Unclassified **DSTI/DOC(2001)4**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

18-Jun-2001

English text only

DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY

DSTI/DOC(2001)4
Unclassified

STI WORKING PAPERS 2001/4

PRODUCTIVITY GROWTH IN ICT-PRODUCING AND ICT-USING INDUSTRIES: A SOURCE OF GROWTH DIFFERENTIALS IN THE OECD?

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JT00109724

English text only

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PRODUCTIVITY GROWTH IN ICT-PRODUCING AND ICT-USING INDUSTRIES: A SOURCE OF GROWTH DIFFERENTIALS IN THE OECD?

Dirk Pilat and Frank C. Lee[1]

This paper examines the roles of the ICT-producing sector and of key ICT-using industries in overall productivity growth in OECD countries. The ICT-producing sector provides a considerable contribution to productivity growth in several OECD countries and explains some of the pick-up in productivity growth in the United States in the second half of the 1990s. ICT manufacturing, in particular, has been characterised by very high rates of productivity growth in many countries. Some countries with a large ICT sector, such as Finland and Ireland, have experienced above-average multifactor productivity (MFP) growth in the second half of the 1990s. But some countries with a small ICT sector, such as Australia, have also observed rapid MFP growth, suggesting that a large ICT sector is no prerequisite for faster MFP growth. In some countries, notably Finland and the United States, certain ICT-using services have also experienced an above-average pick-up in productivity growth in the second half of the 1990s. This may indicate that ICT investment is having spillovers beyond the ICT sector itself. However, there is still insufficient evidence to attribute productivity improvements in these sectors directly to their use of ICT. Differences in the measurement of productivity in ICT-producing and -using industries across countries complicate the cross-country analysis. Considerable differences remain across countries in investment and uptake of ICT, which may be partly due to policy differences, including those related to competition and regulatory reform.

LA CROISSANCE DE LA PRODUCTIVITE DANS LES INDUSTRIES PRODUCTRICES ET UTILISATRICES DE TECHNOLOGIES DE L'INFORMATION ET DES COMMUNICATIONS : UNE SOURCE DE DIFFERENTIELS DE CROISSANCE DANS LA ZONE DE L'OCDE ?

Dirk Pilat et Frank C. Lee

Ce document analyse les rôles respectifs du secteur qui produit les biens et services basés sur les technologies de l'information et des communications (TIC) et des principales industries utilisatrices de TIC dans la croissance globale de la productivité. Le secteur producteur de TIC contribue de façon considérable à la croissance de la productivité dans plusieurs pays Membres de l'OCDE et explique aussi en partie la reprise de la croissance de la productivité aux États-Unis au cours de la seconde moitié des années 90. Dans les industries manufacturières du secteur des TIC, en particulier, la croissance de la productivité a été très forte dans de nombreux pays. Certains pays qui disposent d'un important secteur des TIC (Finlande, Irlande) ont connu des taux de croissance de la PMF plus élevés au cours de la seconde moitié des années 90. Toutefois, d'autres pays dont le secteur des TIC est plus réduit, comme l'Australie, ont eux aussi enregistré une progression rapide de la PMF, ce qui donne à penser qu'il n'est pas indispensable de disposer d'un vaste secteur des TIC pour connaître une forte progression de la PMF. Dans quelques pays (notamment aux États-Unis et en Finlande), certains services utilisateurs de TIC ont enregistré une reprise supérieure à la moyenne de la croissance de la productivité au cours de la seconde moitié des années 90. Cela pourrait indiquer que les TIC ont des effets d'entraînement au-delà du secteur des TIC lui-même. Toutefois, les éléments restent encore insuffisants pour attribuer directement les améliorations de la productivité dans ces secteurs au fait qu'ils investissent dans les TIC ou les utilisent. L'analyse internationale est compliquée par les différences qui existent entre les pays en ce qui concerne la mesure de la productivité du secteur producteur de TIC et des industries utilisatrices de ces technologies. Il subsiste des écarts considérables entre les pays dans les taux d'investissement dans les TIC et dans l'utilisation de ces technologies, ces écarts étant dus en partie à des différences dans les politiques suivies, notamment en matière de concurrence et de réforme de la réglementation.

Introduction

The strong performance of the United States over the past nine years and the uneven performance of other OECD economies have led to renewed attention to the sources of growth and the determinants of convergence and divergence across OECD economies. Studies over the past year (Scarpetta *et al.*, 2000; OECD, 2000*a*; Gust and Marquez, 2000) have demonstrated that there is no single factor that explains divergence in growth performance. OECD countries that have improved performance in the 1990s have generally been able to draw more people into employment, have increased investment, and have improved the overall efficiency of labour and capital, or multifactor productivity (MFP).

Information and communications technology (ICT) plays two roles in the growth process, first by contributing heavily to the increase in overall investment, secondly by contributing to MFP growth. The role of ICT investment in growth performance is confirmed by a range of empirical studies, for the United States and several other OECD countries (Jorgenson and Stiroh, 2000; Oliner and Sichel, 2000; Whelan, 2000; Schreyer, 2000; CPB, 2000*a*; Colecchia, 2001). High investment is partly due to the rapid decline in computer prices, which has led to substitution between different types of capital goods. In addition, investment seems to driven by the perceived benefits that firms expect from ICT, such as higher efficiency.

The contribution that ICT makes to MFP growth is more controversial. A debate has ensued in the United States whether the pick-up in MFP is not primarily due to technological progress in the *production* of ICT goods and services, or whether it also reflects efficiency gains in ICT-*using* sectors (Jorgenson, 2001). The difference between these two interpretations of MFP growth is important. In the first view, the rise in MFP is little more than a reflection of rapid technological progress in the production of computers, semi-conductors and related products. In the second view, ICT is a technology that may also assist other sectors of the economy in becoming more efficient and innovative, which might imply that other countries could also achieve some improvement in MFP growth, albeit in a different context than the United States.

The evidence from the US experience is mixed. A few studies attribute the bulk of the recent improvement in MFP to the ICT-producing sector (Gordon, 2000). OECD work also shows that ICT-producing industries have made significant contributions to labour productivity growth in several OECD countries, including Finland, Japan, Sweden and the United States (Scarpetta *et al.*, 2000). The relative importance of the ICT-producing sector in different countries, and its growth over time, might thus be one cause for the large differences in growth performance that have been observed in several OECD countries in recent years.

Other studies have attributed a substantial part of the pick-up in US MFP growth to non-ICT producing sectors, notably the service sector (*e.g.* Council of Economic Advisors, 2000; Jorgenson and Stiroh, 2000; Stiroh, 2001). Certain services, such as telecommunications, financial services, insurance and business services, are among the key users of ICT, but productivity growth in these sectors has often been sluggish. While measurement may be partly to blame, there is also a view that ICT has not yet had any real impact on MFP in some services sectors. The second issue addressed in this paper is therefore an empirical, cross-country examination of productivity growth in the ICT-using sectors, notably services.

The next section discusses the role of ICT-producing industries in the growth process. Section three discusses the role of ICT-using industries and section four draws some conclusions. An annex to the study provides further detail on the calculations and some methodological issues.

The role of ICT-producing industries

What is the ICT sector?

The ICT sector only accounts for a small share of the economy. The scope of the sector has recently been defined by OECD's Working Party on Indicators for the Information Society (Box 1) and includes both manufacturing and services. Its share in business employment ranges from between 0.5% (in Turkey) to 6.3% (in Sweden). Its share in value-added is slightly larger, showing that it has an above-average level of labour productivity, and ranges from 4.1% (in Australia) to 10.7% (in Korea) of total business sector value-added (Figure 1*a*). The share of ICT manufacturing is substantially smaller and ranges between 0.1 and 2.8 % of total business employment, and between 0.1 and 7.9% of total business value added (Figure 1*b*). Korea and Ireland have the largest ICT manufacturing sectors, followed by Finland, Japan, Sweden and the United States. Australia, New Zealand and Turkey, in contrast, have only a very small sector producing manufactured ICT goods.

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

The ICT-producing sector includes the following industries according to the International Standard Industry Classification (ISIC) Revision 3:

