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PRODUCTION AND USE OF ICT: A SECTORAL PERSPECTIVE ON PRODUCTIVITY GROWTH IN THE OECD AREA

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INTRODUCTION

The strong growth performance of the United States over the 1990s and the uneven performance of other OECD economies have led to new attention for the sources of growth in OECD economies. Studies over the past few years (Scarpetta, *et al.*, 2000; Gust and Marquez, 2000; OECD, 2001a) have demonstrated that there is no single factor that explains divergence in growth performance. Rather, OECD countries that improved performance in the 1990s were generally able to draw more people into employment, increase investment, and improve multifactor productivity (MFP) growth.

Information and communications technology (ICT) plays two roles in this process, first by contributing heavily to the increase in overall investment and thus to capital deepening, second by contributing to MFP growth. The role of ICT investment in growth performance is confirmed by a range of empirical studies, for both the United States and several other OECD countries (*e.g.* Colecchia and Schreyer, 2001; Jorgenson, 2001; Van Ark, *et al.* 2002a). The strength of ICT investment is commonly attributed to rapid technological progress and strong competitive pressure in the production of ICT goods and services, which have contributed to a steep decline in ICT prices. This price fall, together with the growing scope for application of ICT, has encouraged investment in ICT, at times shifting investment away from other assets.

The contribution that ICT has made to MFP growth is more controversial. Some studies for the United States have argued that the pick-up in MFP in the second half of the 1990s was primarily due to technological progress in the *production* of ICT goods and services (Gordon, 2000). Technological progress at Intel, for instance, has enabled the amount of transistors packed on a microprocessor to double every 18 months since 1965, and even more rapidly so between 1995 and 1999. The relative importance of the ICT-producing sector in different countries, and its growth over time, might thus be one factor contributing to the differences in growth performance that have been observed in several OECD countries in recent years. An empirical examination of this issue is the first goal of this paper.

If the rise in MFP due to ICT were little more than a reflection of rapid technological progress in the production of computers, semi-conductors and related products and services, there would be no effects of ICT on MFP in countries that are not already producers of ICT. For ICT to have benefits on MFP in countries that do not produce ICT goods, it needs to have productivity impacts linked to its use in the production process. Some studies for the United States have attributed a substantial part of the pick-up in US MFP growth to ICT-using sectors, notably services (Baily, 2002; Triplett and Bosworth, 2002). This would mark a change with the past, as the productivity record of many services sectors has often been poor. The application of ICT may have allowed some of these sectors to strengthen productivity performance, at least in some countries. The second issue addressed in this paper is therefore an empirical, cross-country examination of productivity growth in the ICT-using sectors, notably services.

Since estimates of MFP growth at the sectoral level can only be derived for a few OECD countries, the paper will first examine the contribution of ICT-producing and ICT-using sectors to labour productivity growth. Attention will also be given to the measurement problems that complicate productivity analysis in ICT-producing and ICT-using sectors. The final section examines the contribution of ICT-producing and ICT-using sectors to MFP growth and draws some conclusions.

GROWTH AND PRODUCTIVITY PERFORMANCE IN ICT-PRODUCING AND ICT-USING INDUSTRIES

The ICT-producing sector

The ICT producing-sector, as defined by the OECD (Box 1), accounts for only a small share of the economy. Its share in business employment ranges from between 3.7 per cent (in Portugal) to 10.9 per cent (in Finland) (OECD, 2002a). Its share in value added is slightly larger, showing that it has an above-average level of labour productivity, and ranges from 4.9 per cent in Greece, to 16.5 per cent in Ireland of business sector value added (Figure 1). ICT manufacturing is typically only a small part of this total and ranges between 1.3 and 13.8 per cent of manufacturing employment, and between 1.5 and 21.5 per cent of manufacturing value added. Finland and Ireland have the largest ICT manufacturing sectors, followed by Korea. New Zealand, Spain and Australia, in contrast, have only a small sector producing manufactured ICT goods (OECD, 2002a).

The relative size of the service part of the ICT sector also varies considerably across countries, with Germany, Japan, Korea and Mexico having a relatively small ICT service sector. Some of this variation is linked to the telecommunications sector, which is very large in Portugal and the Czech Republic, and quite small in Mexico, Korea and Italy. Another part is linked to computer and related services, the sector that accounts for much of the production of software. This sector is particularly large in Ireland, Sweden and Belgium (OECD, 2002a).

Box 1. **OECD definition of ICT-producing industries**

In 1998, OECD countries reached agreement on an industry-based definition of the ICT sector based on International Standard Industry Classification (ISIC) Revision 3. The principles are the following: for manufacturing industries, the products of an industry must be intended to fulfil the function of information processing and communication including transmission and display, or must use electronic processing to detect, measure and/or record physical phenomena or control a physical process. For services industries, the products must be intended to enable the function of information processing and communication by electronic means. The following industries were included:

Manufacturing

3000 Manufacture of office, accounting and computing machinery.

3130 Manufacture of insulated wire and cable.

3210 Manufacture of electronic valves and tubes and other electronic components.

3220 Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy.

3230 Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods.

3312 Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment.

3313 Manufacture of industrial process control equipment.

Services

5150 Wholesale of machinery, equipment and supplies.

7123 Renting of office machinery and equipment (including computers).

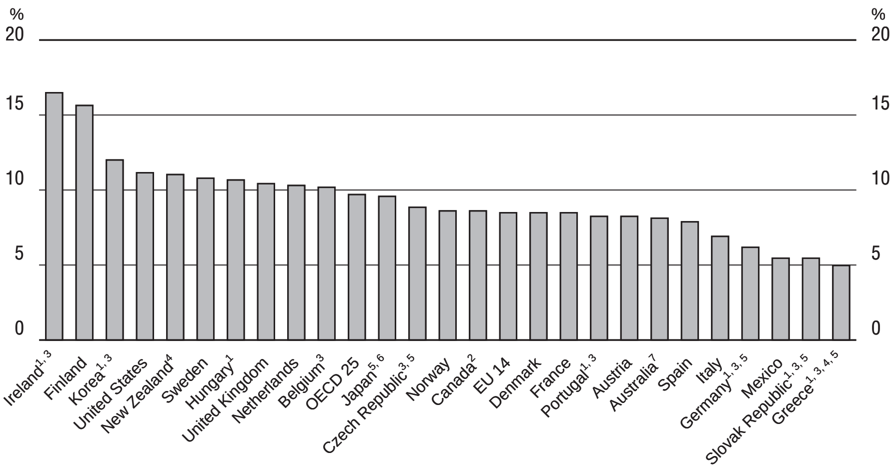
6420 Telecommunications.

7200 Computer and related activities (hardware consultancy, software consultancy and supply, data processing, database activities, maintenance and repair of office, accounting and computing machinery, other).

Source: OECD (2002a).

Figure 1. **The share of the ICT sector in the economy**

Share of the ICT sector in value added of the non-agricultural business sector, 2000



1. 1999.
2. 1998.
3. Excludes rental of ICT (ISIC 7123).
4. Includes postal services.
5. Excludes ICT wholesale (ISIC 5150).
6. Includes only part of computer-related activities.
7. 2000-2001.

Source: OECD (2002), *Measuring the Information Economy*, *www.oecd.org/sti/measuring-infoeconomy*, Paris.

While the ICT-producing sector is relatively small, it can make a relatively large contribution to growth and productivity performance if it grows more rapidly than the remainder of the economy. Bivariate correlations point to a positive correlation between the size of the ICT manufacturing sector and MFP growth, but this is mainly due to the position of Finland and Ireland (OECD, 2001a).[1] A positive correlation should be expected, since the ICT manufacturing sector typically has very high rates of technological progress and MFP growth. However, some countries with a relatively small ICT sector, such as Australia, have also experienced high MFP growth, suggesting that a large ICT sector is not a necessary condition for improvements in MFP growth.[2]

Measuring growth in the ICT-producing sector

Examining the role of ICT-producing sectors in economic growth is heavily influenced by measurement problems, both regarding outputs and inputs. The key measurement problem for the manufacturing of ICT goods on both the output and input side concerns prices, in particular how to statistically capture significant quality improvements associated with technological advances in goods such as computers and semi-conductors. The use of hedonic deflators is generally considered as the best way to address these problems (Box 2; OECD, 2002b).[3]

The measurement of output in the telecommunications industry also raises problems. Some countries use consumer price indexes of phone rates to deflate value added; others use physical quantity indexes of calls, telexes, and other services to measure volume changes in output; and some countries use a composite index of producer price indices for relevant components (OECD, 1996). Most of these methods do not address key measurement problems in this sector, *i.e.* quality change, adjustment for new products and services, the separation of goods and services, and increased price differentiation. A recent overview of price measures for telecommunications services still shows a considerable variety in approaches across the OECD (OECD, 2000a).

