deceleration of productivity growth during the 1990s. Figure 4 shows how EU labour productivity slowed from around 2% in the first half of the 1990s to around 1.5% in the second half (14). This slowdown is largely due to weak investment growth in the EU. The European investment-to-GDP ratio was either falling or stagnant in each year between 1990 and 1997. As would be expected, the contribution from capital deepening (in all forms of capital) to labour productivity growth declined, from 1 percentage point in 1991-95 to 0.5 percentage points in 1995-1999.

In notable contrast to the United States, the contribution to labour productivity growth from TFP in Europe showed no major change throughout the 1990s. TFP growth during this decade, at 1.0 percent per annum, continued the decline during the previous three decades (from 1.2 percent per year in the 1980s, 1.8 percent per year in the 1970s, and 3.0 percent per year in 1960s) to arrive at the same low level as that seen in US during the 1973-1995 period (15).

Figure 4. Average annual labour productivity growth by source



Source: European Commission (2000a), US Bureau of Labor Statistics

14) Figure 4 is only indicative in that it is based on a growth accounting exercise with GDP data for the EU (by the European Commission) and data on the private sector for the United States (by the Bureau of Labor Statistics). While the two calculations are not fully comparable, GDP data for the United States suggest that the differences arising from using these different measures are small.

15) It should be noted that part of the growth in labour productivity in Europe (i.e. of those in work) in earlier decades came from an increase in unemployment - essentially by downsizing or shutting down the least productive companies.

Measurement issues complicate comparisons

If measurement issues meant that interpreting US GDP data was open to debate, international comparisons are even more problematic. The US adopted a new system of national accounts in 1999, and also revised historical data according to the new rules. One key aspect of this shift in definition was that software outlays were counted as investment rather than current expenditures, thus adding directly to GDP. A second change introduced in the United States was the shift towards the hedonic, quality related, price indices we mentioned before. These changes, both of which boosted real GDP growth, were partially offset by the introduction of chain-weighted price indices, where no single year is used as a base-year for the deflator. This has tended to reduce the growth rate of GDP, especially in economies experiencing large shifts in the composition of the economy, such as the United States. Adding these elements together, Seskin (1999) has estimated that the shift to new ways of measuring the US economy has boosted real GDP by 0.4 percentage points on average in 1992-98.

The EU has also followed the recommendations of the new international accounting standard, but has been slower than the United States in implementing the changes. For example, European software expenditures are also supposed to be counted as investment, but in practice the incomplete collection of such data has forced statistical agencies to rely on highly uncertain estimates when aggregating GDP data. In addition, only a few EU countries have begun using hedonic pricing for ICT goods (in line with normal European practice we revert to using the general expression of information and communications technologies, unless we specifically wish to make a distinction between the IT and communications sub-components).

Significantly better US productivity growth is likely to remain, even if the data could be accurately adjusted for measurement differences.

The different pace with which all these changes are being introduced means that the difference in labour productivity seen in Figure 4 is likely to be exaggerated. Stripping out the contribution of software investment and hedonic pricing from the official data, Vanhoudt and Onorante (this volume), show that the difference between US and EU productivity shrinks substantially (i.e. the US estimate drops towards the EU level). However, this is an over-correction. Significantly better US productivity growth is likely to remain, even if the data could be accurately adjusted for measurement differences.

Capital deepening - estimates of the role of ICT

If - going the opposite direction from Vanhoudt and Onorante - it is assumed that US hedonic pricing is correct and that the relative decline of the (quality-adjusted) price of ICT in the US has been the same everywhere, then an estimate for real ICT investment in Europe can be generated. From this, it is possible to split capital deepening into a contribution from traditional equipment and structures, and a contribution from new ICT technologies. The results of one such exercise (by the European Commission, 2000a) was included in Figure 4 (16). It is striking how similar the EU of the late 1990s is to the US of the early 1990s. While ICT capital deepening accelerated in Europe in the late 1990s, its contribution to labour productivity remained only about half the figure seen in the United

16) Additionally, it is necessary to assume a rate of return on ICT capital (set at the real interest rate in this particular calculation), and an assumed elasticity of substitution for ICTcapital goods is needed to calculate the growth of the ICTcapital stock in earlier periods when annual investment data is not available (the Commission develops two scenarios with an elasticity of 1.0 and 1.5: Figure 5 is based upon the latter number). Similar studies have been performed by Schreyer (2000), and Daveri (2000). Note that in Figure 4 the contribution of ICT capital deepening was simply subtracted from the total for capital deepening estimated with national account data.

States during the same period. Interestingly, nearly all capital deepening in Europe comes from ICT, other investment only being sufficient to balance the depreciation of the existing capital stock.

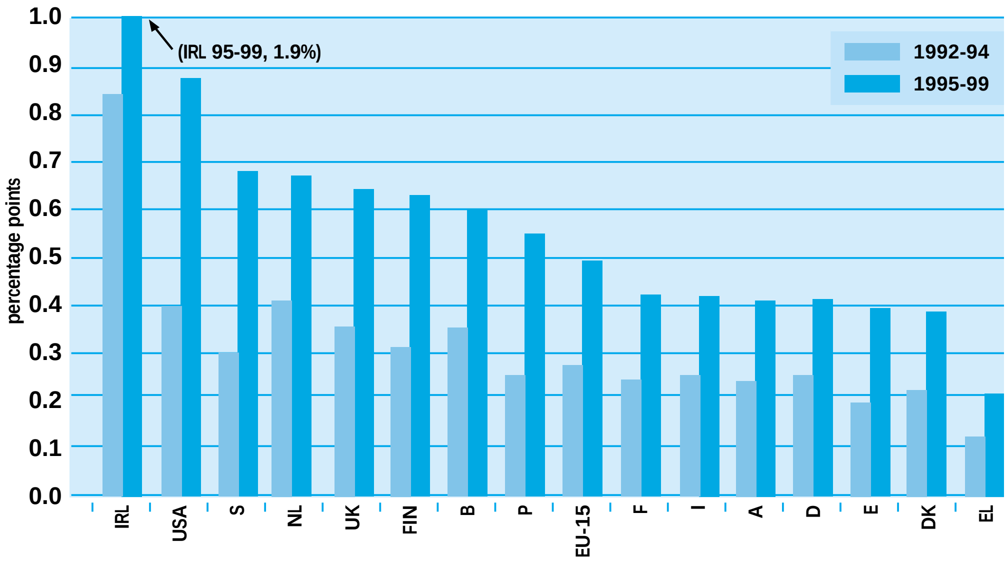
However, the EU average hides substantial diversity across countries. Figure 5 shows that the contribution to GDP growth from ICT capital deepening has been much lower in the large continental economies (and in the Mediterranean) than in the US. The gap with the US is closed substantially in some other countries (such as the Sweden, the Netherlands, the UK and Finland), while Ireland is off the scale.

These estimates are likely to be overestimates, as the assumption that price declines in Europe have matched those in the US is overly optimistic. For example, Gruber (this volume), illustrates how the price of a particular computer converges to the same level in both the US and EU, but how there may be a large difference in the first year of introduction. These initial differences are important when the composition of equipment is changing rapidly. Indeed, if market structure and the mix of ICT purchases are different, then it is unlikely that the same price changes take place everywhere. If quality-adjusted price declines in Europe were only one-half the rate seen in the US, the contribution of ICT capital deepening in the EU would drop to four-fifths of the numbers seen in Figure 5 (see European Commission, 2000a), and a significant gap opens up even with the European front-runners.