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 – goods related

5150	Wholesale of machinery, equipment and supplies
7123	Renting of office machinery and equipment (including computers)

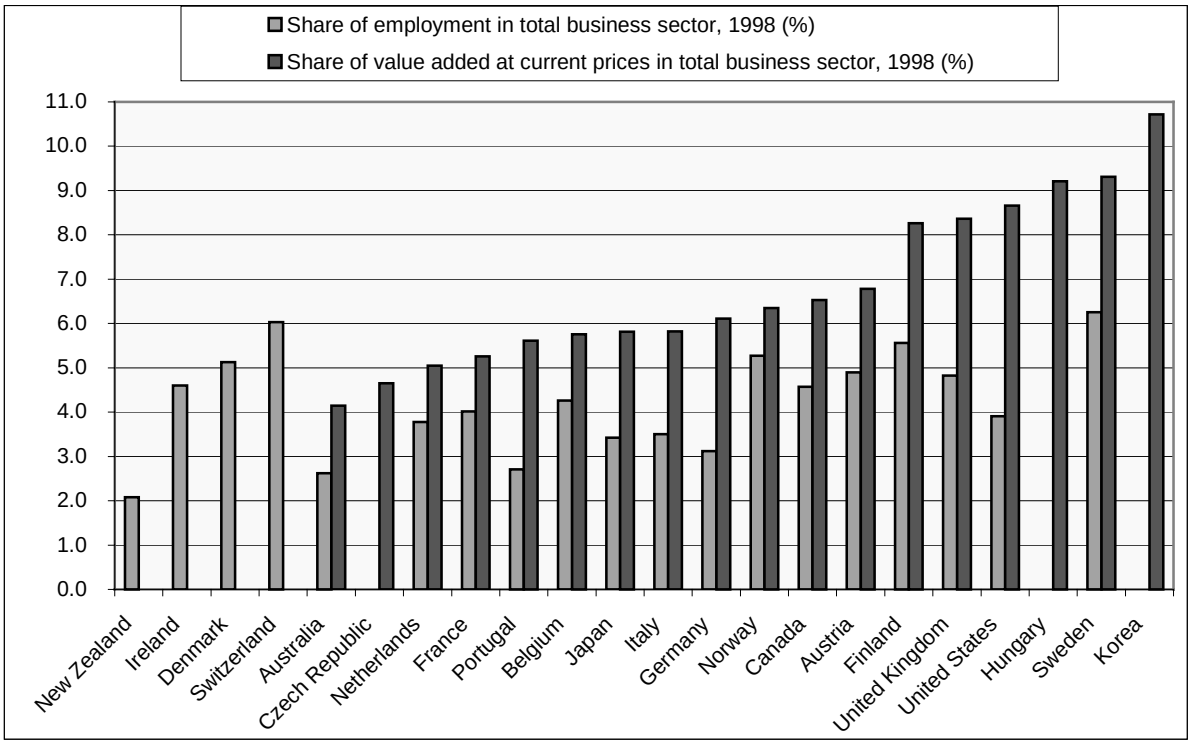
Services – intangible

6420	Telecommunications
7200	Computer and related activities

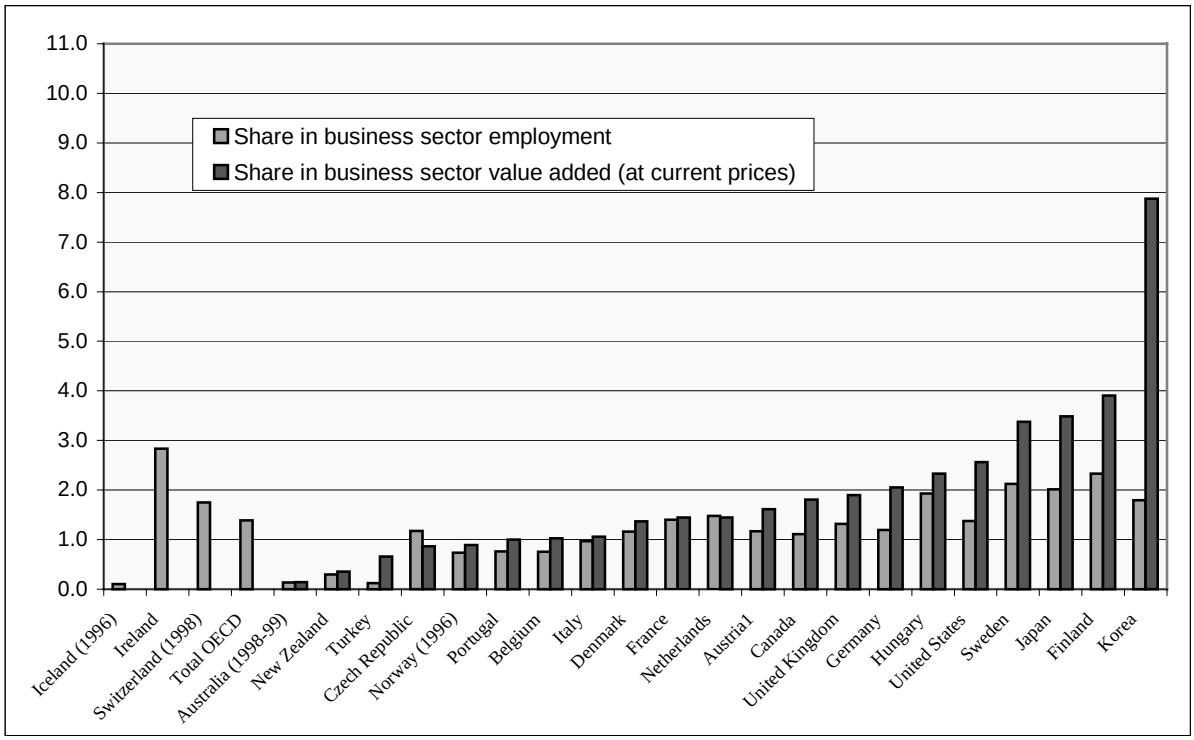
Source: OECD (2000*b*).

Figure 1. **The share of the ICT sector in the economy, 1998**

(a) Total ICT sector



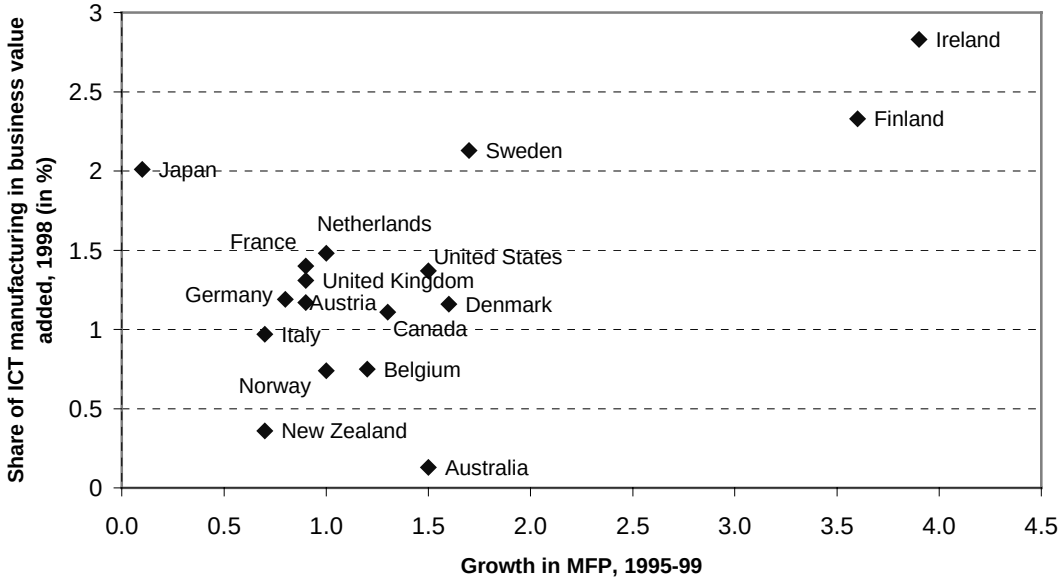
(b) ICT manufacturing only



Source: OECD (2000*b*).

A small sector can make a large contribution to growth and productivity performance if it experiences much more rapid volume growth than the remainder of the economy. Bivariate correlations show only a weak, and statistically insignificant, positive relation between the importance of the overall ICT sector (manufacturing and services) in OECD economies and MFP growth. The correlation between the size of the ICT manufacturing sector and MFP growth is somewhat stronger, although it depends heavily on two countries, Finland and Ireland (Figure 2). The positive correlation between the size of the ICT manufacturing sector and MFP is not surprising, since the ICT manufacturing sector typically has among the highest rates of technological progress and MFP growth in the economy. However, some countries with a 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]

Figure 2. **The size of the ICT manufacturing sector and MFP growth**[1]



1. Correlation coefficient=0.60; T-statistic = 2.91.
Source: Size of the ICT sector from OECD (2000*b*); MFP growth from OECD (2001*a*).

While statistics at the aggregate level show some correlation between ICT-related indicators and country-level productivity growth, better links can typically be found at the industry and firm-level. A host of academic studies at the firm level have shown that the use of ICT can make an important contribution to productivity growth, in particular if accompanied by organisational change, upskilling of the labour force and changes in work practices. Brynjolfsson and Hitt (2000) and OECD (2000*a*) summarise some of this evidence. Further analysis at the firm level is currently underway at OECD (see OECD, 2001*b*).

Measurement issues

This study uses the OECD's completely revised STAN database to investigate the role of ICT by analysing productivity growth at a sectoral level and estimate the contributions of ICT-producing and -using sectors to aggregate productivity growth (Box 2). At the time of writing, STAN covers eleven OECD countries (Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, the Netherlands, the United Kingdom and the United States). New countries are added on a regular basis, depending on the availability of new industry-level data according to ISIC Revision 3.

Box 2. **Measuring Labour Productivity and MFP**

The productivity measurement in the paper follows the procedures outlined in OECD's Productivity Manual (OECD, 2001*c*). 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:

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

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.

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

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 (2001*c*).

Measurement problems have a substantial impact on the analysis in this paper. Productivity measurement in the ICT sector varies across countries and is heavily influenced by differences in the use of hedonic deflators, not only in ICT manufacturing, but also in computer services (Box 3). Standardised or harmonised approaches to these problems are not readily available, since the composition of these sectors differs considerably across countries.

Box 3. **Price measurement issues in ICT goods**

The key measurement problem for the manufacturing of ICT goods on both the output and input side concerns the price measurement of ICT and related goods, *i.e.* computers, semiconductors and related goods. The main problem is how to statistically capture significant quality improvements associated with technological advances which also affect prices. The use of hedonic deflators is generally considered as the best way to address these problems, and is extensively discussed elsewhere (OECD, 2000*c*).[3]

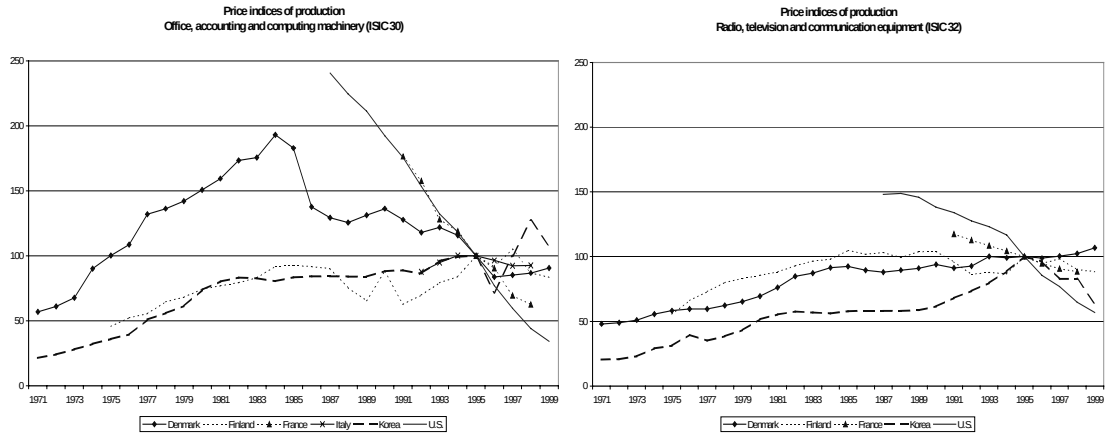
Among the countries currently covered by OECD's STAN (Structural Analysis) database, several use hedonic methods to deflate output in the computer industry (Canada, Denmark, France and the United States). The production price deflators for the ICT manufacturing sectors (ISIC Rev. 3, No. 30 and 32) are shown in Box Figure 1. It shows a very rapid decline in production price indices for France and the United States in both industries, and a gradual decline in Denmark since 1984, but relatively little change in the other countries for which data were available.[4] This is likely to reflect to a considerable extent the use of a hedonic deflator in both France and the United States, the use of an adjusted US hedonic deflator by Denmark, and the use of conventional deflators in the other countries.