Measurement in the third component of the ICT-producing sector, the computer services industry, also raises certain problems. This sector includes difficult-to-measure services, such as hardware and software consultancy services, and maintenance and repair of computer equipment, but also includes several activities where quality has changed rapidly over time and hedonic deflators may be needed. These include the development, production and supply of customised and non-customised software, as well as data processing and database activities. Currently, the United States is among the few countries that applies hedonic methods to estimate price indices for pre-packaged software (OECD, 2000b).[4]

The methodological differences highlighted above affect cross-country comparisons of productivity. Adjusting for these differences is no simple task, as it is not clear, *a priori*, to what extent differences in output and value added deflators for these industries are due to measurement (*e.g.* the use of hedonic deflators) or to differences in industrial specialisation. However, countries that produce computers and semi-conductors, but that apply conventional deflators (*e.g.* Korea), are likely to underestimate output and productivity growth in this industry (see Annex 1). Recent work (Van Ark, *et al.*, 2002b) has applied US deflators to the measurement of output in ICT manufacturing in other countries. This demonstrates the potential size and significance of the problem, although it may overstate growth in the ICT-producing sector of certain countries that are less specialised than the United States in producing ICT goods characterised by very rapid price declines. Clearly, more work on the development of appropriate hedonic deflators in each country is warranted.

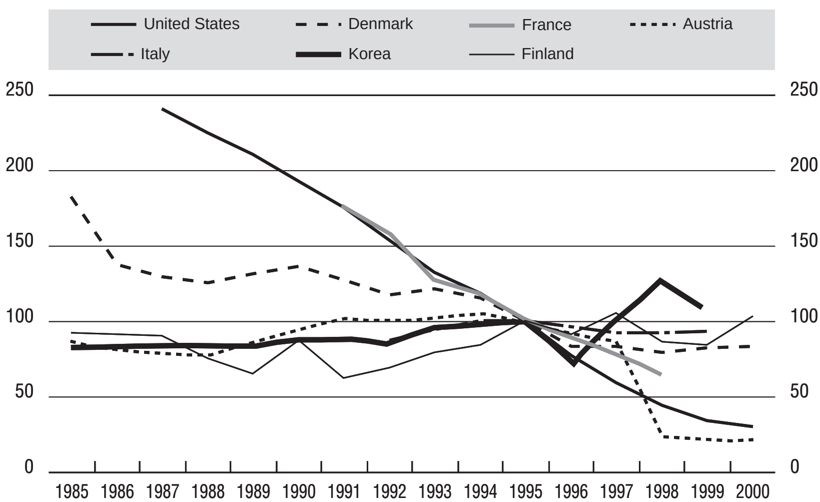
Labour productivity growth in ICT-producing industries

The contribution of the ICT-producing sector to recent growth performance reflects the productivity performance of the different ICT-related industries and

Box 2. **The use of hedonic deflators in the ICT-producing sector**

Several countries currently use hedonic methods to deflate output in the computer industry (*e.g.* Canada, Denmark, France, Sweden and the United States). The production price deflator for the computer industry (ISIC Rev 3, Division 30) is shown in Figure 2.* It shows a very rapid decline in production price indices for France and the United States, and a gradual decline in Denmark since 1984, but relatively little change in some other countries. These differences may partly reflect the use of a hedonic deflator in both France and the United States, the use of an exchange rate adjusted US hedonic deflator by Denmark, and the use of conventional deflators in the other countries.

Figure 2. **Producer price indexes for the computer industry, 1995 = 100**



Source: OECD calculations on the basis of the STAN database.

Adjusting for these methodological differences in computer deflators for the purpose of a cross-country comparison is difficult, however, since there are considerable cross-country differences in industrial specialisation. Only few OECD countries produce computers, where price falls have been very rapid; many only produce peripheral equipment, such as computer terminals. Similar differences in industry composition exist in Radio, Television and Communication Equipment (ISIC 32), which includes the semi-conductor industry. The differences in the composition of

Box 2. **The use of hedonic deflators in the ICT-producing sector** (*cont.*)

output are typically larger than in computer investment, where standardised approaches have been applied (*e.g.* Colecchia and Schreyer, 2001). Annex 1 shows some sensitivity analysis for the impact of different price indexes on output growth (see also Wyckoff, 1995).

* Production price indices for Canada are not available from the OECD STAN database.

their weight in the economy (see Annex 2). The OECD STAN database provides helpful information in this regard. While it does not cover all components of the ICT sector separately, the role of key industries has been examined.[5]

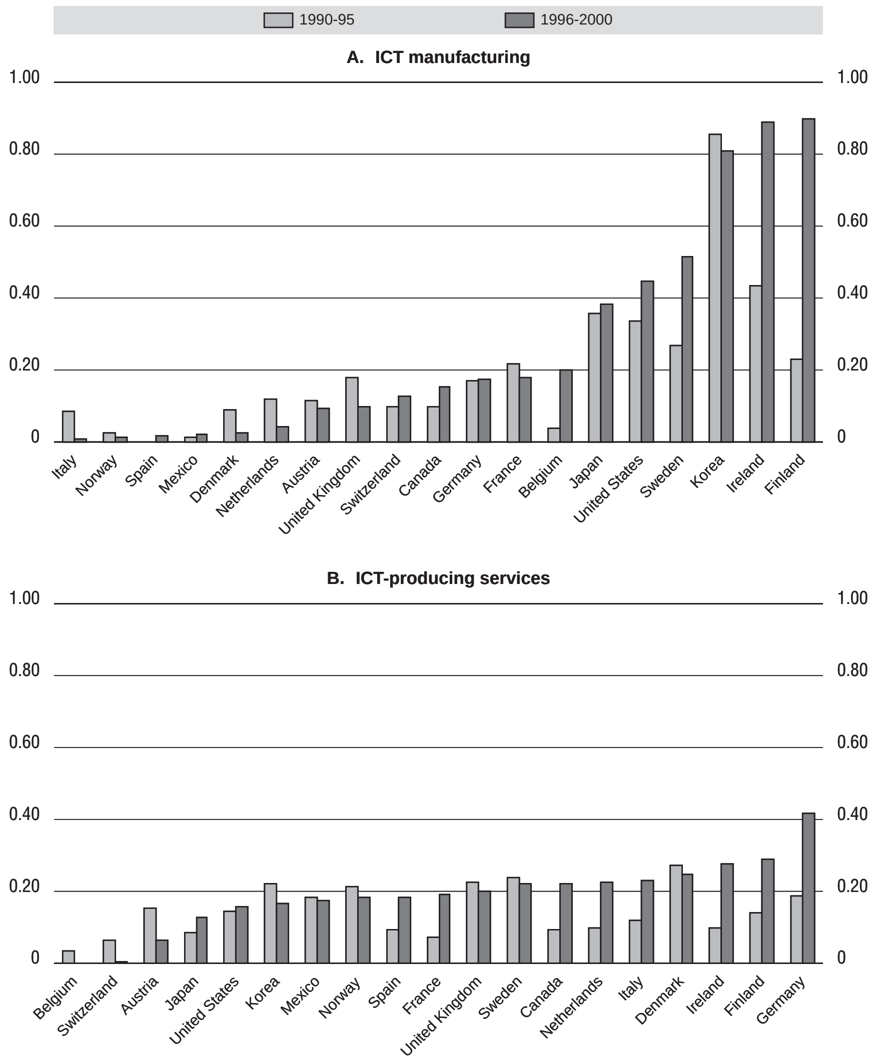
Figure 3a shows the contribution of ICT manufacturing to labour productivity growth over the 1990s, distinguishing between the first and second half of the decade.[6] In most OECD countries, the contribution of ICT manufacturing to overall labour productivity growth has risen over the 1990s. This can primarily be attributed to more rapid technological progress in the production of certain ICT goods, such as semi-conductors, which has contributed to more rapid price declines and thus to higher growth in volumes (Jorgenson, 2001).[7] ICT manufacturing made the largest contributions to aggregate labour productivity growth in Finland, Ireland and Korea, with close to 1 percentage point of aggregate labour productivity growth in the 1995-2000 period being due to ICT manufacturing.

The ICT-producing services sector (telecommunications and computer services) plays a smaller role in aggregate labour productivity growth, although it is also characterised by rapid improvements (Figure 3b). In part, rapid productivity growth is linked to the liberalisation of telecommunications markets and the high speed of technological change in this market. The contribution of this sector to overall labour productivity growth increased in several countries over the 1990s, notably in Finland, Germany and the Netherlands. Some of the growth in ICT-producing services is due to the emergence of the computer services industry, which has accompanied the diffusion of ICT in OECD countries.