Some European countries - in the northern and north-western periphery of the EU - may also be candidates to be considered as "new economies".

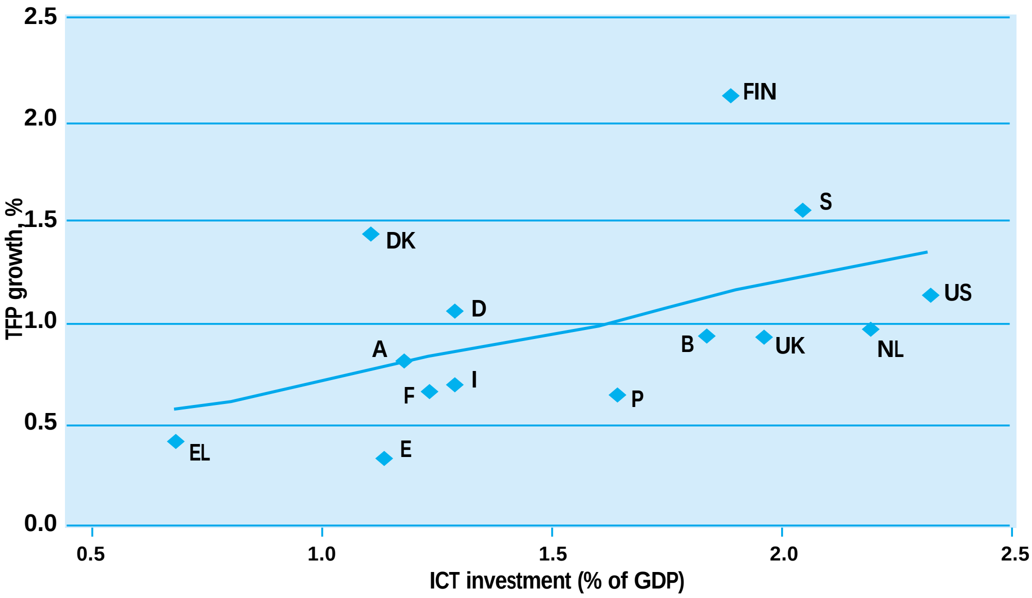
It is interesting that when we go down to the country level there are also substantial differences in TFP growth, with the better performers also being those countries that have spent more on ICT. For example, Figure 6 plots TFP growth against ICT investment. Despite the possibly spurious nature of any relationship between these two variables, it does illustrate that some European countries may also be candidates to be considered as "new economies". These are to be found in the northern and north-western periphery of the EU, and include Sweden, Finland, Denmark, Ireland, the Netherlands and the United Kingdom.

Figure 5. Contribution of ICT capital deepening to output growth



Source: European Commission, 2000a, Table 5, p. 126.

Figure 6. TFP growth and ICT investment (averages for 1992-98)



Source: European Commission (2000a) for investment and Vanhoudt and Onorante (this volume) for TFP growth.
Note: Ireland is excluded from the chart for scaling reasons. Its TFP growth was 3.5 percent during the period while the ICT investment expenditure ratio was 5 percent.

As mentioned before, causality from ICT investment to TFP growth can be due to the fact that the ICT equipment and services are produced domestically, and this exhibits large productivity gains, or because the use of ICT works as a catalyst for organisational change in the economy as a whole. Let us consider each issue in a bit more detail. Are these channels for future economic prosperity likely to exist in Europe? We start with a look at the EU ICT sector.

4.2 The competitive position of European ICT production

The OECD (2000b), reports that value added in the overall ICT sector in 1997 stood at 8.7% of the business sector in the United States, compared with 6.4% for the European Union. A study by Credit Suisse First Boston (2000), also shows that value-added in ICT production in the US has been growing much more rapidly than in Europe (17). The different performance was reflected in a value added per person employed in the ICT sector (i.e. labour productivity) that was 70% higher in the United States than in Europe (1997 data from OECD, 2000a).

That the United States has attained a strong lead in ICT trade is also suggested by its large bilateral trade surplus vis-à-vis Europe. And these figures may not capture a substantial amount of de-facto re-exports of US value-added from Ireland.

Its higher productivity growth suggests that the US has a comparative advantage in ICT production. Often trade data is used to check for those sectors that are competitive internationally, and there is indeed a large US bilateral trade surplus vis-à-vis Europe - a surplus that has widened in the 1990s. Though imports from the United States accounted for almost one-quarter of total ICT sales in the EU in 1998, Europe's share of US domestic sales stood at only 6%.

17) In the US, the value-added in ICT producing sectors went from 5.3 percent of GDP in 1995 to 6.8 percent in 1999. These two figures for the EU were 3.6 percent and 4.2 percent, respectively.

Indeed, this trade data probably understates US dominance in the sector for two reasons (18). Firstly, the bilateral trade surplus with Europe existed despite divergent cyclical positions. To the extent that US ICT imports partially reflect the strong cyclical upswing in US investment demand in recent years combined with a strong dollar, the underlying structural trade balance in ICT goods and services is likely to be even more in favour of US companies.

The US IT sector has consolidated its first-mover advantages through higher R&D. It has also been able to gain economies of scale in a large and unified domestic market.

Secondly, the data is very aggregate and poorly measured. For example, outsourcing along different parts of the ICT value chain might have led lower value-added production - such as the assembly of components - to locate outside the US. Thus, while there is a US trade deficit in computers, there is a US trade surplus in semiconductor components. These various activities are grouped together in the aggregate data even though they exhibit very different labour productivity. Moreover, trade data does not account for the value of copyrighted material sold in third markets (e.g. US software produced under license in Ireland for sale elsewhere in the EU would not appear as a US export). There is also scope for multinational firms to adjust transfer pricing to move profits to low tax locations, especially given the ease with which computer programmes can be sent from one location to another via e-mail. Some of the huge difference in output per worker between foreign-owned (mainly US) and locally owned companies located in Ireland is likely to be explained by these factors (see Barry and Bradley, 1997, and Murphy, 2000) (19).

The reasons for the high performance of the US IT sector include first-mover advantages in a sector where there are network externalities, and the consolidation of its competitive position through higher R&D spending. Tracking the high economic growth rate, total US business-funded R&D remained stable at around 2% of GDP between 1990 and 1998 (OECD, 2000a). In the EU this ratio fell from 1.3% of GDP to 1.1% in the same period, amidst weak economic growth.