Adjusting for these differences in computer deflators is difficult, since there are large cross-country differences in industrial specialisation; only few countries produce computers or semi-conductors, many only produce peripheral equipment. The differences in the composition of output are typically larger than in the composition of computer investment, the standardised approaches can be applied under certain assumptions.[5] It is therefore not clear, *a priori*, to what extent differences in output and value added deflators for these industries are due to measurement (*i.e.* the use of hedonic deflators) or to differences in industrial specialisation. However, countries that are large producers of computers and semi-conductors, but that nevertheless apply conventional deflators (*e.g.* Korea), are likely to substantially understate output and productivity growth in this industry.

The measurement of output in the service components of the ICT sector – telecommunications and computer services – also raises problems. The last – and not up-to-date – overview of methods used by statistical agencies to estimate the output of telecommunications shows a large variety (OECD, 1996). Some countries use consumer price indexes of phone rates to deflate value-added; others use physical quantity indexes of calls, telexes, and other services; and some a composite index of producer price indices for relevant components. Most of these methods do not address the major 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 more recent overview of price measures for telecommunications services still shows a considerable variety in measurement approaches across the OECD (OECD, 2000*d*).

The final component of the ICT sector, the computer services industry, also creates measurement 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 might be needed. This includes 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, 2000*f*).

Box Figure 1. **Producer price indexes for ICT-related industries**



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

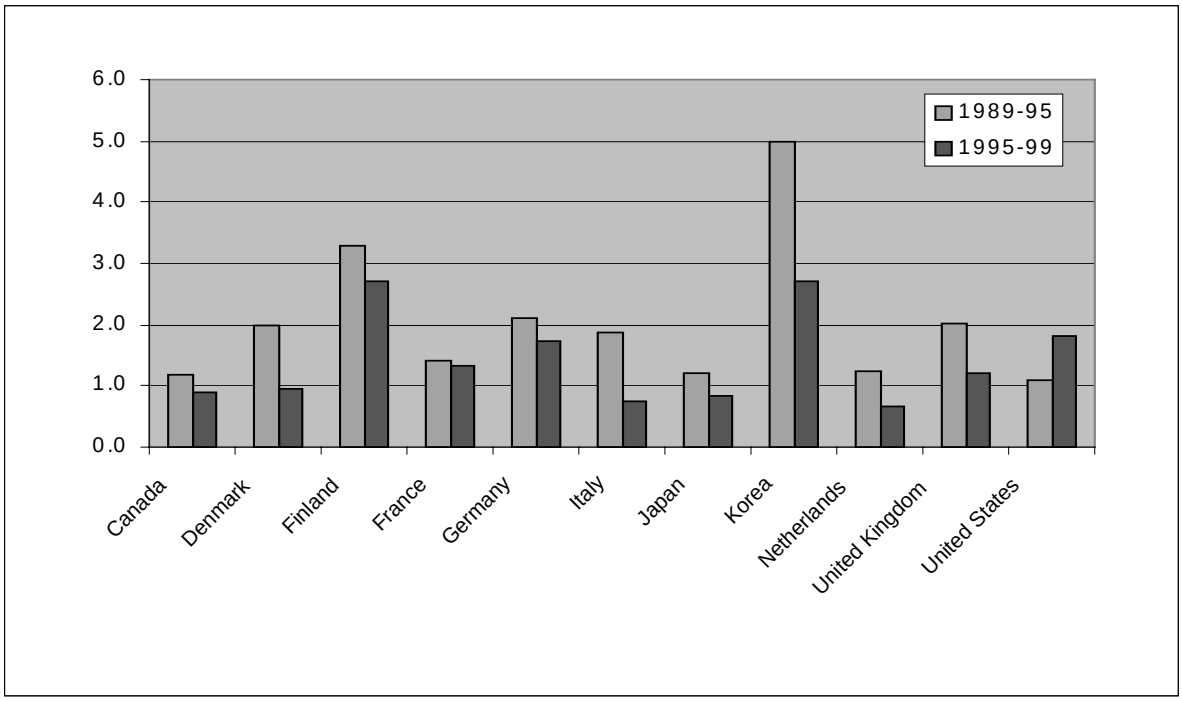
Productivity growth

The importance of the ICT-producing industry in recent growth performance can be examined by analysing sectoral productivity performance and the contribution of each sector to overall productivity growth.[6] Annex Table 4 presents labour productivity growth in the machinery and equipment industry as well as in manufacturing, services and the total business sector.[7] In addition, labour productivity growth in the electrical and optical equipment is presented for the purpose of comparison. It shows that the machinery and equipment industry had considerably higher productivity growth than the manufacturing sector overall in most countries except Denmark in 1995-99 and Italy for all four sub-periods. It also illustrates that labour productivity in machinery and equipment grew much faster in Finland, Korea and the United States than other countries in the 1990s.[8] Labour productivity growth in the electrical and optical equipment industry - two key ICT producers - is higher than that in the machinery and equipment industry in most countries. In general, the manufacturing part of the ICT sector has considerably higher productivity growth than manufacturing overall, whereas the services part of the ICT sector tends to have more rapid productivity growth than the service sector as a whole. The very high productivity growth rates in some parts of the ICT sector are commonly linked to the very high rate of technological progress in this industry. The large variation in performance across countries points, amongst others, to the variation in industrial specialisation within the ICT-sector. Some countries mainly produce computer peripheral equipment, where price declines and technological progress are more limited than is the case in the production of computers and semi-conductors.

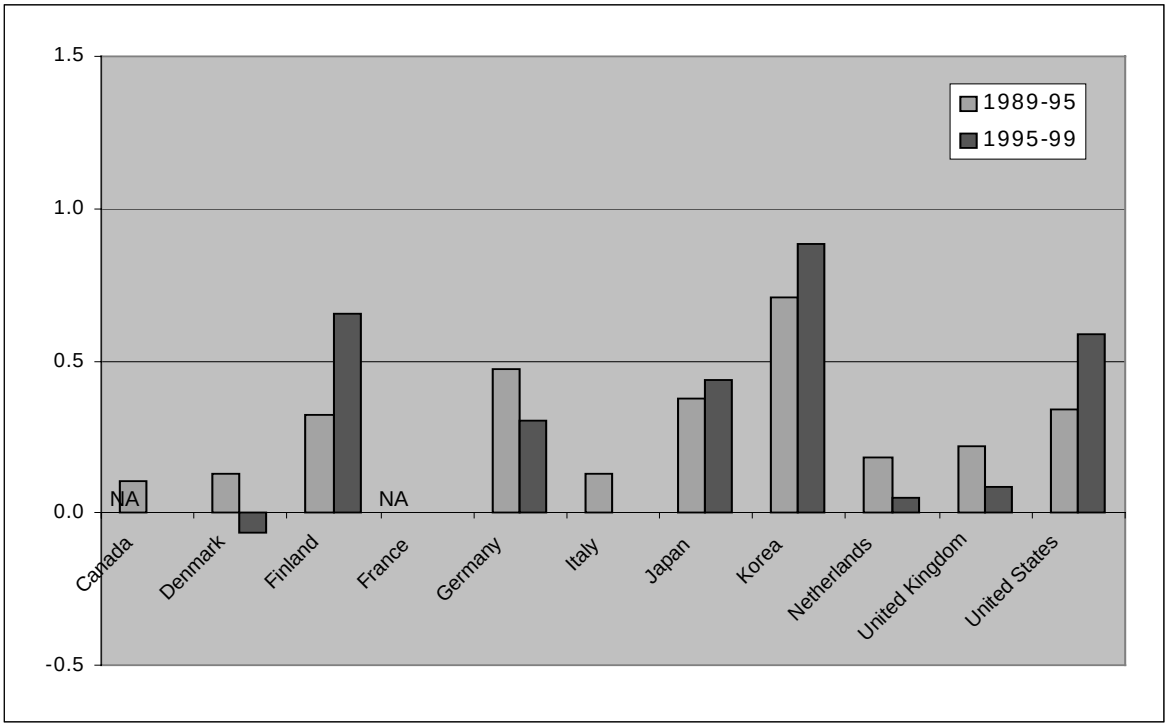
The contribution of the machinery and equipment industry to overall economic performance depends not only on the rate of productivity growth, but also on the size of the different components in the economy. It shows that the machinery and equipment industry makes an important contribution to productivity in Finland, Japan, Korea and the United States (Annex Table 5). The contribution of the machinery and equipment industry to labour productivity has increased in the second half of the 1990s in several OECD countries, including Finland, Japan and the United States (Figure 3). But in spite of the increased contribution of the machinery and equipment industry to overall growth of labour productivity, only France and the United States have shown an improvement in labour productivity growth in the second half of the 1990s.[9] Strong growth in the machinery and equipment industry can thus only provide a partial explanation for overall economic performance. Only Denmark, Finland and Germany have enough data at a detailed industry level to assess the contribution of ICT-producing industries to the total economy.[10] In Finland and Germany, the contribution of the ICT producing sector increased dramatically in the second half of the 1990s compared to the first half the 1990s (Figure 4). However, the role of the ICT sector in Denmark declined over the same period.