Figure 3 suggests that the ICT sector is indeed an important driver of growth and productivity in a few OECD countries. But in most countries, the contribution of this sector to overall productivity growth is quite small, although it has typically increased over the 1990s.[8] This result is linked to differences in specialisation. Only

Figure 3. **Contribution of ICT-producing industries to aggregate labour productivity growth**

Total economy, value added per person employed, annual average contribution in percentage points



Note: 1991-1995 for Germany; 1992-95 for Italy and 1993-1995 for Korea; 1996-98 for Japan, Korea, Spain and Sweden, 1996-99 for France, Germany and the United Kingdom; 1996-2001 for Austria, Finland, Italy and the United States.

Source: Estimates on the basis of the OECD STAN database and data underlying Van Ark, *et al.* (2002b). See Annex tables for detail.

few OECD countries are specialised in those parts of ICT sector that are characterised by very rapid technological progress, *e.g.* the production of semi-conductors and electronic computers. Much of the production of this type of ICT hardware is highly concentrated, because of its large economies of scale and high entry costs. Establishing a new semi-conductor plant cost some USD 100 million in the early 1980s, but as much as USD 1.2 billion in 1999 (United States Council of Economic Advisors, 2001). In other words, only a few countries will have the necessary comparative advantages to succeed in producing these types of ICT products. This may not necessarily be a problem for countries that do not produce such goods to the extent that a substantial part of the benefits of ICT production accrue to importing countries and to users, as these can benefit from investment and consumer goods characterised by rapid price declines.

Does ICT use increase productivity growth?

Much of the current interest in ICT's potential impact on growth is not linked to the ICT-producing sector, but to the potential benefits arising from its use in the production process elsewhere in the economy. The use of ICT could have several impacts on productivity. For example, it might help more productive firms gain market share. In addition, the use of ICT may help firms expand their product range, customise the services offered, or respond better to client demand; in short, to innovate. Moreover, ICT may help reduce inefficiency in the use of capital and labour, *e.g.* by reducing inventories. All these effects might lead to higher productivity growth.

Investment in ICT might also have benefits going beyond those accruing to investors in ICT. For instance, the diffusion of ICT may help establish networks, which produce greater benefits (the so-called spillover effects) the more customers or firms are connected to the network. Moreover, the spread of ICT may reduce transaction costs, which could lead to a more efficient matching of supply and demand, and enable the growth of new markets. Increased use of ICT may also lead to greater efficiency in the creation of knowledge. Where such spillovers exist, they raise overall MFP growth (Bartelsman and Hinloopen, 2002). Studies at the firm level (for example Brynjolfsson and Hitt, 2000) indeed point to spillovers from ICT capital, but it has generally been difficult to confirm these results at more aggregate levels of analysis (Box 3).

One way to examine the role of ICT use in more detail is by focusing on those sectors that are the most intensive users of ICT. If the use of ICT is having effects on MFP growth, it is likely that heavy users would be the first sectors to experience such effects. Although computers may appear to be everywhere, the use of ICT is actually highly concentrated in the services sector and in a few manufacturing sectors (McGuckin and Stiroh, 2001).

Box 3. **The productivity paradox – has it been solved?**

The Solow paradox, attributed to economist Robert Solow who once observed that computers are everywhere except in the productivity data, was appropriate during much of the 1980s and early 1990s, when the rapid diffusion of computing technology seemed to have little impact on productivity growth (Solow, 1987). Many studies in the 1970s and 1980s showed negative or zero impacts of investment in ICT on productivity. Many of these focused on labour productivity, which made the findings surprising as investment in ICT adds to the productive capital stock and should thus, in principle, contribute to labour productivity growth. Later studies did find some evidence of a positive impact of ICT on labour productivity. Some also found evidence that ICT capital had larger impacts on labour productivity than other types of capital, suggesting that there might be spillovers from ICT investment.

Studies over the past decade have pointed to several factors that contributed to the productivity paradox. First, some of the benefits of ICT were not picked up in the productivity statistics (Triplett, 1999). This is mainly a problem in the service sector, where most ICT investment occurs. For instance, the improved convenience of financial services due to automatic teller machines (ATMs) is only counted as an improvement in the quality of financial services in some OECD countries. Similar problems exist for other activities such as insurance, business services and health services. ICT may have aggravated the problems of measuring productivity, as it allows greater customisation, differentiation and innovation in the services provided, most of which is difficult to capture in statistical surveys. Progress towards improved measurement has been made in some sectors and some OECD countries, but this remains an important problem in examining the impact of ICT on performance.

A second reason is that the benefits of ICT use might have taken a considerable time to emerge, as did the impacts of other key technologies, such as electricity. The diffusion of new technologies is often slow and firms can take a long time to adjust to them, *e.g.* in changing organisational arrangements, upgrading the workforce or inventing and implementing effective business processes. Moreover, assuming ICT raises MFP in part via the networks it provides, it takes time to build networks that are sufficiently large to have an effect on the economy. ICT has diffused very rapidly in many OECD countries in the 1990s and many recent empirical studies find a larger impact of ICT on economic performance than studies that were carried out with data for the 1970s or 1980s.

A third reason is that many early studies that attempted to capture the impact of ICT at the firm level were based on relatively small samples, drawn from private sources. If the initial impact of ICT on performance was small, such studies might find little evidence, as it would easily get lost in the econometric "noise". It is also possible that such samples were not representative of the total population. Moreover, several studies have suggested that the impact of ICT on economic performance may differ between activities, which implies that a sectoral distinction

Box 3. **The productivity paradox – has it been solved?** (*cont.*)

in the analysis is important. More recent studies based on large samples of (official) data and covering several industries are therefore more likely to find an impact of ICT than earlier studies. In addition, early studies used a wide variation of data on ICT and ICT diffusion, often of unknown quality. Much progress has been made in recent years in measuring ICT investment and the diffusion of ICT technologies, implying that the range of available data is broader, more robust and statistically more sound than previous data.

Empirical evidence on ICT use by industry is available for several countries, based on capital flow matrices and capital stock estimates. US capital flow data for 1992, for instance, show that certain manufacturing industries (*e.g.* printing and publishing, electronic equipment, instruments) as well as transport services, wholesale trade, finance, insurance and business services, are the largest relative investors in ICT equipment (BEA, 1998; Figure 4). These results are broadly confirmed for Canada, the Netherlands and the United Kingdom.

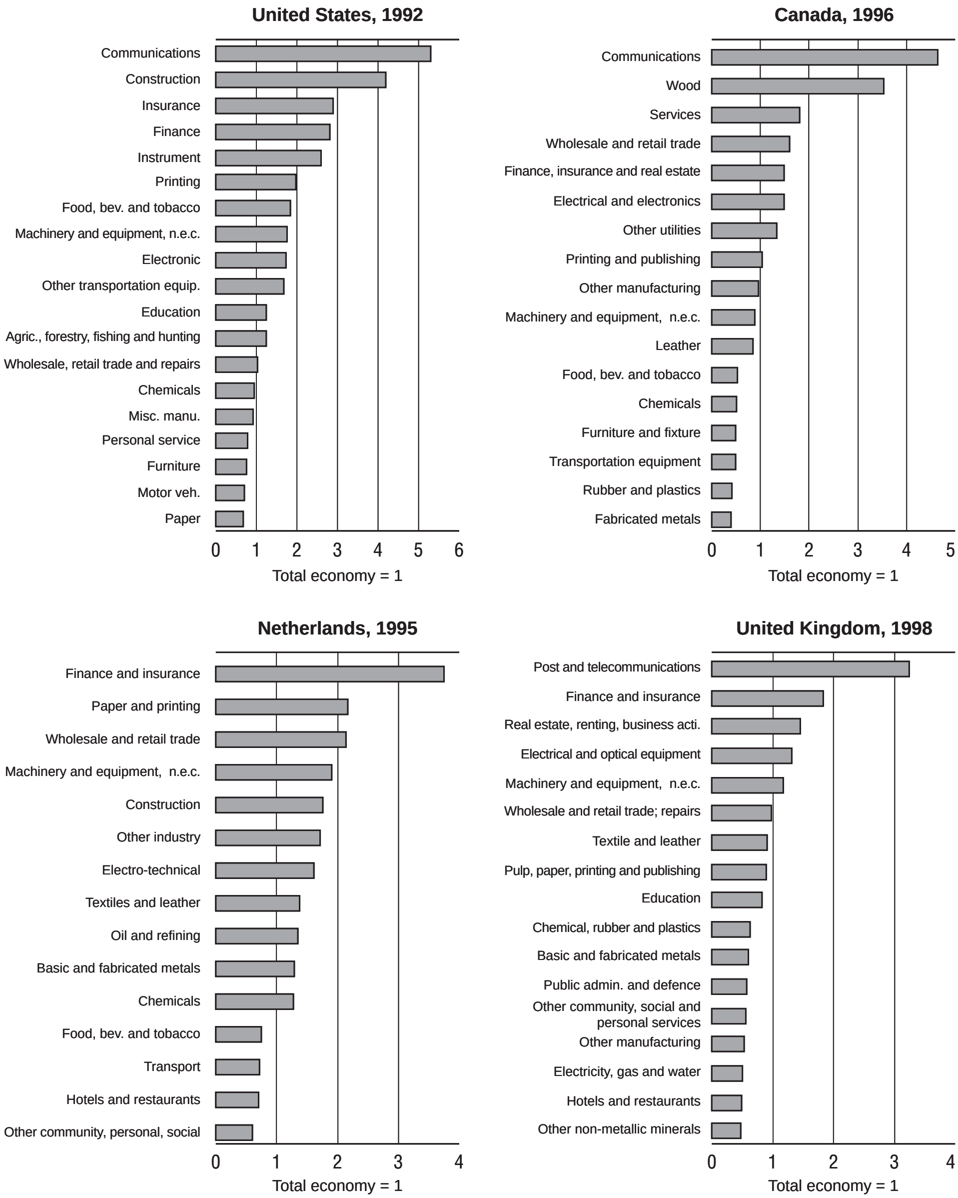
Several studies have focused on those industries that are intensive users of ICT (Stiroh, 2001; Van Ark, *et al.*, 2002b). Examining the performance of these sectors over time and comparing it with sectors of the economy that do not make intensive use of ICT, can help point to the role of ICT use in strengthening productivity growth.[9]