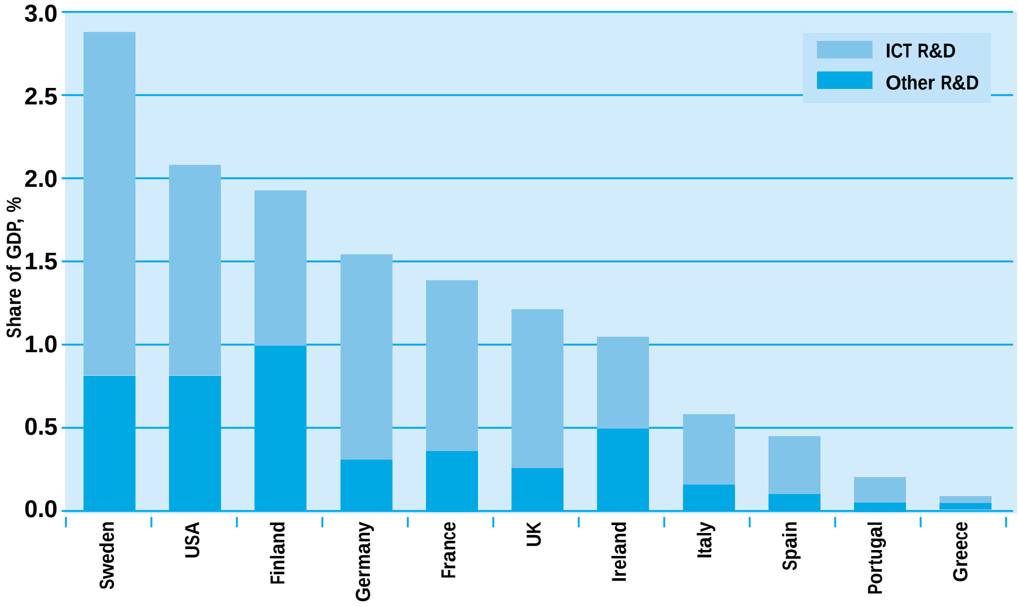
As ICT is one of the most R&D intensive sectors, these global differences are also visible within the sector. Whereas US R&D expenditures in the Office and Computing Machinery sector stood at 15% of total sector output in 1995, the corresponding figure for the EU was only 4%. Again, one should be cautious of generalising too much, as there is enormous variation within Europe (see Figure 7). R&D spending in Scandinavia, for example, is on a par with the US. European Commission (2000a), notes that, unlike most of Europe, the Scandinavian high-tech sector was able to keep pace with the US countries in terms of productivity growth during the 1990s.

Though internationally traded goods, having a large domestic market has nonetheless helped the US industry to exploit economies of scale. Figure 8 gives an indication of how net imports account for only a tiny share of the total expenditure on ICT in each region. The importance of home markets could help explain why countries have come to specialise in different areas of ICT production when there is no obvious ex ante comparative advantage. Indeed, the adoption of GSM as a standard throughout the EU has played a critical role in establishing European market leaders in technology for mobile networks (e.g. Ericsson and Nokia). The increasing demand for chips in European communications equipment also lies behind the recent growth of the European semiconductor industry (e.g. Infineon, ST Microelectronics, and Philips).

18) Thus, they may be several explanations for the surprising fact, noted by Quah (this volume), that the US is a net importer of ICT with respect to the rest of the world (with a trade deficit of USD 40 billion in 1998).

19) Output per worker in foreign owned firms is almost an order of magnitude greater than that in Irish owned firms.

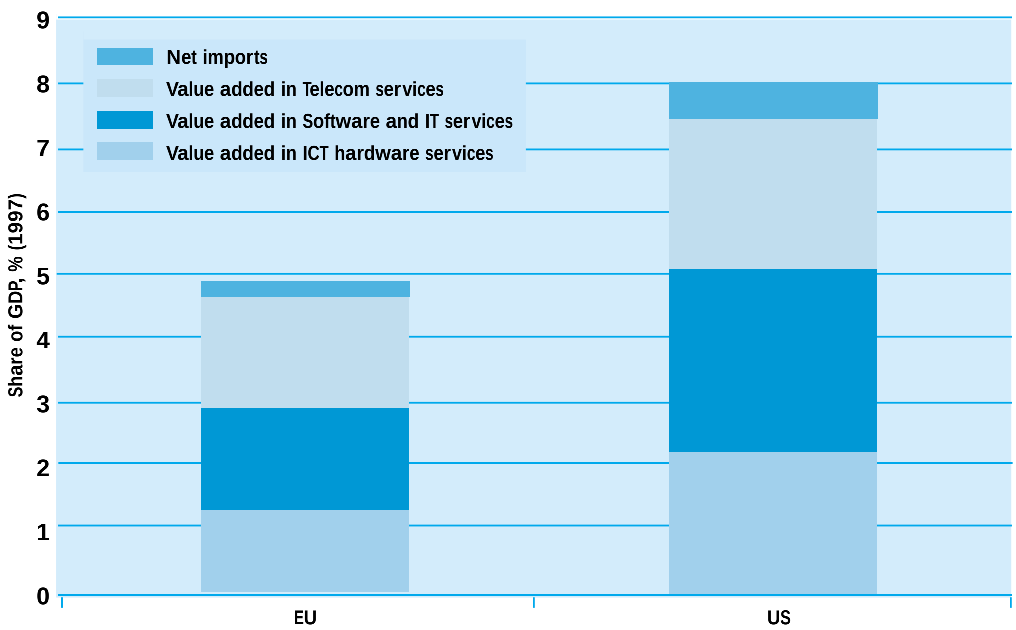
Figure 7. Business-funded R&D as a share of GDP



Source: Calculated from OECD data (1997 or latest).

A similar position exists in software. The OECD (1998), has estimated that the United States supplies around 80% of the world's packaged software and is the only region with a strong position in foreign markets. Especially the market for PC software is dominated by US companies. European producers have around one-third of their home market for packaged software, but are largely absent outside Europe.

Figure 8. Domestic ICT expenditures by origin



Source: estimated from data in OECD (2000b), and EITO.

Within Europe, Ireland is a major software producer. The OECD (2000c), even reports that the software exports of USD 3.3 billion from Ireland in 1998 were more than the USD 3.0 billion exported by the United States. However, as we have already mentioned, these exports are likely to hide a substantial amount of de facto re-exports of US value-added. Thus, the one-third position in packaged software sales held by European companies in the EU market may reflect a substantial role for US software giants based in Ireland (20).

As with equipment manufacture, US software companies have been able to gain economies of scale in a large and unified domestic market. European software developers have largely concentrated on their home markets because of language and cultural barriers within Europe (21). Nevertheless, Europe has several software producers that have attained a global reach (e.g. SAP, Software AG, Baan, and Cap Gemini Ernst & Young). European companies have also acquired an early lead in producing software for the mobile Internet, which has reached a more advanced stage in Europe than in the United States as a result of the greater adoption of mobile phones.

Thus, while there are ICT market segments where EU companies perform very well, this excellence does not seem sufficiently broad-based for the ICT production sector to make the same kind of contribution to overall economic growth that has been seen in the US. In terms of GDP, the European hardware-producing sector is only about 60 percent the size of that in the US. North American computer companies also have a commanding lead in some of the highest value-added and most rapidly developing market segments (e.g. Intel with semiconductors) and have been at the forefront of developing new manufacturing models (e.g. Dell and Cisco Systems). Putting a much smaller size together with slower productivity growth necessarily means that the ICT sector's direct contribution to growth is significantly less in Europe. With lower R&D spending, and fewer innovative start-ups, European catch-up with the US is likely to be a slow process.

This being said, substantial diversity can be observed within the EU. Some EU countries even had larger value added ratios than the US (6.8%), including Sweden (9.3%), the UK (8.4%) and Finland (8.3%). It could also be the case that demand will shift towards those sub-sectors where Europe performs particularly well (such as wireless communications) - generating faster growth in the future.

If the acceleration of US growth has come only from the production of computers, then the EU "new economy" is unlikely to be quite so novel as the North American version.