Figure 3. **Labour productivity growth, 1989-95 and 1995-99**

(a) Total economy

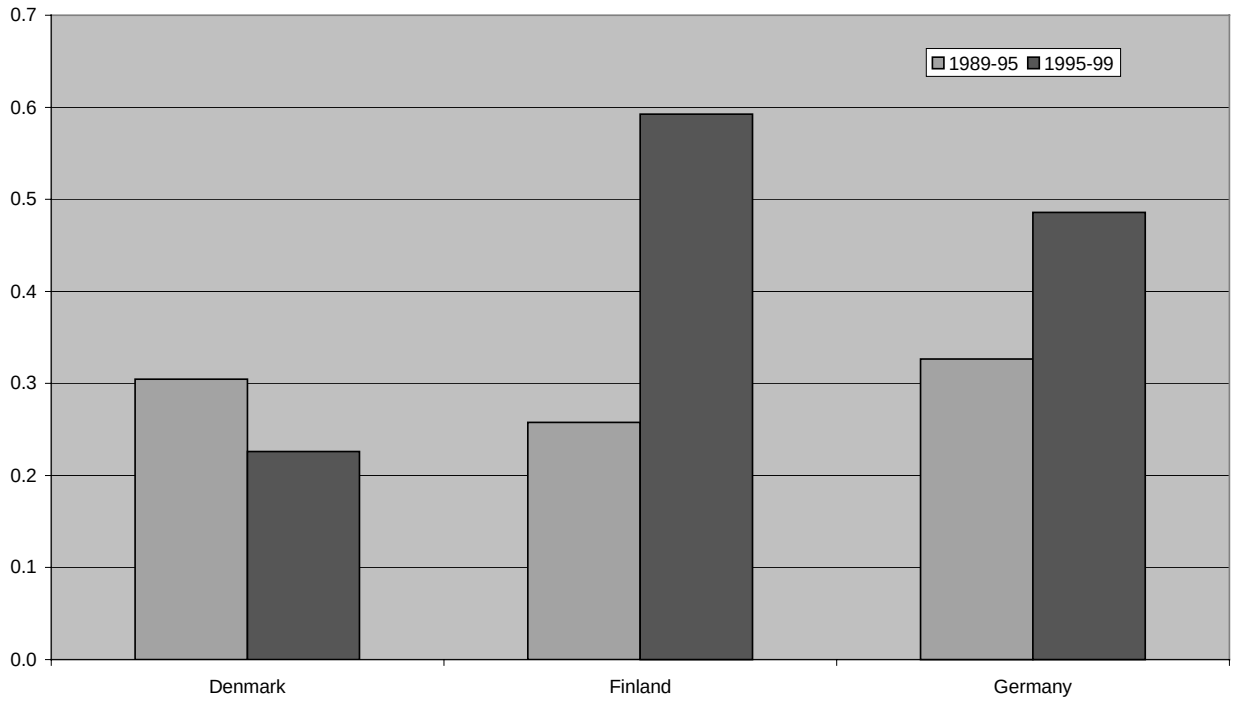


(b) Contribution of machinery and equipment to total (% point)



Note: 1991-95 and 1995-97 for Germany; 1995-98 for Japan.
Source: Calculations on the basis of the OECD STAN database, see Annex Table 4.

Figure 4. **Contribution of ICT-producing industries to total (% point)**



Note: 1991-95 and 1995-97 for Germany.
Source: Calculations on the basis of the OECD STAN database, see Annex Table 4.

MFP growth in the electrical and optical equipment industry outperformed the total manufacturing sector in the four countries examined since the early 80s.[11] Finland shows a substantial acceleration of MFP growth in both machinery and equipment and electrical and optical equipment in each sub-period. For Finland, the MFP calculations broadly confirm the importance of the ICT sector for overall MFP growth (Annex Tables 6 and 7); about 20% of MFP growth over 1995-99 is due to the ICT sector, which is substantially more than in previous periods.[12]

The importance of the ICT-producing sector for recent growth performance has been confirmed by several national studies. In Finland, the mobile telephone producer Nokia accounted for 1.2 percentage points of GDP growth of 4% in 1999, even though it accounted for only 4% of overall GDP (Forsman, 2000). Furthermore, labour productivity growth in the ICT services was substantially higher than that in the total economy (Fløttum, 1998). The Bank of Korea found that 40% of recent GDP growth in Korea came from the ICT sector, five times its 1999 share in GDP (Yoo, 2000). In the Netherlands, the ICT-producing sector accounted for about 17% of GDP growth over the 1995-98 period, four times its share in GDP (CPB, 2000*b*). And a recent study for Canada attributes much of the Canada-US productivity gap in manufacturing to the performance of two sectors, machinery and electronic products, both of which are important producers of IT products (Gu and Ho, 2000). The ICT-producing sector is thus an important driver of growth and productivity, although certain countries, such as Australia, have improved growth and productivity while being only a very small producer of ICT-related goods and services.

ICT-using industries

The benefits of ICT use

Investment in ICT might have benefits going beyond those accruing to investors and owners, for example through network externalities.[13] Where such externalities exist, they can raise overall MFP growth. Investment in ICT can also raise the overall level of information and knowledge which exhibit spillover benefits to market participants. Studies at the firm-level (for example Brynjolfsson and Kemerer, 1996; Gandal *et al.*, 1999) point to spillovers from ICT capital, but it has generally been difficult to confirm these results at the aggregate level.

Some national studies point to the use of ICT as an important factor in improved MFP growth. For the United States, the *Economic Report of the President* (Council of Economic Advisors, 2000, 2001), Whelan (2000), Oliner and Sichel (2000), and Jorgenson and Stiroh (2000) attribute a considerable part of the pick-up in MFP growth to sectors of the economy that do not produce ICT, which could point to networks effects arising from ICT use (Box 4). For Australia, there is evidence that increased productivity has been accompanied by greater technology use, including ICT (Productivity Commission, 1999). There are also some studies at the sectoral level that suggest that ICT investment has had impacts on MFP. In the distribution sector, for instance, some studies point to a greater use of ICT in explaining recent productivity gains (Reardon *et al*., 1996; Broersma and McGuckin, 1999).

Box 4. **Non-ICT sector contributions to MFP growth for the United States**

	Jorgenson and Stiroh (2000)		Oliner and Sichel (2000)	
	1990-95	1995-98	1991-95	1996-99
Aggregate MFP growth	0.36	0.99	0.48	1.16
Contributions from non-ICT sector	0.11	0.55	0.20	0.50

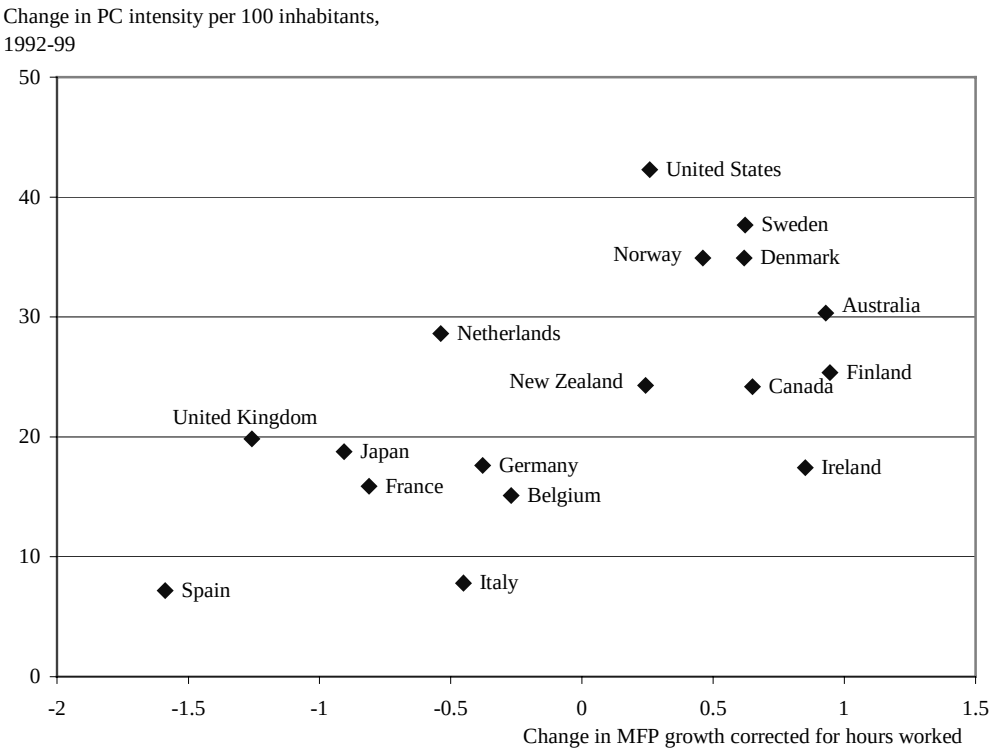
Box 5. **MFP growth for selected industries in Australia**

	1988-89 to 1993-94	1993-94 to 1997-98
Agriculture, forestry and fishing	0.9	1.4
Construction	0.1	1.0
Wholesale trade	1.8	3.2
Retail trade	0.5	0.9
Transport and storage	1.1	1.4

Source: OECD (2000i), *OECD Economic Surveys Australia,* Paris.