Labour productivity growth in ICT-using industries

In several of the sectors that are important users of ICT, output and productivity are hard to measure (Box 4). These measurement problems may obscure actual productivity gains (Gullickson and Harper, 1999). The STAN database distinguishes several of the ICT-using industries that were mentioned above, notably wholesale and retail trade, finance, insurance and business services. For the discussion here, the focus is primarily on these services, which are all intensive users of ICT. Figure 5 shows the contribution of the key ICT-using services to aggregate labour productivity growth over the 1990s.

Figure 5 suggests small improvements in the contribution of ICT-using services in Finland and Sweden, and substantial increases in Ireland and Mexico (where it reflects a rebound of very poor productivity performance in the first half

Figure 4. **Relative investment in ICT by economic activity**



Source: OECD calculations based on the data from the Bureau of Economic Analysis, Statistics Canada, CPB Netherlands Bureau for Economic Analysis, UK Office of National Statistics.

Box 4. **Measurement of productivity in ICT-using services**

For several parts of the services sector, output is difficult to measure (Dean, 1999). There is little agreement, for example, on the output of banking, insurance, medical care and retailing. In addition, it is difficult to separate service output from the consumer's role in eliciting the output. For example, output of the education sector is partly due to the efforts made by students themselves. Such difficulties indicate that the volume and price of services – and changes in their quality – are harder to measure than those of goods. In addition, some services are not sold in the market, so that it is hard to establish prices. In practice, these constraints mean that output in some services is measured on the basis of relatively simple indicators. Several series are deflated by wages or consumer prices or extrapolated from changes in employment, sometimes with explicit adjustment for assumed labour productivity changes. Given these difficulties, adjusting for quality is even more difficult.

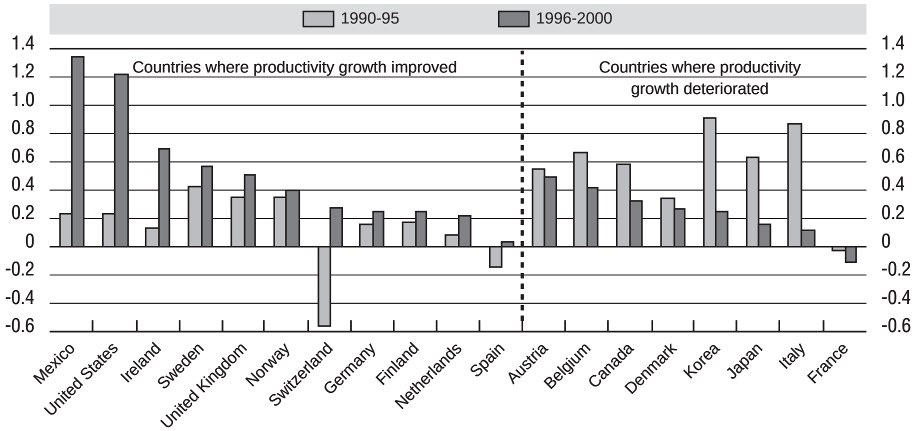
With better measurement, potential productivity gains may become visible. Fixler and Zieschang (1999), for example, derive new output measures for the US financial services industry (depository institutions). They introduce quality adjustments to capture the effects of improved service characteristics, such as easier and more convenient transactions, *e.g.* use of ATMs, and better intermediation. Their output index grows by 7.4 per cent a year between 1977 and 1994, well above the official measure for this sector of only 1.3 per cent a year on average. The recent revisions of GDP growth for the United States also incorporate improved estimates of banking output, notably on the real value of non-priced banking services, which better capture productivity growth in this industry.

While some new approaches to measurement in these sectors are being developed (Triplett and Bosworth, 2000), only few countries have thus far made substantial changes in their official statistics to improve measurement. The measurement problems can be seen clearly in the official productivity statistics for several countries, with several service industries showing negative MFP growth over a prolonged period.

of the 1990s). The United States has experienced the strongest improvement in labour productivity growth in ICT-using services over the 1990s, which is due to more rapid labour productivity growth in wholesale and retail trade, and in financial services (notably securities). In Switzerland, ICT-using services made a strong negative contribution to productivity growth in the first half of the 1990s, while France and Spain experienced small negative contributions during the second half of the 1990s.[10]

Figure 5. **Contribution of ICT-using services to aggregate labour productivity growth**

Total economy, value added per person employed, annual average contribution in percentage points



Note: See Figure 3 for period coverage.
Source: Estimates on the basis of the OECD STAN database and data underlying Van Ark, *et al.* (2002b). See Annex tables for detail.

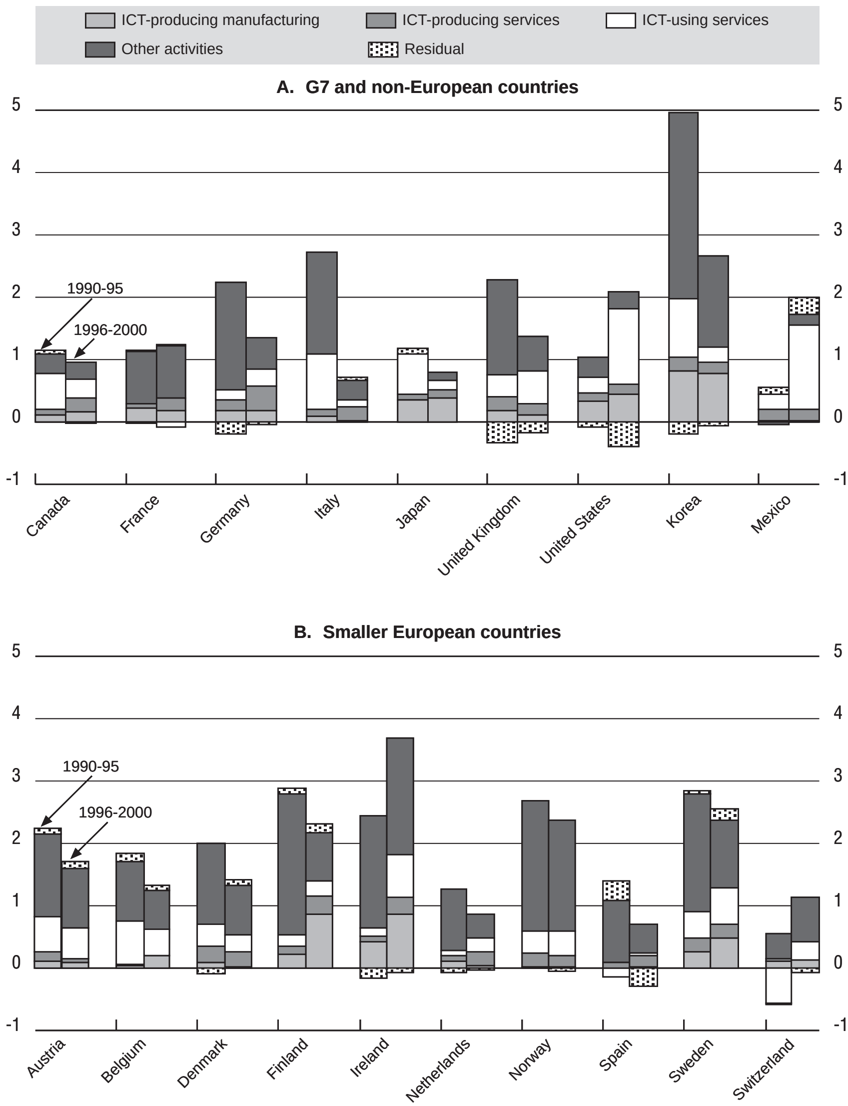
The impact of ICT use and production on aggregate productivity growth