4.3 The structure of ICT investment and possible consequences for TFP growth

If Gordon (2000), were right, and the acceleration of US growth has come only from the production of computers, then the previous section would suggest that the EU "new economy" is unlikely to be quite so novel as the North American version. However, we have also seen evidence at the firm-level that there can be substantial productivity gains associated with the use of ICT. This implies that Europe could gain from the adoption of ICT even when it is not producing much of it.

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20) Irish software sales account for around 40% of Europe's packaged software market and 60% of its market for business applications. Even though they account for a relatively small share of the total (120 out of 760 firms), in 1998 foreign owned firms in Ireland accounted for more than 80 percent of the sector's revenues, and almost 90 percent of exports (OECD, 2000c).

21) The total European software market was estimated by EITO (2001), at around EUR 67 billion in 1999 (split evenly between systems, applications software, and implementation). Note that customised software does not benefit from large measured quality improvements (see Vanhoudt and Onorante, this volume). Thus, the contribution to reported real GDP growth will not be the same as equipment manufacture or packaged software (where hedonic price adjustments are made).

We have little idea of what combination of computer hardware, communications equipment and services provides the optimal foundations to support organisational change. Indeed, this must depend upon the activity in question. For want of a better yardstick, we can compare the structure of ICT expenditures in Europe to those in the US to see if there are notable differences.

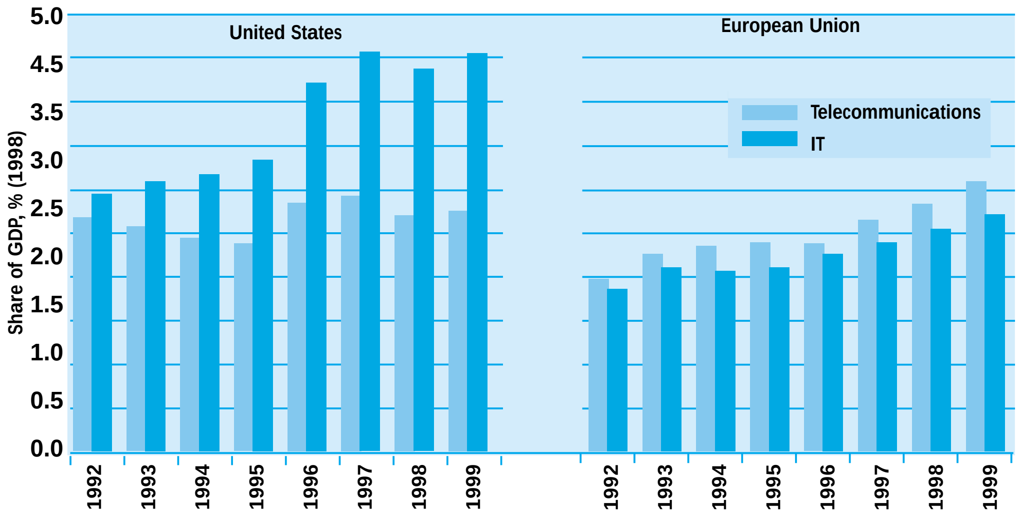
A first observation is that the US lead over Europe is entirely in IT (see Figure 9). And while there has been convergence in telecoms spending within Europe, there are notable differences across countries when it comes to IT. Figure 10 looks more closely at spending on IT (as in Figure 9, data is shown in nominal terms to avoid issues of price deflators). To avoid going into a country-by-country discussion, we have split the EU into only two groups according to the importance of IT spending. A striking feature of this graph is the large and widening gap between the United States and the EU, and particularly with the "below average" group. Since this latter group includes the three large continental economies, it accounts for two-thirds of EU GDP.

This converts into a large difference in terms of the IT capital stock available, and particularly the adoption of newer technologies. For example, the stock of computers and Internet hosts in each country largely line up as one would expect given accumulated expenditures over the past decade (see Gruber, this volume).

The US lead over Europe is entirely in IT spending. Telecoms spending has recently surpassed that of the US in terms of GDP.

In contrast with IT expenditures, EU telecommunications spending has recently surpassed that of the US in terms of GDP. A large share of these expenditures is actually for services that cannot be considered as investment - making telephone calls and sending data messages. Figure 11 looks more narrowly at investment in telecommunications equipment in the two regions (22). It shows that Europe has traditionally invested more than the United States in telecommunications equipment and has retained this lead in the second half of the 1990s.

Figure 9. ICT expenditures as a percentage of GDP

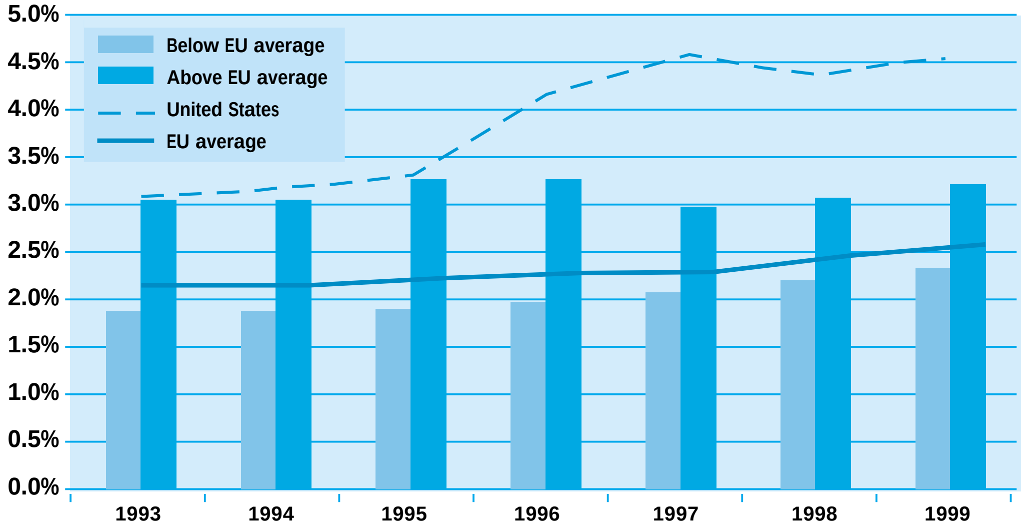


Source: EITO (various issues)

Note: nominal ratios including services.

22) Since EITO does not produce comparable data for the United States at this level of disaggregation, we change the date source to the OECD for this chart.