There are other indications that countries which invest most in ICT, or diffuse it most widely are characterised by higher rates of economic growth and MFP growth. Time series of ICT investment and ICT use are still too short for more sophisticated econometric analysis. Nevertheless, some patterns and insights may emerge from simple correlations. First, both the rate of investment in ICT and the diffusion of ICT technologies (PCs, internet hosts, secure servers) are highly correlated with levels of GDP per capita, suggesting that ICT use has some links to average income levels (Annex Figure 1). There is also a strong positive correlation between indicators of ICT use, such as the numbers of secure servers, Internet host density, PC density and Internet access costs, and the pick-up in MFP growth in the second half of the 1990s (Annex Figures 2 and 3). Countries that have experienced a substantial pick-up in MFP growth in the second half of the 1990s, typically have had a more rapid diffusion of ICT technologies, as well as lower costs of ICT technologies (Figure 5; OECD, 2001*a*).

Figure 5. **Pick-up in MFP growth and increase in ICT use**

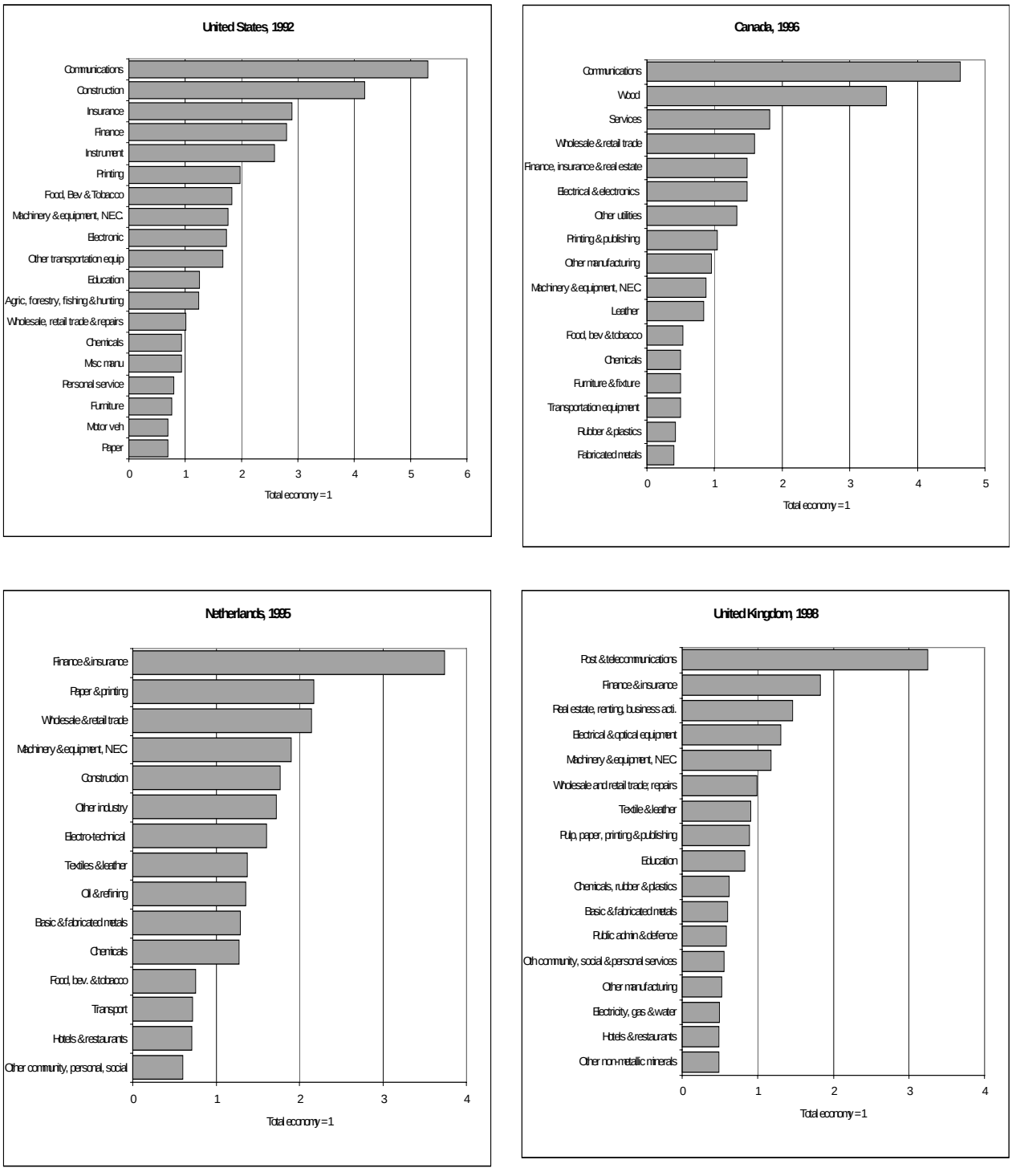


Note: Correlation coefficient: 0.61; T statistic: 3.0.
Source: OECD Information Technology Outlook 2000; MFP from OECD (2001a).

There is also a correlation between the relative importance of innovative activity in the ICT area – as measured by ICT-related patents taken in the United States – and MFP growth (Annex Figure 4). The causality of this finding may run in two ways. First, a high rate and innovation in the ICT sector may boost MFP growth directly, in particular if the innovations are linked to ICT goods. Second, the productive use of ICT often needs to be accompanied by specific ICT-related innovations, both regarding hardware and software, to make ICT suited for a specific application. Countries may therefore need to be innovators in the ICT area if they wish to experience higher MFP growth.

One other approach to examining the role of ICT in more detail is by focusing on those sectors that are the most intensive users of ICT. 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, 1998). If the use of ICT is having important effects on MFP, it is likely that heavy users would be the first sectors to experience such effects.

Figure 6. **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.

Measurement issues

Empirical evidence on ICT use by industry is available for several countries, based on capital flow matrices and capital stock estimates. Figure 6 shows relative investment in ICT in the top two-third industries for the United States, Canada, the Netherlands and the United Kingdom. Although industry classifications are different across these countries, a broad generalisation about ICT use can be made. For instance, certain manufacturing industries (*e.g.* printing and publishing, electronic equipment, machinery and equipment) as well as communications, wholesale and retail trade, finance, insurance and business services, are the largest relative investors in ICT equipment.

In several of the sectors that are important users of ICT, output and productivity are hard to measure. These measurement problems may obscure actual productivity gains (Gullickson and Harper, 1999). For many parts of the services sector, output measures are of dubious quality, partly because of the lack of basic data. However, measurement problems also arise because services output is often difficult to define (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. 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 crude indicators. Several series are deflated by wages or consumer prices or extrapolated from changes in employment, sometimes with explicit adjustment for labour productivity changes. Given these difficulties, adjusting for quality is even more difficult. Measuring productivity in may parts of the ICT-using sector may have become even more difficult due to the use of ICT; it allows greater customisation of services, leading to a greater variety in quality and price, and thus making measurement more difficult.

With better measurement, productivity gains may be considerable. Schreyer (1998), for example, simulates the effect of quality adjusted price changes in ICT products on productivity growth for selected OECD countries. He concludes that this adjustment raises productivity growth. Fixler and Zieschang (1999) 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% a year between 1977 and 1994, well above the official measure for this sector of only 1.3% a year on average. The recent revisions of GDP growth for the United States incorporate improved estimates of the real value of non-priced banking services, which better capture productivity growth in this industry. A similar study for the Netherlands found that labour productivity rose by 5.9% annually between 1991 and 1995 using detailed quantity indicators, compared with 1.4% annually on the basis of the former input-method (De Boer, 1995).[14] The Council of Economic Advisors (2001) also report that U.S. labour productivity growth in the information technology intensive group was 50% higher than the less intensive group between 1989 and 1999.While some new approaches to measurement in these sectors are being developed (Triplett and Bosworth, 2000), only few countries have 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 long period. While negative MFP growth is quite possible over a short period, it is less likely over a long period.

Productivity growth

There are indications that sectors which are intensive users of ICT may contribute to productivity growth through spillover effects. The STAN database distinguishes several of the ICT-using industries that were mentioned above. For the purpose of accounting exercise, those industries that are included as part of the ICT-producing industries are excluded from the ICT-using industries. Moreover, certain manufacturing industries, such as printing and publishing, which are also important users of ICT, are also excluded, since the primary focus here is on services that are intensive users of ICT. Annex Tables 8-11 provide the basic calculations for the key components of the ICT-using services, that include wholesale and retail trade, finance, insurance and business services.[15] Figure 6 provides a summary of the findings as regards labour productivity.