From the examination above it is possible to determine how productivity growth in ICT-producing and ICT-using sectors have contributed to aggregate productivity growth in OECD countries. The contribution of ICT-producing, ICT-using industries and other activities to aggregate labour productivity growth is shown in Figure 6. Among the G7 countries, the United States is the only one that has experienced a marked improvement in labour productivity growth over the 1990s. Both ICT-producing and ICT-using industries contributed to the improvement in labour productivity growth, with the ICT-using sector accounting for the bulk of the pick-up in labour productivity in the second half of the 1990s.[11]

In the other G7 countries, the ICT-producing sector provided a slightly stronger contribution to labour productivity growth in the second half of the 1990s, but the contribution of ICT-using industries was small and declined in several countries over the 1990s. Among the other OECD countries, the growing contribution of the ICT-producing sector to labour aggregate productivity growth in the 1990s is also visible, in particular in Finland, Ireland and Korea. The ICT-using industries experienced no strong pick-up in labour productivity growth in the 1990s, however, Ireland and Mexico being exceptions.

Figure 6. **Contributions to aggregate labour productivity growth, 1990-1995 and 1996-2000**

Total economy, annual average contributions to total value added per person employed, in percentage points



Source: Estimates based on the OECD STAN database and data underlying Van Ark, *et al.* (2002b). See Annex tables for detail.

THE CONTRIBUTION OF ICT PRODUCTION AND USE TO MFP GROWTH

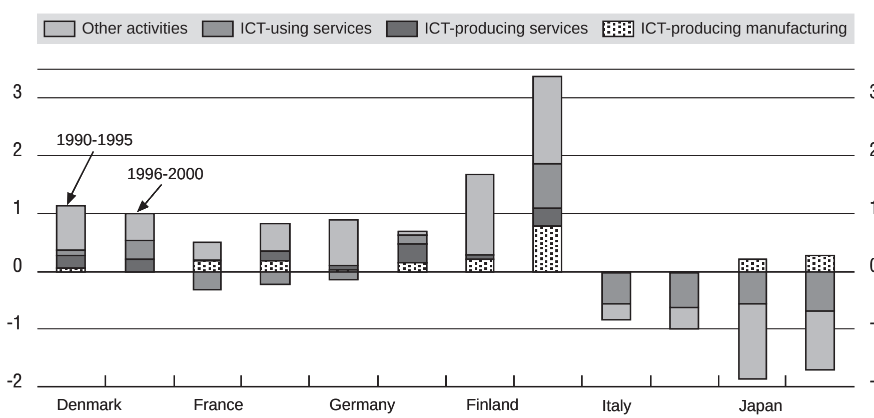
Stronger growth in labour productivity in ICT-producing and ICT-using industries could simply be due to capital deepening. Estimates of MFP growth adjust for this factor. Breaking aggregate MFP growth down in its sectoral contributions can help show whether changes in MFP growth should be attributed to ICT producing sectors, to ICT-using sectors, or to other sectors. Figure 7 shows the contribution of all activities to aggregate MFP growth for the six countries for which estimates of capital stock at the industry level were available in the OECD STAN database. It shows that the ICT-producing sector provided an important contribution to the acceleration in productivity growth in Finland, with both ICT-producing manufacturing and ICT-producing services providing a strong contribution. In Germany, the contribution of ICT production to MFP growth also increased over the 1990s, confirming rapid technological progress in this sector. In France, ICT-producing services provided a strong contribution to productivity growth in the second half of the 1990.

In ICT-using services, the MFP estimates point to growing contributions to aggregate productivity in Denmark and Germany, and to a substantial improvement in Finland. In the other countries, MFP growth in the ICT-using services was negative over the 1990s.

The OECD STAN database does not yet include capital stock for the United States, which implies that MFP estimates for the United States can not be derived

Figure 7. **Contributions of key sectors to MFP growth, 1990-95 and 1996-2000**

Total economy, contributions to annual average growth rates, in percentage points



1. Estimates are based on official estimates of capital stock and sector-specific labour shares (adjusted for self-employment). No adjustment is made for capital services, due to lack of relevant information at the industry-level.

Source: Estimates on the basis of the OECD STAN database.

Table 1. **Accounting for the acceleration in US productivity growth in the non-farm business sector**

1995-2000 minus 1973-1995 (percentage points per year)

	Oliner-Sichel (2002), 1974-1990 versus 1996-2001	Gordon (2002), 1972-95 versus 1995-2000	US Council of Economic Advisors (2001)	Jorgenson, Ho and Stiroh (2002)
Output per hour	0.89	1.44	1.39	0.92
Cycle	n.a.	0.40	n.a.	n.a.
Trend	0.89	1.04	1.39	0.92
Contributions from:				
Capital services	0.40	0.37	0.44	0.52
IT capital	0.56	0.60	0.59	0.44
Other capital	–0.17	–0.23	–0.15	0.08
Labour quality	0.03	0.01	0.04	–0.11
MFP growth	0.46	0.52	0.91	0.51
Computer sector	0.47	0.30	0.18	0.27
Other MFP	–0.01	0.22	0.72	0.24

Source: Gordon (2002); Jorgenson, Ho and Stiroh (2002); Oliner and Sichel (2002) updated from estimates received from Dan Sichel; Council of Economic Advisors (2001) as updated in Baily (2002).

from this source. Several studies provide estimates of the sectoral contributions to US MFP growth, however (Table 1). The results show considerable variation. Oliner and Sichel (2002) found no contribution of non-ICT producing industries to MFP growth; Gordon (2002) and Jorgenson, Ho and Stiroh (2002) found a relatively small contribution, while Baily (2002) and the US Council of Economic Advisors (2001) found a much more substantive contribution.[12]

The problem with some of the studies presented in Table 1 (*e.g.* Oliner and Sichel, 2002 and Gordon, 2002) is that all non-ICT producing sectors are combined, and the contribution of the non ICT-producing sector to aggregate MFP growth is calculated as a residual. More detailed examination for the United States suggests that this residual is indeed small, but typically made up of a positive contribution from wholesale and retail trade and financial services to MFP growth, and a negative contribution of other service sectors. For example, Triplett and Bosworth (2002) find a relatively strong pick-up in MFP growth in certain parts of the US service sector. They estimated that MFP growth in wholesale trade accelerated from 1.1 per cent annually to 2.4 per cent annually from 1987-1995 to 1995-2000. In retail trade, the jump was from 0.4 per cent annually to 3.0 per cent, and in securities the acceleration was from 2.9 per cent to 11.2 per cent. Combined with the relatively large weight of these sectors in the economy, this would translate into a considerable contribution to aggregate MFP growth of these ICT-using services.

There is therefore some evidence of strong MFP growth in the United States in ICT-using services. More detailed studies suggest how these productivity changes due to ICT use in the United States could be interpreted. First, a considerable part of the pick-up in productivity growth can be attributed to retail trade, where firms such as Walmart used innovative practices, such as the appropriate use of ICT, to gain market share from its competitors (McKinsey, 2001). The larger market share for Walmart and other productive firms raised average productivity and also forced Walmart's competitors to improve their own performance. Among the other ICT-using services, securities accounts also for a large part of the pick-up in productivity growth in the 1990s. Its strong performance has been attributed to a combination of buoyant financial markets (*i.e.* large trading volumes), effective use of ICT (mainly in automating trading processes) and stronger competition (McKinsey, 2001; Baily, 2002). These impacts of ICT on MFP are therefore primarily due to efficient use of labour and capital linked to the use of ICT in the production process. They are not necessarily due to network effects, where one firms' use of ICT has positive spillovers on the economy as a whole.