Figure 10. IT expenditures as a percentage of GDP

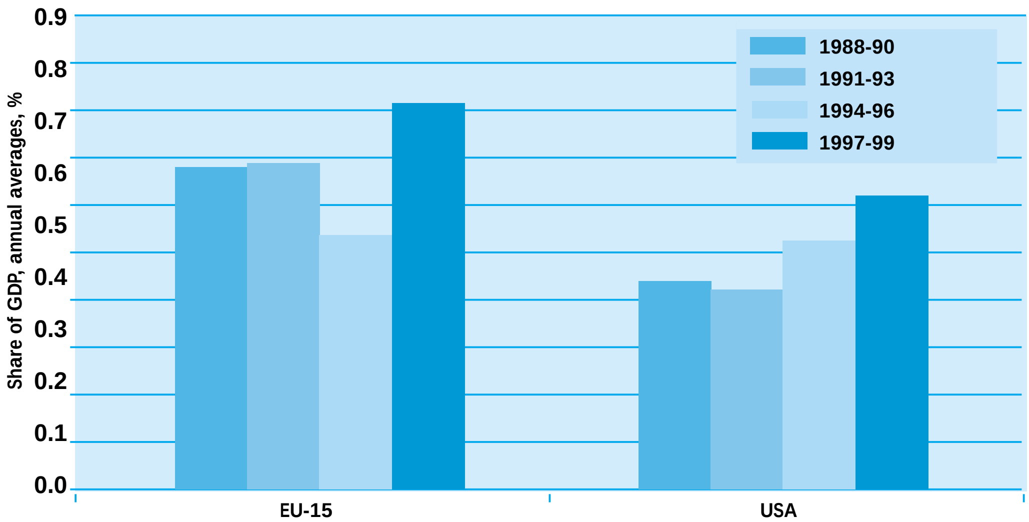


Source: EITO (various issues)

Note: The "above average" group consists of Portugal, Netherlands, Ireland, Denmark, Finland, UK and Sweden. The "below average" group consists of Greece, Italy, Austria, Belgium, Germany, France and Spain.

Though higher investment was needed in Europe to bring the telecoms network towards US standards (and there are still more lines per head in the US than in the EU) essentially all households and firms are now connected, and Europe is even ahead of the US in the diffusion of enhanced data access such as ISDN (see Gruber, this volume). Thus, it seems unlikely that the quality of communications infrastructure is the constraint to the development of a new economy in Europe. Any competitive disadvantage relative to the United States is more likely to relate to prices and competition in the sector more generally (we return to this issue in Section 6).

Figure 11. EU and US investment in telecommunications equipment



Source: Calculations based on OECD data

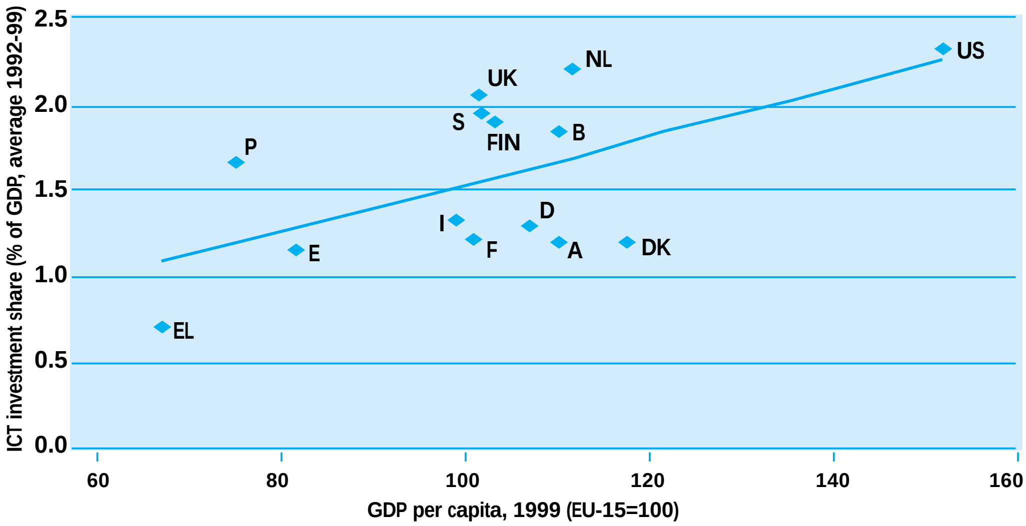
4.4 Diversity in Europe - will the rich get richer?

Being a follower can have its advantages for *users* of ICT. It allows companies to adopt only those new business models that have already been proven to work. If investment in IT is focused in the areas of highest pay-off, then a relatively lower investment share does not preclude large productivity gains. However, we must be left with some unease by the fact that large parts of Europe lag far behind the United States in information technology, and that this gap is closing at a very slow pace.

In so far as there is link from ICT production and investment to growth, the bias to higher ICT spending in higher-income countries may induce divergent economic trends in Europe.

Of course, some European countries have ICT adoption rates that are on par with the US. This is particularly so for Scandinavia. With international ICT production companies, these economies may be just as "new" as the US. But the diversity across EU countries also poses a serious challenge to the goal of economic convergence within Europe. Investment in ICT expenditures appears to have at least some positive correlation with income levels, i.e. richer countries tend to both produce and spend more on ICT (see Figure 12). All of the six EU countries with the highest ICT spending ratios have GDP per capita above the EU average. In so far as there is a causal link from ICT production and investment to growth, the bias to greater ICT spending in higher-income countries may induce divergent economic trends in Europe.

Figure 12. Relative GDP per capita and ICT investment



Source: European Commission (1999, 2000a).

Note: As before, Ireland is excluded from the chart for scaling reasons. Its GDP per capita was 111.5 percent of the EU average, while the ICT investment ratio was 5 percent.

The growth of the new economy may also shift regional wealth in a more subtle way by influencing the economic forces that cause economic activity either to concentrate in clusters or to spread more uniformly through space. This could either amplify the rate of regional divergence, or act as a balancing counter force to the direct productivity effects we have been discussing. This question is the topic of the next section.

5. The implications of ICT on the spatial distribution of economic activity

The last volume of the *EIB Papers* (Volume 5, Numbers 1 & 2, 2000) dealt with spatial market failures in some detail. Broadly put, there are three reasons why economic activity may concentrate in some locations. These are:

- Economies of scale in production and technological spillovers across companies.
- Externalities that occur when people and companies move from one location to the other without taking into account the impact they have on local markets (changing prices and demand in each location).
- Coordination failure, when many people and companies must move together to a particular location to launch a new product, but do not have the information or means to organise this.

The net result may be a geographical concentration of economic activity - typically a core and periphery pattern - that is not socially optimal (23).

It has been suggested that ICT can have a major impact on the centripetal forces leading to concentration, with the commonest theme in the popular literature being that the "death of distance" associated with the Internet will lead to a more uniform distribution of economic activity. As we will discuss, this conclusion depends rather on the sector in question.

5.1 The ICT sector

Innovative activity

Returns to scale that support the development of clusters include the shared use of services (such as accountants and lawyers), and a better functioning labour market (as people with the right skills also congregate in the same location). Additional technological externalities come from the "knowledge spillovers" as companies learn new ways of solving problems from their neighbours. Face-to-face meetings are thought to be critical to this process. Hauser (this volume) emphasises that while a well-functioning real estate market, good basic infrastructure and accessible services are all part of any healthy cluster of entrepreneurial activity, a key element is also the existence of "social networks" that can be relied on to help with problem solving. This is particularly the case for start-up businesses. A similar argument applies with bringing venture capitalists, especially wealthy individuals (the so-called "angels"), together with researchers. The use of e-mail, though it makes cheap communication possible over long distances, is unlikely to support the same kind of mutually beneficial relationships. In fact, California's Silicon Valley should be considered exactly as a network for innovation - the manufacture of ICT having migrated to other cheaper locations long ago.

Innovative activity related to ICT is also highly concentrated. The economic landscape may not change very much, as the process of geographical lock-in has already taken place.

Innovative activity related to ICT is also highly concentrated in a few regions in Europe (Hauser mentions the examples of Cambridge, Sophie Antipolis and Munich). The clustering of industry is not restricted to the high-tech sector (24); however, clustering within ICT is reinforced by two factors.