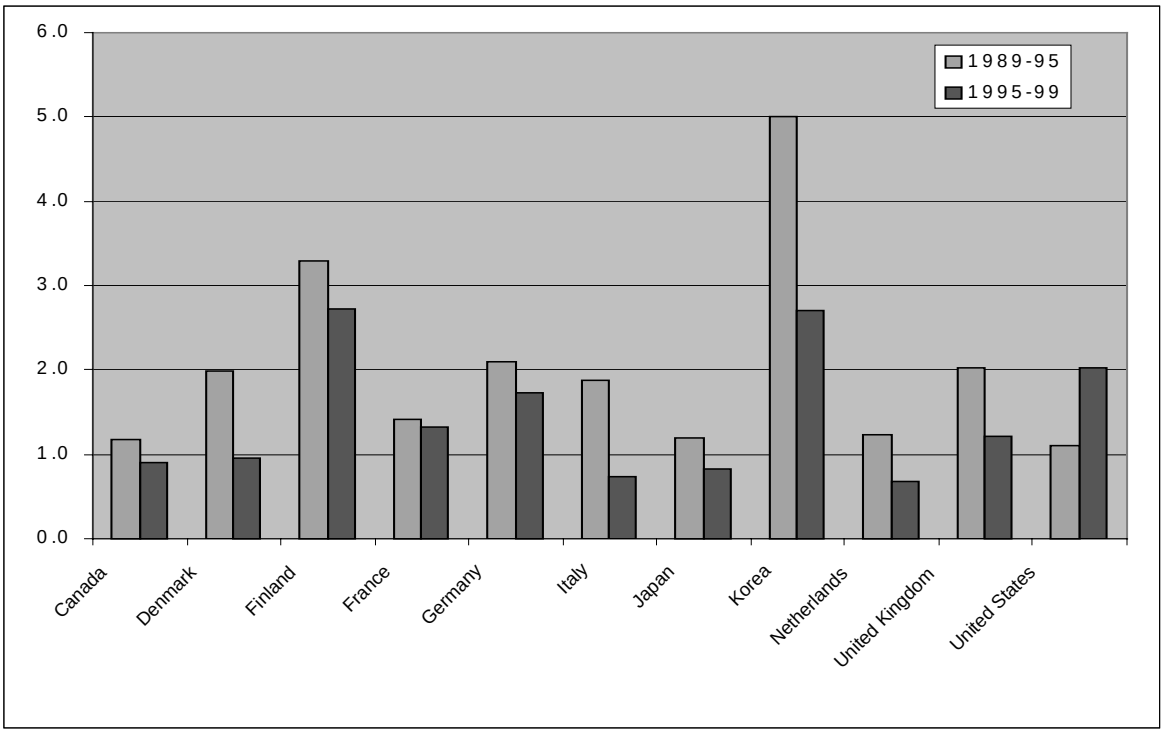
Figure 7 shows that Denmark, Finland, Germany, the Netherlands and the United States have experienced an increase in the contribution of ICT-using services to labour productivity growth. Figure 8 presents contributions by two ICT-intensive using industries (wholesale and retail trade; finance, insurance, real estate and business services) as well as by transport and storage. Four countries (Canada, Finland, the Netherlands and the United States) have shown an increase in the contribution of wholesale and retail trade to labour productivity growth while six countries have experienced the increased contribution by the finance, real estate and business services sector. It also shows that the transport and storage industry - not a very intensive user of ICT - did not increase in its contribution to labour productivity growth in any of the countries examined. In Australia, wholesale trade made the largest contribution to the pick up in aggregate productivity growth in the 1990s, further illustrating the impact of ICT led innovation on productivity growth (Gruen, 2001).

Finland and the United States are the only countries that experienced a marked improvement in the contribution by both ICT-intensive using industries. A closer examination shows that in the United States, substantially higher productivity growth in wholesale and retail trade, and in finance, insurance and business services explain the strong contribution of ICT-using services to overall performance. Finland experienced substantial productivity gains in wholesale and retail trade and in finance and insurance, but the overall contribution of ICT-using services to productivity improved only slightly, due to a strong negative contribution from business services. The strong improvement in Finland's ICT-using services does, however, emerge from an examination of MFP growth rates (Annex Tables 10 and 11). This shows that ICT-using services accounted for just over one-third of the pick-up in MFP growth from 1995-99. This contribution is considerably larger than in the 1970s or 1980s, and is due to strong productivity growth in wholesale and retail trade, and financial intermediation.

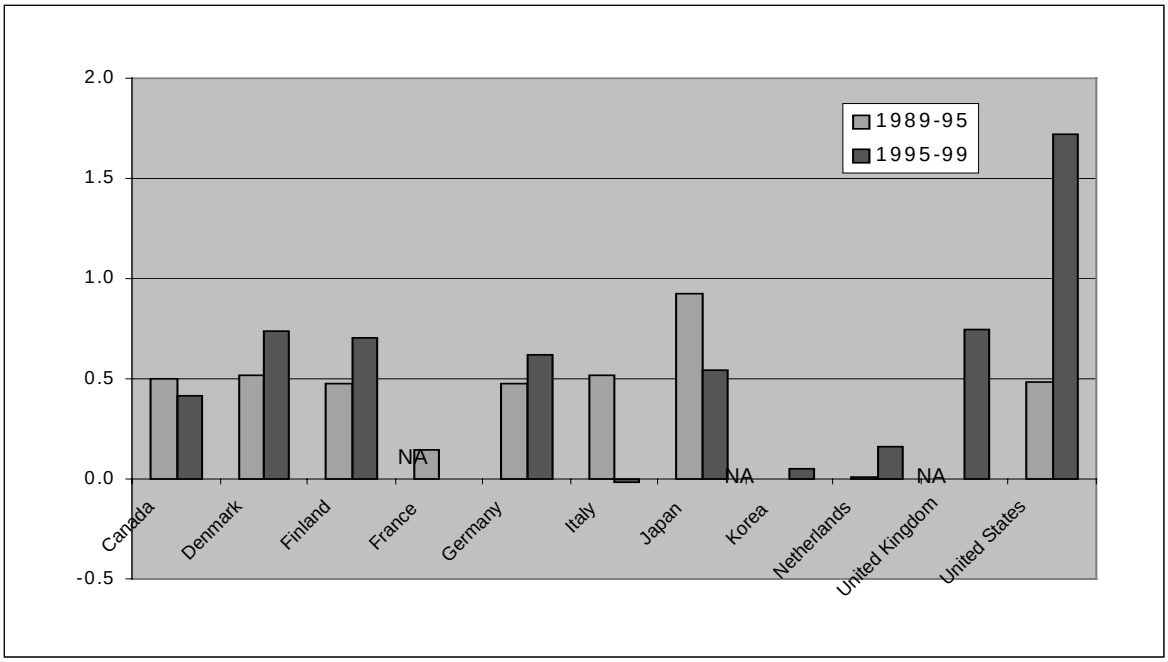
Figure 9 illustrates the contributions of both machinery and equipment, and ICT-using services to overall productivity growth. Only two countries, Finland and the United States, experienced improvements in the contributions by both machinery and equipment (also ICT-producing in Finland) and ICT-using industries to overall productivity growth in the second half of the 1990s.

Figure 7. **Labour productivity growth in ICT-using services, 1989-95 and 1995-99**[1]

(***a) Total economy***



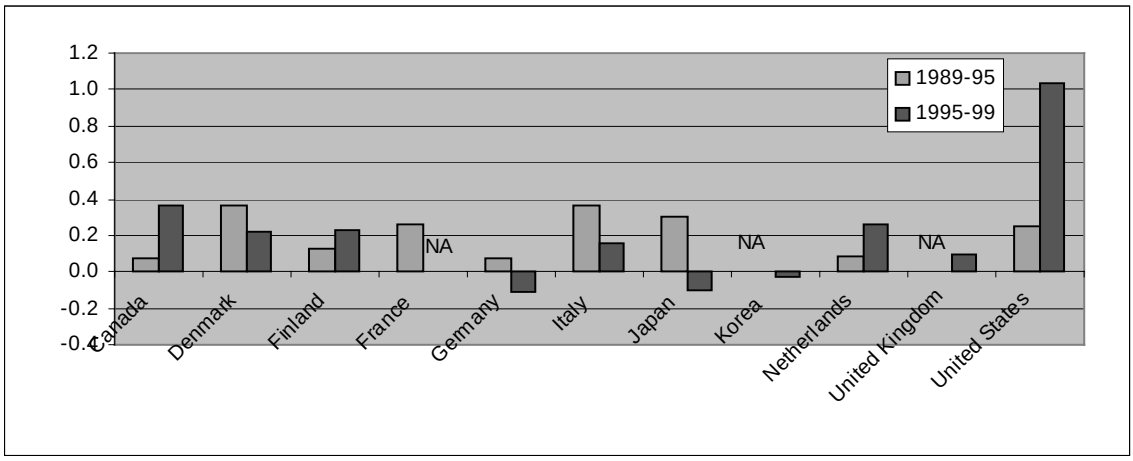
(*b) Contribution of ICT using sector to total (% point)*



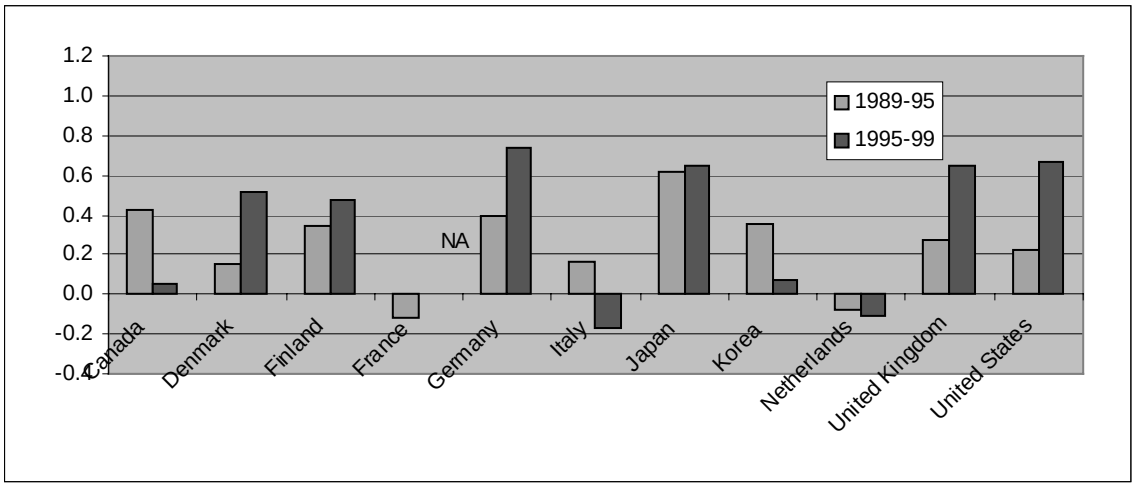
Note: 1991-95 and 1995-97 for Germany; 1995-98 for Japan. Employment-based labour productivity growth is used for the U.S. since hours worked is not available for ICT-using industries.
Source: Calculations on the basis of the OECD STAN database, see Annex Tables 8 and 9.