Spillover effects may also play a role, however, as ICT investment started earlier, and was stronger, in the United States than in most OECD countries (Colecchia and Schreyer, 2001; Van Ark, *et al.*, 2002a). Moreover, previous OECD work has pointed out that the US economy might be able to achieve greater benefits from ICT since it got its fundamentals right before many other OECD countries (OECD, 2001a). Indeed, the United States may have benefited first from ICT investment ahead of other OECD countries, as it already had a high level of competition in the 1980s, which it strengthened through regulatory reforms in the 1980s and 1990s. For example, early and far-reaching liberalisation of the telecommunications sector boosted competition in dynamic segments of the ICT market. The combination of sound macroeconomic policies, well-functioning institutions and markets, and a competitive economic environment may thus be at the core of the US success. A recent study by Gust and Marquez (2002) confirms these results and attributes relatively low investment in ICT in European countries partly to restrictive labour and product market regulations that have prevented firms from getting sufficient returns from their investment.

The United States is not the only country where ICT use may already have had impacts on MFP growth. Studies for Australia (Parham, *et al.*, 2001; Simon and Wardrop, 2001), suggest that a range of structural reforms have been important in driving the strong uptake of ICT by firms and have enabled these investments to be used in ways that generate productivity gains. This is particularly evident in wholesale and retail trade and in financial intermediation, where most of the Australian productivity gains in the second half of the 1990s have occurred.[13]

In sum, the United States and Australia are almost the only OECD countries where there is evidence at the sectoral level that ICT use can strengthen labour productivity and MFP growth. For most other OECD countries, there is little evidence that ICT-using industries are experiencing an improvement in labour productivity growth, let alone any change in MFP growth. Further improvements in labour and product markets, as well as a focus on policies to seize the benefits from ICT may be required in these countries before ICT will clearly show up in the productivity statistics.

NOTES

1. The available data are still somewhat too limited to permit regression analysis on the link between the size of the ICT sector and aggregate performance.
2. See Productivity Commission (1999) and Parham, *et al.* (2001) for an extensive discussion of the factors driving MFP growth in Australia.
3. Hedonic deflators for the output of ICT manufacturing are not the only measurement problem in this sector. Measuring input prices for these industries is also complicated, and requires detailed input-output tables as well as hedonic deflators for certain inputs, such as semi-conductors.
4. US price indexes for other types of software, *i.e.* custom-made and own-account, are of the conventional type and do not adjust for quality change.
5. The analysis here focuses on ISIC 30-33 (Office and computing machinery; Electrical machinery and apparatus; Radio, television and communication equipment; and Medical, precision and optical instruments) for ICT manufacturing, and ISIC 64 (Post and telecommunications) and ISIC 72 (Computer services) for ICT services. These sectors are often available from detailed national accounts. More detailed breakdowns, as demanded by the OECD definition of the ICT sector, create some problems in particular in estimating output and value added in constant prices. Data for wholesale of ICT equipment (ISIC 5150) and renting of ICT equipment (ISIC 7123) are also not available from STAN. Van Ark, *et al.* (2002b) provide more detailed estimates and discuss the methodological problems involved.
6. The productivity measurement in the paper follows the procedures outlined in OECD's Productivity Manual (OECD, 2001b). Since value added is more widely available in the STAN database than production, productivity measurement is based on value added. An industry's contribution to aggregate labour productivity growth is calculated as the difference between its contribution to the growth of total value added and its contribution to the growth of total labour input. See Annex 2 for details.
7. Aizcorbe (2002) shows that part of the decline in the prices of Intel chips over the 1990s can be attributed to a decline in Intel's mark-ups, which points to stronger competition in the production of chips.
8. Van Ark, *et al.* (2002b) show that this conclusion also holds up when US hedonic price indexes are applied to ICT production in other OECD countries.
9. A more rigorous method would be to examine the link between ICT use and productivity performance through econometric methods, *e.g.* panel estimation across countries. Unfortunately, the data to engage in such work are still too limited as only few countries provide the relevant ICT data by industry.

10. Poor measurement of output in the financial sector (banking, insurance and financial services) may be one factor driving this result. An OECD taskforce is currently working to improve output measurement in the banking sector.
11. The "residual" shown in Figure 6 is due to aggregation effects. It is typically small.
12. The differences between the various US studies are partly due to the data sources and methodology used, as well as the timing of various studies.
13. At the time of writing, Australia is not yet included in the OECD STAN database.

Annex I

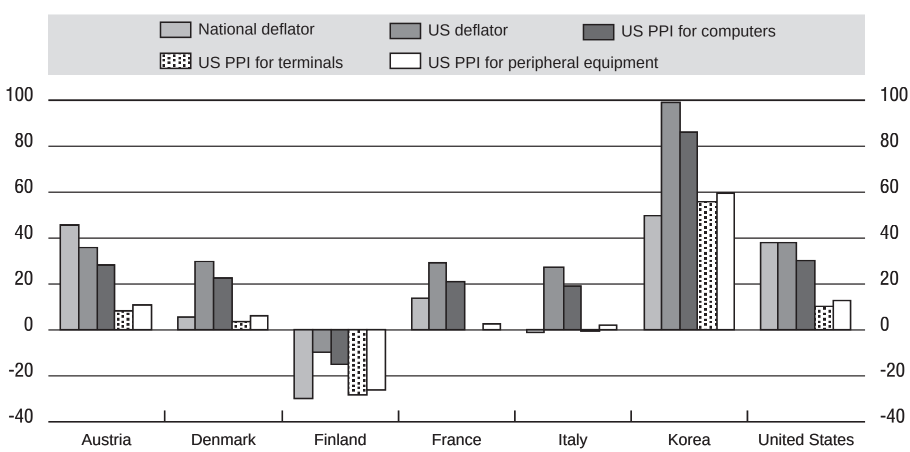
SENSITIVITY OF PRODUCTION GROWTH IN THE COMPUTER INDUSTRY TO PRICE INDEXES

The main paper argued that differences in industrial specialisation might limit the scope for application of the hedonic price index for the US computer industry to other countries. If certain countries only produce peripheral equipment or computer terminals, the US producer price index for the computer industry as a whole may not be appropriate, since the US index is heavily influenced by products where price declines are much more rapid, such as electronic computers. To illustrate this, Figure A1 shows average production growth in seven OECD countries, using five different producer price deflators, namely the deflator used in national statistics for ISIC 30 (Office, accounting and computer machinery), the US deflator for this industry, and the detailed PPIs for computers, computer terminals and peripheral equipment.

The graph illustrates the sensitivity of production growth to price deflators. In Austria, the price index used in the national accounts already adjusts for the sharp fall in computer prices.

Figure A1. **Growth of production in office, accounting and computer machinery, 1996-2000**

Annual average growth rates, in per cent



Source: OECD calculations based on STAN database, US PPI deflators from BLS, www.bls.gov.

In Denmark, the particular hedonics index that is used is quite close to the US PPIs for computer terminals or for peripheral equipment. The Italian result also mirrors the US PPI for these two industries. In Finland, use of the US PPI for the entire computer industry would understate the sharp fall in production, whereas the French hedonic deflator for ISIC 30 leads to slower growth than the US deflator for this industry. In Korea, the national deflator falls even slower than the US PPI for computer terminals, leading to a lower estimate of growth rates.

All of this shows that industrial specialisation matters. Hedonic price indexes for computer equipment are in general more appropriate for the computer-producing industry than conventional deflators, but they should be adjusted to the industry in question. The Danish hedonic deflator appears appropriate for a country that primarily produces peripheral equipment. Moreover, the conventional deflator used by the Italian Statistical Office may also be appropriate. Applying the US deflator would substantially overestimate production growth in these countries. This implies that further work is needed in statistical offices to develop appropriate hedonic indexes for the computer industry in each individual country.

Annex II

MEASURING LABOUR PRODUCTIVITY AND MULTIFACTOR PRODUCTIVITY

The productivity measurement in the paper follows the procedures outlined in OECD's *Productivity Manual* (OECD, 2001b). Since value added is more widely available in the STAN database than production, productivity measurement in this paper is based on value added. The value-added based measure of labour productivity by industry (π^{j}) is given by the relation $\pi^{j} = V\hat{A}^{j} - \hat{L}^{j}$. $V\hat{A}^{j}$ denotes the rate of change of real value-added in industry *j* and $\hat{L}^{j}$ the rate of change of labour input. The aggregate rate of change in value added is a share-weighted average of the industry-specific rate of change of value-added where weights reflect the current-price share of each industry in value-added:

$$V\hat{A} = \sum s_{VA}^{j} \cdot V\hat{A}^{j} \text{ , where } s_{VA}^{j} = \frac{P_{VA}^{j} VA^{j}}{P_{VA} VA},\ P_{VA} VA = \sum_{j} P_{VA}^{j} VA^{j}$$

On the input side, aggregation of industry-level labour input is achieved by weighting the growth rates of hours worked by industry with each industry's share in total labour compensation.

$$\hat{L} = \sum_{j} s_{L}^{j} \cdot \hat{L}^{j} \text{, where } s_{L}^{j} = \frac{w^{j} L^{j}}{wL} \text{ , } wL = \sum_{j} w^{j} L^{j}$$

Aggregate labour productivity growth is defined as the difference between aggregate growth in value-added and aggregate growth in labour input:

$$\Pi = \sum_{j} (s_{VA}^{j} V\hat{A}^{j} - s_{L}^{j} \hat{L}^{j})$$

An industry's contribution to aggregate labour productivity growth is $s_{VA}^{j} V\hat{A}^{j} - s_{L}^{j} \hat{L}^{j}$, or the difference between its contribution to total value-added and to total labour input. If $s_{VA}^{j} = s_{L}^{j}$, total labour productivity growth is a simple weighted average of industry-specific labour productivity growth.