23) The first two factors, technological and pecuniary externalities, do not always lead to excessive concentration (see Thisse, 2000). For example, firms may not move to the core of they can benefit from less competition in peripheral markets, resulting in insufficient concentration.

24) See the examples described in Krugman (1991), and Porter (1990).

One comes from the link to advanced research, and the role of universities as a source of ideas (25). Clearly, not all universities, and not even some of the most prestigious universities, have been a catalyst for entrepreneurial activity. Hauser believes that having had a successful high-tech business in the vicinity (possibly by chance) as a training ground for future start-ups is important. It is also the case that successful entrepreneurs are likely to choose locations with an attractive environment and social amenities. While the reason why certain regions have become home to innovative clusters is the subject of speculation, there does, however, seem to be a process of lock-in at a relatively early stage.

Gillespie, Richardson and Cornford (this volume), draw the following conclusions. Firstly, high-tech clusters along the lines of Silicon Valley are likely to remain very much part of the scene. Secondly, the economic landscape may not change very much. There will be continued development of existing ICT clusters rather than new clusters springing up in completely new locations, as the process of geographical lock-in for these industries has already taken place. As a result, policy measures that have attempted to recreate knowledge-based clusters in less advantaged regions have not been successful.

"Weightless" goods and services

Quah (this volume) notes that the production of some ICT goods exhibits large economies of scale. This is taken to extreme in the production of computer software. Once the first copy has been programmed, additional copies can be run off at almost zero marginal cost. This could be thought to lead to concentration of the software industry. However, the extent to which economies of scale for a particular product convert into economies of scale at the industry level depends upon whether consumers value diversity. On the one hand, the publishing industry provides an example of a sector with economies of scale, but where there is a strong demand for diversity, and where many competing companies exist. On the other hand, Microsoft provides the example of a market where diversity is not at all valued, as consumers wish to use compatible systems. Thus, the extent to which low marginal production costs convert into industry concentration depends upon whether network externalities are at play. This is by no means the case in all parts of the ICT sector.

However, it may be the case that increased sophistication by consumers is increasing the entry costs to the industry. Even relatively simple products often entail many person-years of programming if they are to be what is now considered as a "standard" quality. Together with economies of scale and scope in marketing, this could lead to a market structure where relatively few major companies dominate the industry (one could think of the film industry as an example).

Quah also notes another specific feature of some ICT goods and services (though obviously not hardware) is that they are weightless, the cost of sending digital information via the Internet being unrelated to distance. Other things being equal, this would tend to lead to the geographical concentration of the industry as, in theory, one location could serve the entire world (26). However, concentration also leads to congestion and high property prices, and it becomes efficient to use the Internet to spread out those activities that do not benefit from proximity. This is reinforced if a

25) More generally, Jaffe (1989) finds a significant effect of US university research on corporate patents, particularly in drugs and medical technology, electronics, and nuclear technology.

26) Of course, time zones could create barriers, as would language and other cultural barriers.

workforce with suitable skills already exists in the peripheral location and there are costs to relocation (27). The main candidate is routine software programming.

Thus, the balance between centrifugal and centripetal forces will depend upon the sector. The highest value added part of the ICT sector is likely to concentrate in a few innovative clusters. For lower value added part of the programming chain, the reverse can be expected, with more uniform production through space (28). The production of ICT equipment is really no different from other parts of the manufacturing sector, and it is to this more general economic activity that we now turn.

5.2 ICT using sectors in general

ICT remains a small, if a profitable and rapidly growing part of the economy. What may the impact of ICT be on the bulk of the economy - those sectors that purchase these technologies? As ICT reduces the barrier of distance to the flow of information, it will tend to increase economic relations between core and peripheral areas. This could support more dispersed economic activity. However, the crux of the matter is not that firms in lagging regions do not know of business opportunities elsewhere (though they may not), but that they are not competitive with respect to firms in more advanced regions. This is particularly the case for small businesses (see Gillespie *et al.*, this volume). Therefore, ICT may equally give the residents of lagging regions greater access to markets in the economic core, with negative consequences for firms in their locality. The analogy, then, is with improved transport infrastructure in traditional models of economic geography. The effect may be either positive or negative depending upon the particular circumstance. In any case, given the other forces at play, the marginal impact of ICT may be very small.

As with computer programming, the situation is substantially changed for the particular set of activities that process data that can be transmitted electronically. Examples are back offices for administrating transactions, translation of documents, etc. Improvements to transmission technologies have reduced costs to the point that even real-time communications (where the capacity of telecommunications networks becomes a factor) are unaffected by distance. Telephone call centres for telemarketing, customer support and technical services fall in this category (29). Here too there will be strong centrifugal forces at least for the next few years. The issue is whether some of the more routine activities may themselves be automated with computers, eliminating this particular window of opportunity for peripheral locations to attract labour-intensive investment (Gillespie *et al.*, this volume).

Rather than directly affecting firm location decisions, the regional impact of the new economy will largely be determined by the extent to which regions reap differential productivity gains from use of ICT.

The conclusion is that rather than directly affecting firm location decisions, the regional impact of the new economy will largely be determined by the extent to which regions reap differential productivity gains from use of ICT. From the investment data of Section 4 we may have concerns that this will be the case. And there are other institutional factors why the pay-off from ICT investment may vary from country to country.

27) The growth of the Indian computer programming industry is the most striking example of this.

28) Following Quah, this can also be seen as the difference between intangible assets that are codified in patents and copyrighted material (development activities associated with these may spread) and those due to individual human capital (namely, innovation which remains concentrated).

29) There are currently about 1.2 million people employed in call centres in Western Europe (EITO, 2001).

6. Institutional preconditions for a new economy

The preconditions for the dynamic development of a new economy are really only threefold. The first is to have an economy that generates new ideas in the development of technology, and has the skills to use them in practical applications. The second is for the economy to be sufficiently flexible that organisational change can take place within existing companies. Since start-ups are an important source of innovation, a third condition is to have institutions, including the availability of venture capital, that support the establishment of new companies. In this section we comment briefly on each on of these goals - all of which are easier to state than achieve.

6.1 Skills and ideas

Computerisation reduces the time spent on routine tasks, freeing time for workers to use their professional skills. This increases the return from skills and so widens wage differentials.

Innovation - the generation and exploitation of new ideas - is the product of both human capital and research and development. We have already documented the shortfall in R&D spending in some regions of Europe. It is well known that the level of R&D spending is usually less than optimal, as the benefits from a new innovation may not be fully appropriable by the inventor. Thus, there is a logic for public policy intervention, including public spending on R&D.

The other cornerstone of innovation is human capital. It is needed both to generate new technical ideas, and to subsequently turn them into business applications. Clearly, the ICT production sector requires staff with high computer related skills (30). Demand for staff has been growing rapidly and is expected to continue to do so, raising the prospect of increasing skills shortages. A detailed discussion of the ICT workforce is beyond the scope of this paper, but we can say that the main short-term solutions relate to additional on-the-job training. Hauser (this volume) also argues that the immigration of skilled professionals is a solution.