Figure 8. **Labour productivity contributions by selected service industries (% point)**[1]

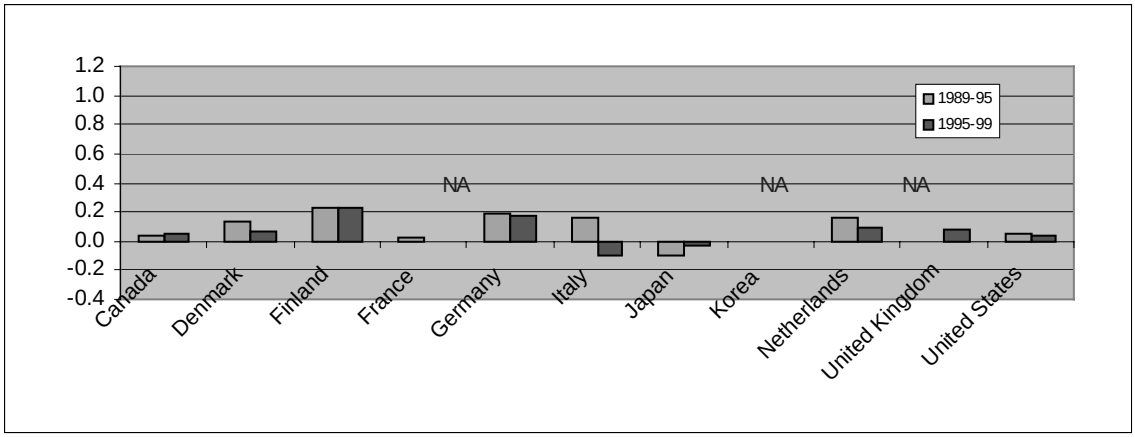
(***a) Wholesale and retail trade; repairs***



(b) Finance, insurance, real estate and business services



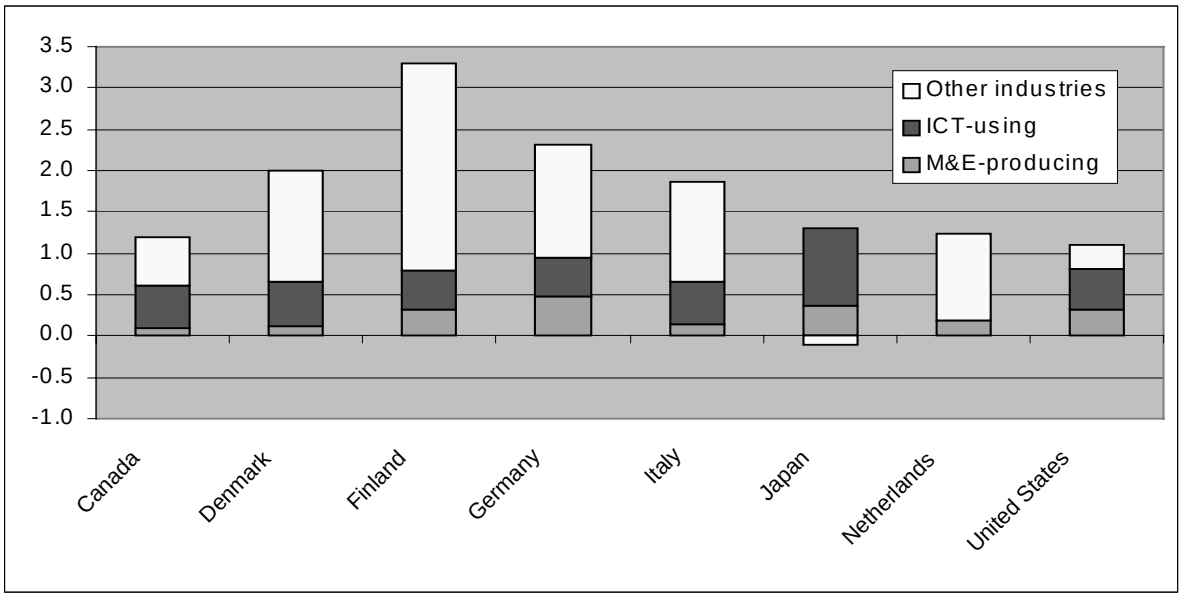
(c) Transport and storage



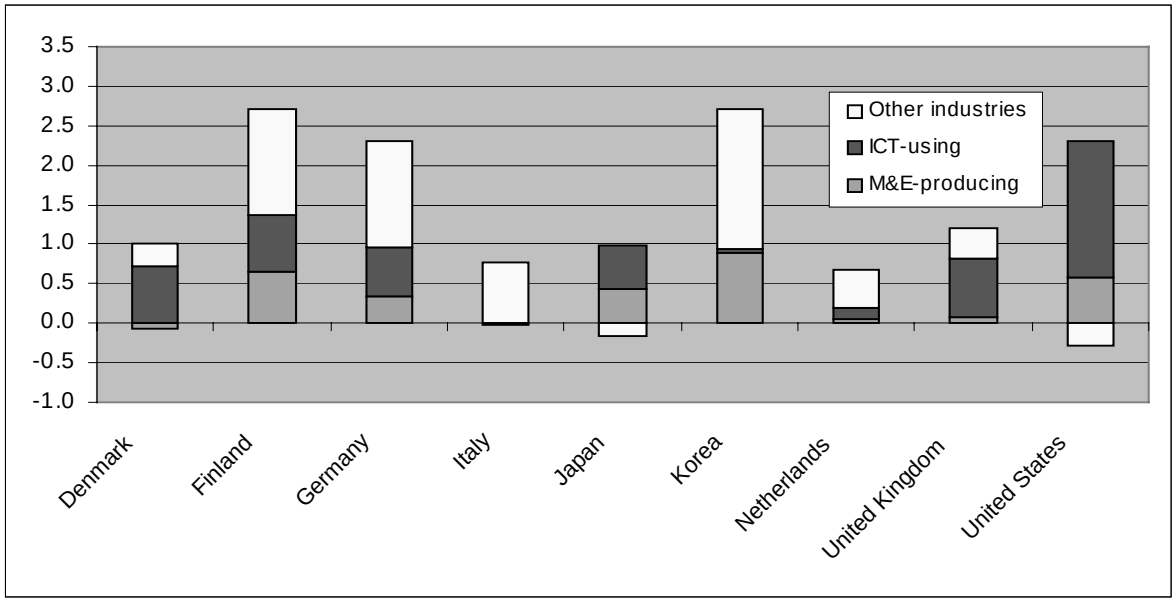
Note: 1991-95 and 1995-97 for Germany; 1995-98 for Japan.
Source: Calculations on the basis of the OECD STAN database, see Annex Table 9.

Figure 9. **Breakdown of labour productivity growth, 1989-95 and 1995-99**

(a) 1989-95



(b) 1995-99



Note: 1991-95 and 1995-98 for France; 1991-95 and 1995-97 for Germany; 1995-98 for Japan. Employment-based labour productivity growth is used for the United States.
Source: Calculations on the basis of the OECD STAN database, see Annex Tables 4, 6, 8 and 10.

Conclusions

This paper has shown that differences in ICT production and use contribute to recent growth patterns across OECD countries. The ICT-producing sector (manufacturing and services) provides a considerable contribution to productivity growth in several OECD countries. It also explains some of the pick-up in productivity growth in the United States in the second half of the 1990s. ICT manufacturing, in particular, has been characterised by very high rates of productivity growth in many countries. Some countries with a large ICT sector (Finland, Ireland) have experienced above-average MFP growth in the second half of the 1990s. However, other countries with a large ICT sector, such as Japan, have seen little change in MFP growth over the 1990s. Moreover, some countries with a small ICT sector, such as Australia, have also observed rapid MFP growth, suggesting that a large ICT sector is not a necessary condition for higher MFP growth in certain national contexts.

There is also evidence for some countries (notably Finland and the United States) that certain ICT-using services have experienced an above-average pick-up in productivity growth in the second half of the 1990s. This may indicate that ICT is starting to have spillovers beyond the ICT sector itself, which is also confirmed by firm-level studies and studies for individual sectors that are heavy users of ICT, such as retail trade, transport and financial services. It remains difficult to attribute productivity improvements in such sectors directly to their investment or use of ICT, partly because data on ICT investment are still scarce for some countries and also because causality is always difficult to establish.

Despite the emerging benefits of ICT, diffusion in some OECD countries has been slow. There are several reasons for this, a lack of ICT skills, limited capacity to adjust the production process to ICT technologies, or poor access to finance, being just three typical ones. Insufficient competition may be another factor, because this can harm efficiency and slow the adoption of new techniques. 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. Globalisation, although common to all OECD countries, has added to this process, by forcing firms to look more and more to innovation and technology to help them restructure and thrive.

The available evidence suggests that there have been considerable differences in the costs of ICT investment goods across OECD countries (OECD, 2001*a*). Barriers to trade, in particular non-tariff barriers related to standards, import licensing and government procurement, may partly explain these cost differentials. The higher price levels in other OECD countries may also be associated with a lack of competition within countries. In time, however, international trade and competition should erode these cross-country price differences. Policy could help to accelerate this trend, by implementing a more active competition policy and measures to promote market openness, both domestically and internationally.

The investment and diffusion of ICT do not just depend on the cost of the investment goods themselves, but also on the associated costs of communication and use once the hardware is linked to a network. Increased competition in the telecommunications industry, thanks to extensive regulatory reform, has been of particular importance in driving down these costs. It has led to more entrants, greater technology diffusion, improved quality and a higher rate of innovation. This has benefited the industry, as well as the economy as a whole. Countries that moved early to liberalise their telecommunications industry now have much lower communications costs and, consequently, a wider usage and diffusion of ICT technologies than those that followed later on.[16]

Debate also remains on whether a strong ICT sector is needed to benefit from ICT use (Cohen and Debonneuil, 2000). Close links between ICT-producers and ICT-users might be needed to develop ICT technologies for specific user needs. But having an ICT sector may not be a prerequisite for growth based on new technology for three reasons. First, proximity to hardware producers may not be as important for ICT users as proximity to software producers and service providers, which are useful to firms needing

skills and advice to implement ICT-related changes. Second, much of the production 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, a hardware sector cannot simply be set up, and only a few countries will have the necessary comparative advantages to succeed in it. The third, and most compelling, point is that several countries characterised by high ICT investment and use, as well as high MFP growth, do not have a large ICT sector. Australia is the clearest example (Gruen and Stevens, 2000). And one or two other countries that do have a large ICT sector, *e.g.* Japan, have not been among the high growth countries of the 1990s. In sum, governments should resist believing that deliberately developing an ICT manufacturing sector would be a sure route to improved economic growth.