Multifactor productivity growth, on the basis of value added, is computed as the difference between the rate of growth of deflated value-added and the rate of growth of the primary factor inputs. It is straightforward to aggregate industry-level productivity growth to an economy-wide measure. Aggregation weights are simply each industry's current price share in total value-added.

Source: OECD (2001b).

Annex Table 1. **Contributions to labour productivity growth by industry, 1990-1995**[1]

Contributions to value added per person engaged, in percentage point per year

	ISIC Rev. 3	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Ireland	Italy	Japan	Korea	Mexico	Netherlands	Norway	Spain	Sweden	Switzerland	UK	US
Total economy	**01-99**	**2.32**	**1.91**	**1.19**	**1.99**	**3.01**	**1.17**	**2.10**	**2.39**	**2.83**	**1.20**	**4.94**	**0.51**	**1.24**	**2.79**	**1.30**	**2.95**	**–0.03**	**2.02**	**0.97**
ICT-producing manufacturing	**30-33**	**0.12**	**0.04**	**0.10**	**0.09**	**0.23**	**0.22**	**0.17**	**0.43**	**0.08**	**0.36**	**0.85**	**0.01**	**0.12**	**0.03**	**..**	**0.27**	**0.10**	**0.18**	**0.33**
Office, accounting and comp. mach.	30	0.00	..	0.02	0.02	0.01	0.07	0.05	0.28	0.01	..	0.04	0.02	..	0.00	..	0.01	0.00	..	..
Electrical machinery, nec	31	0.04	..	0.01	0.04	0.04	0.06	0.03	0.12	..	..	0.04	–0.01	..	0.01	..	0.03	0.00	..	..
Radio, TV and comm. equipment	32	0.06	..	0.03	0.01	0.19	0.09	0.07	..	..	..	0.75	0.01	..	0.01	..	0.19	0.03	..	..
Medical, precision and optical instr.	33	0.02	..	0.04	0.02	0.00	–0.01	0.03	0.03	0.02	0.00	0.05	..	..	0.00	..	0.04	0.06	..	0.00
ICT-producing services	**64+72**	**0.15**	**0.04**	**0.09**	**0.27**	**0.14**	**0.07**	**0.19**	**0.10**	**0.12**	**0.08**	**0.22**	**0.19**	**0.10**	**0.21**	**0.09**	**0.24**	**0.06**	**0.23**	**0.14**
Post and telecommunications	64	0.14	0.04	0.07	0.12	0.15	0.04	0.17	0.07	0.11	0.08	0.22	0.19	0.10	0.22	0.09	0.18	0.09	0.17	0.14
Computer services	72	0.02	..	0.03	0.15	–0.01	0.04	0.02	0.03	0.01	..	..	..	..	0.00	..	0.05	–0.03	0.05	..
ICT-using services		**0.59**	**0.70**	**0.61**	**0.37**	**0.19**	**–0.02**	**0.17**	**0.15**	**0.92**	**0.67**	**0.96**	**0.25**	**0.09**	**0.37**	**–0.15**	**0.45**	**–0.58**	**0.37**	**0.24**
Wholesale and retail trade, repairs	50-52	0.15	0.24	0.22	0.36	0.21	0.16	0.07	–0.04	0.57	0.31	0.10	–0.33	0.02	0.38	0.06	0.42	–0.15	0.15	0.25
Financial intermediation	65-67	0.23	..	0.34	–0.07	–0.06	–0.02	0.06	0.33	0.25	–0.04	0.44	0.27	–0.03	–0.08	–0.18	0.10	–0.06	0.13	0.12
Financ. interm, excl. insur./pens.	65	0.24	..	0.27	–0.07	–0.05	–0.07	0.05	0.21	0.18	..	..	..	..	–0.10	..	0.10	–0.12	0.09	0.06
Insurance and pension funding	66	0.00	..	0.07	–0.01	–0.01	0.00	0.03	0.09	0.03	..	..	..	..	0.01	..	..	0.08	0.05	0.02
Activities related to fin. int.	67	0.00	..	..	0.02	0.00	0.04	–0.01	0.04	0.04	..	..	..	..	0.00	..	..	–0.02	0.01	0.01
Renting of m.and eq., other buss. act.	71-74	0.21	..	0.06	0.22	0.04	–0.13	0.04	–0.15	0.11	0.41	0.41	0.30	0.10	0.08	–0.03	–0.07	–0.37	0.18	–0.10
Renting of mach. and equipm.	71	0.07	..	..	0.07	–0.01	–0.01	0.04	0.01	..	..	..	..	..	0.03	..	–0.04	0.00	0.03	..
Research and development	73	0.02	..	0.03	0.00	0.00	–0.02	0.00	–0.03	..	..	..	..	..	0.00	..	0.00	–0.01	0.01	..
Other business activities	74	0.10	..	0.03	–0.01	0.05	–0.12	–0.01	–0.13	0.11	..	..	..	..	0.05	..	–0.03	–0.36	0.03	..

Annex Table 1. **Contributions to labour productivity growth by industry, 1990-1995**[1] (*cont.*)

Contributions to value added per person engaged, in percentage point per year

	ISIC Rev. 3	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Ireland	Italy	Japan	Korea	Mexico	Netherlands	Norway	Spain	Sweden	Switzerland	UK	US
Other activities		**1.38**	**1.04**	**0.31**	**1.35**	**2.35**	**0.89**	**1.79**	**1.87**	**1.78**	**0.02**	**3.96**	**–0.04**	**1.13**	**2.20**	**1.04**	**1.95**	**0.41**	**1.77**	**0.68**
Agriculture, forestry, fishing	01-05	0.31	0.07	0.03	0.24	0.41	0.19	0.19	0.52	0.39	0.08	0.82	0.12	0.19	0.31	0.04	0.07	–0.02	0.03	0.01
Mining and quarrying	10-14	–0.01	0.01	0.15	0.05	0.02		0.09	0.07	0.02	0.00	0.08	0.08	0.06	1.38	0.05	0.01	–0.01	0.27	0.05
Non-ICT manufacturing	15-29, 34-37	0.68	0.52	0.31	0.31	0.90	0.61	1.03	1.77	0.84	0.13	2.61	0.50	0.59	0.12	0.46	0.91	0.52	0.81	0.56
Electricity, gas and water	40-41	0.06	0.08	0.07	0.10	0.10	0.02	0.07	0.11	0.08	0.07	0.21	0.01	0.06	0.07	0.05	0.02	0.16	0.18	0.06
Construction	45	0.18	–0.03	–0.07	–0.04	0.12	0.06	–0.10	–0.08	0.01	–0.09	0.32	–0.21	–0.05	0.18	0.14	0.15	–0.12	0.14	0.00
Hotels and restaurants	55	–0.03	0.00	0.04	0.02	0.11	–0.15	–0.09	–0.26	–0.01		–0.19	–0.11	–0.01	–0.04	0.07	0.05	–0.18	–0.05	0.01
Transport and storage	60-63	0.01	0.08	0.06	0.14	0.25	0.04	0.19	0.17	0.26	–0.09	0.21	–0.07	0.15	0.36	0.15	–0.02	–0.14	0.13	0.06
Real estate	70	0.15	..	..	0.06	0.35	0.16	0.32	–0.03	0.12	0.32	..	..	..	0.12	0.15	0.29	0.28	–0.05	0.23
Comm., social, pers. services	75-99	0.03	0.32	–0.28	0.47	0.10	–0.04	0.10	–0.41	0.08	–0.40	–0.09	–0.37	0.14	–0.30	–0.06	0.47	–0.09	0.32	–0.30
Sum of sectors		**2.23**	**1.82**	**1.12**	**2.08**	**2.91**	**1.16**	**2.31**	**2.55**	**2.90**	**1.13**	**6.00**	**0.40**	**1.43**	**2.81**	**0.98**	**2.90**	**–0.01**	**2.55**	**1.40**
Residual		**0.09**	**0.10**	**0.07**	**–0.09**	**0.10**	**0.01**	**–0.21**	**–0.16**	**–0.07**	**0.07**	**–1.06**	**0.11**	**–0.19**	**–0.02**	**0.32**	**0.05**	**–0.02**	**–0.53**	**–0.43**

1. 1991-95 for Germany; 1992-95 for Italy and 1993-95 for Korea.