As we have suggested earlier, however, Europe's ICT strategy is likely to be as much user-based as producer-based. This raises the broader question of the need for computer skills in the community in general. Many studies conclude that computer skills are highly rewarded in the economy. A critical assumption in this analysis is that the workers using a computer are the most qualified to do so - the correlation between computer use and higher wages can thus be interpreted as one of causality. However, Soete and Ter Weel (this volume) document a number of research results that are not consistent with this view. They reach the conclusion that causality runs the other way: it is high wages themselves that lead to the adoption of computers. This is because computerisation reduces the time spent on routine tasks, freeing time for workers to use their professional skills in a more productive way. This increases the return from skills and so widens wage differentials (31).

In this sense, what is needed is some basic computer operating knowledge in order to complement more general cognitive skills - a result that is in line with the model of the new economy where ICT is a catalyst for the development of intangible assets. Thus, while courses to acquaint people with

30) EITO (2001) reports that there are some 9.2 million ICTprofessionals working in Western Europe, the bulk of which work in applications development (i.e. software programming) and network support. Another 2.3 million people are involved in e-commerce, split more-or-less equally between business strategists (marketing, sales and project managers) and technology specialists (web designers).

31) The impact on industrial organisation may be complex. For example, Kremer and Maskin (1996), suggest that there has been greater segregation of high- and low-wage workers into separate teams, while Acemoglu (1999), notes that there are greater incentives for firms to differentiate job descriptions even if this requires more screening of job applicants.

computers are necessary, the technology should be viewed as only a tool (and not particularly difficult one to use since the invention of windowed graphical interfaces) to exploit other skills. As the returns to these skills will increase with widening wage differentials there should be greater demand for education and training. The question for educational systems is whether they will be able to meet this demand.

6.2 Flexibility

Naturally, the use of ICT as a catalyst for organisational change requires a certain flexibility in the economy. This is needed in three areas in particular: in product markets; in labour markets; and in parts of the ICT sector itself.

Competition and product market flexibility

A competitive product market is needed to stimulate product innovation and to encourage constant improvement in work processes. In this context, the US Council of Economic Advisers (2001), has stressed that competition in the US economy was strengthened by a combination of deregulation (such as in telecommunications and finance) and free trade agreements (such as NAFTA and various multilateral agreements within the framework of the WTO) in the 1990s.

In comparison, the general perception is that the EU still lies behind the US in having a competitive economy (32). Cross-country evidence also shows that the European countries showing the strongest progress in innovation and productivity growth in the 1990s, such as the Scandinavian countries and Ireland, have gone through a process of structural and regulatory reform and the liberalisation of previously protected sectors.

Technical change and labour market rigidities

Organisational innovation also requires flexibility in labour markets, without which the productivity gains from investing in new technologies may be more difficult to realise. To the extent that Europe's preoccupation with employment protection is hindrance to organisational flexibility, the costs of shifting towards a new economy in Europe may prove substantially higher in Europe than in the United States (33).

An excessive level of job protection could lock an economy in a relatively static position.

In general, however, the need to protect workers from technologically induced unemployment is overstated. For example, Soete and Ter Weel (this volume) observe that technical progress should not change unemployment over the longer-term. The jobs that are lost by the introduction of a new labour saving process in one sector should be compensated by output growth and additional employment creation in other sectors - with everybody better off in the process (34). However, it is true that there could be a downward pressure on wages for some workers if technical advancement has a skill-bias. This has been cited as one reason for the widening wage inequality seen in the

32) See, for example, the European Commission (2000b) and the OECD Review of Regulatory Reform (OECD, 1999).

33) European employment policies were discussed in more depth in EIB Papers*, Volume 3, Number 1, 1998.*

34) Put another way, there is no relationship between the level of technology and unemployment. The NAIRU is unaffected, as technical progress influences wage aspirations and productivity equally. There could be a transitory decline in the NAIRU if workers underestimate the growth rate of productivity, but this misconception will inevitably disappear as information on the true state of the economy becomes more widely available.

United States over the last decades (Soete and Ter Weel, this volume). Technical change in sectors where there is little competition would have the same effect if wages have been maintained at above market-clearing level. Workers that are displaced from companies in these sectors will inevitably face lower wages elsewhere.

In Europe, a declining demand for the unskilled together with minimum wage legislation could mean that workers who lose their jobs are unable to find new ones. However, Saint-Paul (1998), finds that there is little evidence for this particular explanation of EU unemployment. In any case, this would be a consequence of technical change to be dealt with through other policy measures, such as training (or more passively by accepting greater inequality in society). Here, labour market policies do not necessarily influence the adoption of a new technology *per se*.

What may be more pernicious is job protection legislation, i.e. restrictions on hiring and firing workers. These increase the costs of company reorganisation if this implies outsourcing certain activities or replacing staff due to changing job descriptions. There may also be dynamic effects. If taking on a new worker has large fixed costs (e.g. several months of severance pay must be paid in the event that a contract is terminated), then it can be considered as an investment decision. Faster growth in corporate profits from reorganisation could reduce the time needed to recover fixed hiring costs, and thus the inclination of companies to create new posts (35). An excessive level of job protection could lock an economy in a relatively static position of low job losses, but also of low economic growth and low job creation. Hauser (this volume) believes that this has been exactly the situation in Europe.

Regulation of telecommunications

Internet host density in OECD countries is inversely correlated with Internet access costs. There is still great dispersion of access costs across Europe.

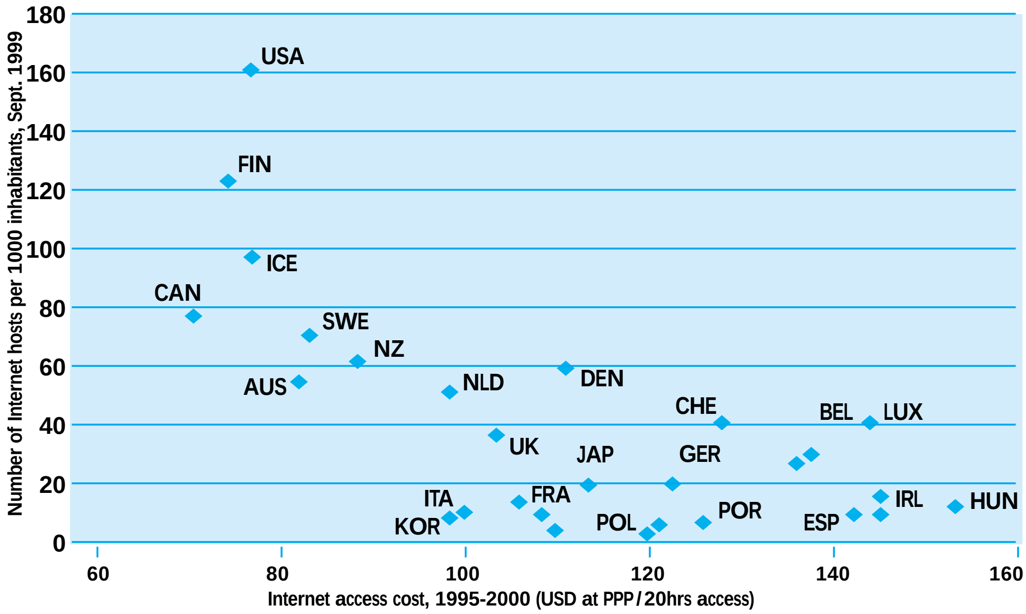
Realising the new economy depends not only on flexibility in labour and product markets in general, but can also be greatly encouraged by a more dynamic and competitive ICT sector. Specifically, the diffusion of ICT equipment is likely to be encouraged by cheap telecommunications costs. As shown in Figure 13, Internet host density in OECD countries is inversely correlated with Internet access costs. This is presumably key for the development of retail e-commerce activities. A broad based use of computers in society could also be important to familiarise the (current and future) workforce with the technology.