Source: OECD STAN database and data underlying Van Ark, *et al.* (2002b).

Annex Table 2. **Contributions to labour productivity growth by industry, 1996-2000**[1]

Contributions to value added per person engaged, in percentage point per year

	ISIC Rev. 3	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Ireland	Italy	Japan	Korea	Mexico	Netherlands	Norway	Spain	Sweden	Switzerland	UK	US
Total economy	**01-99**	**1.78**	**1.39**	**0.94**	**1.47**	**2.41**	**1.18**	**1.34**	**3.76**	**0.74**	**0.83**	**2.70**	**2.07**	**0.89**	**2.41**	**0.44**	**2.67**	**1.10**	**1.21**	**1.74**
ICT-producing manufacturing	**30-33**	**0.09**	**0.20**	**0.15**	**0.03**	**0.90**	**0.18**	**0.17**	**0.89**	**0.01**	**0.38**	**0.81**	**0.02**	**0.04**	**0.01**	**0.02**	**0.51**	**0.13**	**0.10**	**0.45**
Office, accounting and comp. mach.	30	0.03	..	0.00	0.01	0.00	0.04	0.04	0.37	0.00	..	0.09	..	..	0.00	0.00	0.01	0.01	0.07	..
Electrical machinery, nec	31	0.05	..	0.05	–0.01	0.05	0.01	0.06	0.36	..	..	–0.10	..	..	0.01	0.02	0.01	0.10	..	..
Radio, TV and comm. equipment	32	–0.01	..	0.05	0.00	0.85	0.11	0.06	..	..	..	0.71	..	..	0.01	0.00	0.43	0.00	..	..
Medical, precision and optical instr.	33	0.01	..	0.05	0.02	0.01	0.01	0.02	0.18	0.00	0.02	–0.02	..	..	–0.01	0.00	0.07	0.02	–0.03	–0.01
ICT-producing services	**64+72**	**0.06**	**..**	**0.22**	**0.25**	**0.29**	**0.19**	**0.42**	**0.28**	**0.23**	**0.13**	**0.17**	**0.17**	**0.23**	**0.18**	**0.18**	**0.22**	**0.01**	**0.20**	**0.16**
Post and telecommunications	64	0.09	..	0.21	0.17	0.36	0.20	0.31	–0.03	0.19	0.13	0.17	0.17	0.27	0.18	0.19	0.18	0.04	0.23	0.16
Computer services	72	–0.02	..	0.01	0.08	–0.07	–0.01	0.11	0.31	0.04	..	..	..	–0.04	0.00	0.00	0.05	–0.04	–0.03	..
ICT-using services		**0.52**	**0.44**	**0.34**	**0.28**	**0.26**	**–0.11**	**0.27**	**0.73**	**0.13**	**0.17**	**0.27**	**1.41**	**0.23**	**0.42**	**0.04**	**0.60**	**0.29**	**0.54**	**1.29**
Wholesale and retail trade, repairs	50-52	0.20	–0.05	0.14	0.16	0.18	0.02	–0.01	0.25	0.05	–0.10	–0.04	1.01	0.32	0.39	0.09	0.40	–0.08	0.10	0.92
Financial intermediation	65-67	0.20	0.22	0.22	0.15	0.21	–0.07	0.30	0.03	0.12	0.08	0.09	0.19	0.01	–0.05	0.00	0.24	0.56	0.12	0.43
Financ. interm, excl. insur./pens.	65	0.20	..	0.22	0.11	0.18	–0.05	0.30	0.03	0.15	..	..	..	–0.01	–0.05	0.03	0.24	0.50	0.12	0.21
Insurance and pension funding	66	0.04	..	0.00	0.08	0.00	–0.01	–0.02	0.00	0.00	..	..	..	0.00	0.00	–0.06	..	0.05	0.00	0.01
Activities related to fin. int.	67	–0.01	..	..	–0.03	0.04	0.00	0.02	0.00	–0.01	..	..	..	0.03	0.00	0.03	..	0.01	0.00	0.19
Renting of m. and eq., other buss. act.	71-74	0.10	0.28	–0.02	0.05	–0.18	–0.07	0.10	0.45	–0.02	0.19	0.21	0.21	–0.15	0.08	–0.06	–0.04	–0.18	0.28	–0.05
Renting of mach. and equipm.	71	0.07	..	..	0.00	0.01	0.03	0.10	0.04	..	..	..	..	0.07	0.03	0.01	–0.01	0.00	0.02	..
Research and development	73	0.00	..	0.00	0.00	–0.01	–0.01	0.00	–0.02	..	..	..	..	–0.02	0.00	0.00	0.00	–0.02	–0.03	..
Other business activities	74	0.04	..	–0.03	–0.04	–0.13	–0.08	–0.11	0.43	–0.01	..	..	..	–0.21	0.05	–0.11	–0.03	–0.16	0.32	..

Annex Table 2. **Contributions to labour productivity growth by industry, 1996-2000**[1] (*cont.*)

Contributions to value added per person engaged, in percentage point per year

	ISIC Rev. 3	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Ireland	Italy	Japan	Korea	Mexico	Netherlands	Norway	Spain	Sweden	Switzerland	UK	US
Other activities		**0.98**	**0.66**	**0.26**	**0.82**	**0.81**	**0.88**	**0.54**	**1.93**	**0.31**	**0.53**	**1.53**	**0.18**	**0.41**	**1.84**	**0.49**	**1.14**	**0.74**	**0.58**	**0.27**
Agriculture, forestry, fishing	01-05	0.16	0.05	0.14	0.15	0.19	0.14	0.09	0.24	0.09	0.03	0.10	0.07	0.04	0.22	0.24	0.09	–0.12	–0.02	0.07
Mining and quarrying	10-14	0.01	0.00	0.02	0.21	0.00	..	0.03	0.01	–0.01	0.01	–0.02	0.04	–0.03	1.40	0.00	0.00	0.01	0.03	–0.01
Non-ICT manufacturing	15-29, 34-37	0.69	0.55	0.31	0.31	0.36	0.43	0.11	2.84	0.21	0.59	1.04	0.52	0.35	0.06	0.01	0.41	0.64	0.13	0.09
Electricity, gas and water	40-41	0.09	0.14	0.04	–0.03	0.08	0.09	0.08	0.09	0.06	0.13	0.19	0.00	0.04	0.02	0.15	0.01	–0.01	0.10	–0.01
Construction	45	0.13	0.07	0.02	0.00	–0.12	–0.10	0.11	–0.38	0.01	–0.40	0.61	–0.37	–0.04	0.06	–0.12	0.00	0.02	–0.11	–0.06
Hotels and restaurants	55	0.06	0.01	–0.06	–0.03	–0.04	–0.03	–0.10	–0.24	–0.04	..	–0.16	0.07	0.02	–0.06	0.00	0.04	0.04	–0.01	–0.01
Transport and storage	60-63	0.08	0.13	0.06	0.22	0.14	0.12	0.12	–0.05	–0.04	–0.04	0.30	0.24	0.11	0.44	0.20	0.15	0.10	0.08	0.01
Real estate	70	0.12	..	..	0.19	0.34	0.20	0.21	0.04	0.07	0.40	..	..	0.17	0.05	0.04	0.11	0.30	0.30	0.32
Comm., social, pers. services	75-99	–0.36	–0.29	–0.28	–0.19	–0.13	0.05	–0.11	–0.62	–0.05	–0.19	–0.53	–0.39	–0.24	–0.34	–0.03	0.33	–0.22	0.08	–0.14
Sum of sectors		**1.65**	**1.29**	**0.97**	**1.37**	**2.27**	**1.15**	**1.40**	**3.83**	**0.68**	**1.21**	**2.77**	**1.78**	**0.91**	**2.47**	**0.74**	**2.48**	**1.17**	**1.41**	**2.16**
Residual		**0.12**	**0.10**	**–0.04**	**0.09**	**0.14**	**0.04**	**–0.05**	**–0.07**	**0.06**	**–0.38**	**–0.07**	**0.28**	**–0.02**	**–0.06**	**–0.30**	**0.19**	**–0.07**	**–0.20**	**–0.42**

1. 1996-98 for Japan, Korea, Spain and Sweden; 1996-99 for France, Germany and the United Kingdom; 1996-2001 for Austria, Finland, Italy and the United States.

Source: OECD STAN database and data underlying Van Ark, *et al.* (2002b).

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