Allowing new entrants into the telecommunications sector is the best way of encouraging price competition and innovation (36). Many EU countries have only liberalised the telecommunications sector recently, and there is still great dispersion of access costs. Most of the leading Internet-economies have Internet access costs below the OECD average. However, Irish telecoms prices were structured to offer cheap transatlantic rates to bulk users (see Gillespie *et al*., this volume). There is thus a dichotomy in this country between the use of ICT by large businesses and by society at large. Even so, liberalisation of the telecommunications sector in Ireland was accelerated due in part by pressures from inward investors for better and more advanced services.

35) See, for example, Cohen et al.*, (1997).*

36) This point was emphasised by Robert Verrue when speaking at the EIB conference. Gillespie et al.*, (this volume) also discuss the implications of telecommunications provision in some detail.*

Figure 13. Internet access costs and Internet host density, 1999



Source: OECD (2000a)

6.3 Entrepreneurs and the financing of start-ups

Venture capital has played a significant role in developing the ICT sector in the US.

Though a small part of the ICT-sector, start-up businesses are an important source of innovation. This is because of the short gap from advanced scientific research in universities to business applications, together with the completely new opportunities presented by the new technology (the "dot-coms" being the most recent example). As a result, venture capital has played a significant role in developing the ICT sector in the US. Its importance for innovation depends as much on the quality of support provided by the venture capital firms as the amount of funds provided. Indeed, it is this transfer of know-how and direct involvement in the new operations more than just the willingness of investors to make risky bets that makes venture capital different from other forms of financing. This quality element is visible in the patenting data. For example, Kortum and Lerner (1998), found that venture capital-supported firms accounted for less than 3% of R&D spending, but 15% of patenting in the 1990s.

In 1998, venture capital in Europe for the earlier stages of new firms was around half that of the United States as a share of GDP (OECD, 2000a), but had close to the US rate of growth. It is not certain, however, whether such figures are directly comparable across countries. A large gap between the US and Europe is likely to exist with "business angels", those wealthy individuals who invest in new companies at their inception. These investors need to be knowledgeable both of the sector and of the problems of starting new businesses. Consequently, there are cumulative effects as it is often successful ICT entrepreneurs who support the second generation of companies.

This section has shown that realising the new economy goes beyond investing in ICT equipment. Europe's catching-up with the United States is likely to be augmented by its ability to pick best practice directly, i.e. the technological and organisational solutions that have proven successful in the leading economy. But realising the new economy in Europe may also be impeded by the institutional shortcomings listed here, suggesting that its catching-up with the United States may be a slow process.

7. Conclusions

This exercise began with the observation that there may be something new in the US economy, and that Europe may be missing out on the phenomenon. It is certainly striking that rather than there being catch-up, the world's most advanced economy was able to outpace its followers (such as the EU) during most of the 1990s.

There can be little doubt that the US computer manufacturing sector has made a direct contribution to US growth. It has seen such rapid productivity gains that its performance has pushed up the national average. There is the risk that hedonic, quality adjusted, price indices overstate the real value of the equipment that is being purchased, but correcting for this would only account for a small proportion of what has been seen.

Estimating what has been happening in the rest of the US economy is difficult due to the relatively short time period for analysis (essentially from 1996 onwards). Depending upon the assumptions made to adjust for cyclical effects, productivity gains in the computer using part of the economy can either be significant, or can vanish away.

This being said, the microeconomic evidence shows that companies have been investing heavily in ICT and have been using this technology to develop more efficient organisations. While supply chain management may seem banal (and certainly far from 2001 A Space Odyssey), modest cost savings can generate a large increase in profitability in sectors where margins are thin. Interestingly, it is the computer sector itself (e.g. Dell and Cisco Systems) that have been at the forefront of these changes. It seems inconceivable that firm-level gains of this type are not meaningful in economy-wide terms. Indeed, David (this volume), cautions that conventional growth accounting - the basis for estimating the sources of productivity growth from the macroeconomic data - is "*less than wholly enlightening about the behaviour of the economy over the short and medium term*".

In comparison with the United States, Europe seems to have a number of important weaknesses. While the European computer industry may lag because US has "first-mover" advantages in sectors where network effects and technological lock-in are important, it is more the case that US companies maintain their dominance by investing much more in R&D. Likewise, the role of start-up companies as a source of innovation is weaker due to less entrepreneurial activity (including venture capital investment). Moreover, the use of ICT as the basis for developing new business models is hampered by fewer incentives (i.e. less competitive pressures in some sectors) and greater costs (for example, due to rigidities in labour markets).

But the most striking feature of a closer look at the EU is how much the production and use of ICT varies across the continent. While some economies - notably in the north and north-western fringe of the Union - are as heavily involved in ICT as the US, there are large areas of the EU that lag far behind. If there is such a thing as a new economy, this could mean widening regional income differentials. This does not, however, imply that there is a role for governments in promoting national ICT champions. It would be impossible to demonstrate that exporters in other countries are unfairly benefiting from anti-competitive practices, a necessary condition for distorting trade through subsidies or tax incentives.

What of regional development in this environment? The evidence suggests that not much has changed with the advent of ICT. Innovative clusters along the lines of Silicon Valley will largely remain where they are today. Policies aimed at the creation of new clusters in lagging regions are doomed to failure in all but the most exceptional cases. Likewise, new communications possibilities will not open up huge new market opportunities for firms in lagging regions as they are mostly not competitive outside their local markets.

However, ICT has rendered a part of the economy footloose. This includes corporate back offices, call centres, and some computer programming activities. Lagging areas can also try to attract computer production facilities just as they could any other manufacturing plant. Policy instruments include the traditional tools of subsidies, the provision of infrastructure, and training of the local workforce. Unfortunately, the ICT sector may not be ideal for regional development. Equipment manufacture may not be appropriate in the sense that it does not have the kind of linkages to local companies needed to develop indigenous enterprises. And call centres and other standardised operations may not provide sustainable development if these activities are progressively automated in the future. In any case, their very footloose nature means that any home may be temporary.

We can say that ICT is likely to provide the technical basis for keeping the economy on an upward growth path, though performance is unlikely to match the golden eras of the past.

Our definition of a "new economy" is a modest one. It means that ICT will support robust productivity growth, but mainly by improvements to the practices of existing companies. Eventually, the effect must peter out when all companies have moved to best practice. Permanently higher productivity growth would only be possible if the rate of innovation in society increases. This could be the case due to the greater access to information provided by the Internet. The possibility to generate new information related goods and services also seems unlimited. Most of the authors in this edition of the *EIB Papers* tend to take this relatively optimistic view of the longer term.

However, this is a question for tomorrow. For today we can say that ICT is likely to provide the technical basis for keeping the economy on a long-run growth path towards greater prosperity, though performance is unlikely to match that of the golden eras of the past. The main engine for increased productivity will be greater efficiency in the private enterprise sector of the economy. The right economic environment is a necessary condition, and it is certain that ICT does not remove any of the difficult policy trade-offs in society. In this sense, an old truth remains: "*there is nothing new under the sun*" (Ecclesiastes, 9:1).

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