This paper has not resolved all issues and several areas require further exploration Measurement differences across countries and insufficient data on ICT investment and use imply that detailed cross-country analysis of productivity growth and the role of ICT remains difficult. More precise identification of measurement approaches in the different parts of the ICT-producing and ICT-using sector, combined with sensitivity analysis of the impact of such differences on productivity growth, might be helpful.

There also several empirical extensions of this paper that could help to deepen understanding of the role of ICT. Further expansion of the number of countries covered by the paper, particularly countries that have recently observed a substantial pick-up in MFP growth or that have a large ICT sector (Ireland, Sweden), would be helpful. In addition, analysis of MFP growth as opposed to labour productivity growth for more countries would give better insights in possible spillover effects from ICT. Detailed capital stock data for some OECD countries are about to be released and will be included in STAN once they become available, allowing an extension of the work. In the longer term, estimates of ICT capital stock by industry would allow the analysis of spillover benefits from the use of ICT within a regressional framework.

The policy implications of this work also require further investigation. Understanding how ICT is affecting the "old economy" would help to better understand the future role of ICT-driven growth. Examination of the relationship between competition and ICT would be helpful to the policy debate, as would the identification of government policies that may help realise productivity gains from ICT production and use, *e.g.* in areas such as competition policy, science and technology policy and other business-related policies.

NOTES

1. Economic Analysis and Statistics Division, and Industry Division, respectively. The authors are grateful to Karine Lepron, Chai So and Colin Webb for their help in preparing this paper, and for useful comments from Thomas Andersson, Bart van Ark, Someshwar Rao, Paul Schreyer, Candice Stevens and Andrew Wyckoff. Previous versions of this paper were discussed by the Statistical Working Party and the OECD Committee for Industry and Business Environment. Participants of these meetings provided helpful comments.

2. See Productivity Commission (1999) for an extensive discussion of the factors driving MFP growth in Australia.

3. Hedonic deflators are not the only measurement problem for the ICT manufacturing sector. The correct measurement of input prices for these industries is also quite complicated, and demands detailed input-output tables as well as hedonic deflators for certain inputs.

4. STAN does not include production price indices for Canada.

5. See Schreyer (2000) and Colecchia (2001) for applications of standardised hedonic deflators to ICT investment.

6. The STAN database lacks detailed ICT sectoral data on a consistent basis across countries. In order to make an international comparison of the ICT producing sector, we first broaden our analysis to the role of the machinery and equipment industry in aggregate productivity growth and then discuss some key parts of the ICT sector. The machinery and equipment industry includes two key ICT producing industries (ISIC Rev. 3 No. 30 "Office, Accounting and Computing Machinery" and ISIC Rev. 3 No. 32 "Radio, Television and Communication Equipment") as well as more traditional industries such as "Engines and Turbines", "Household Appliances" and "Industrial Machinery". The ICT-producing industries as defined in Box 1 cannot be analysed since the data are not available at such a detailed level for all countries. But some key parts including ISIC Rev. 3 No. 30 "Office, Accounting and Computing Machinery", ISIC Rev. 3 No. 32 "Radio, Television and Communication Equipment", ISIC Rev. 3 No. 64 "Post and Telecommunications", and ISIC Rev 3. No. 72 "Computer and Related Activities" are analysed. ISIC Rev. 3 No. 33 "Medical, Precision and Optical Instruments" is excluded here, even though some parts of this belong to the ICT sector. Categorising industries by ICT-producers *vs.* ICT-users can be subjective. See Ark (2001) for a slightly different definition.

7. Labour productivity based on hours worked is used whenever possible. For those countries where hours worked is not available at a detail industry level, labour productivity based on person employed is presented. Annex Table 3 compares hourly-based labour productivity growth with employment-based labour productivity growth. The basic qualitative results do not change between the two measurements, especially in the machinery and equipment industry.

8. As alluded earlier, there exists substantial methodological differences in deflating ICT and related goods across countries which could partly explain labour productivity growth differences. Annex 2 provides a sensitivity analysis of using the US deflator on labour productivity growth.

9. France has shown an improvement in labour productivity growth in 1995-99 compared to the first half of the 1990s. However, France lacks detailed sectoral data for 1999 thereby limiting a detailed analysis only up to 1998.

10. Related studies in the U.S. confirm that there has been a substantial increase in contributions from ICT (Jorgenson and Stiroh, 2000; Oliner and Sichel, 2000). For instance, the US Department of Commerce (1999) estimates that IT industries' output contributed more than one-third of economic growth in the United States.

11. The OECD STAN database currently only enables MFP calculations – on a value-added basis – for four countries, Canada, Finland, Italy and Japan. This is mainly due to the absence of capital stock data for several countries. Capital stock data for France were recently released and will be included in STAN shortly. US capital stock series from the Bureau of Labor Statistics can also be included for manufacturing industries.

12. Finland was struck by a large macro-economic shock in the first half of the 1990s. The current upswing in productivity growth may thus partly be due to the business cycle. The increased role of the ICT sector in overall growth seems more difficult to explain by cyclical conditions only.

13. This term refers to the case where the value of the network with increases the increased number of users.

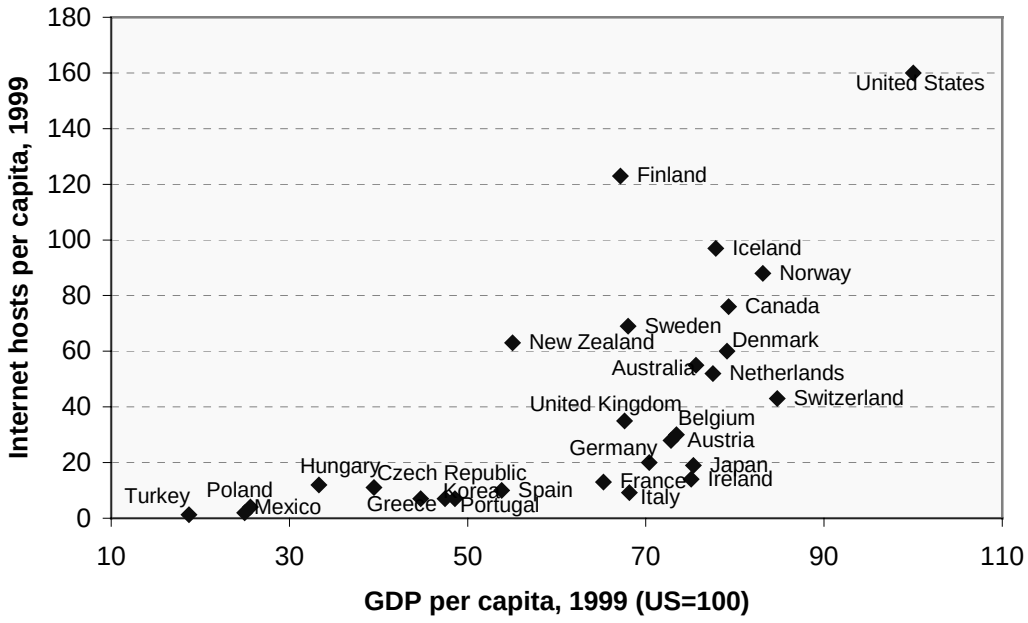
14. However, the new method does not always lead to higher productivity growth. Recent labour productivity growth estimates with the new method for the Netherlands in 1996-98 produced lower growth rates than calculations based on the old method.

15. Council of Economic Advisors (2001) notes that almost 70% of all information technology products are purchased by the wholesale and retail trade, finance, and telecommunications industries.

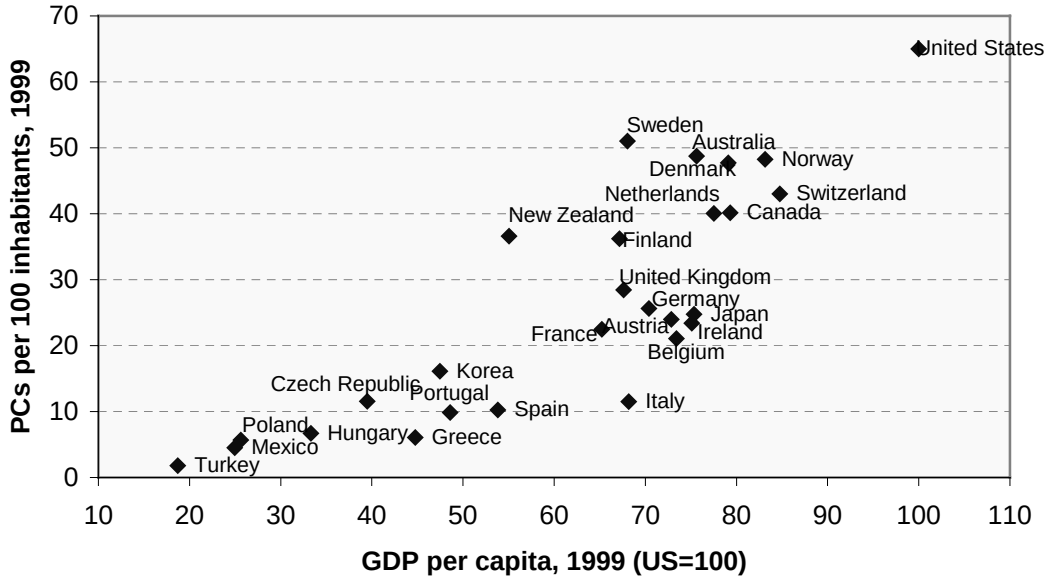
16. The role of competition and some of the policies that can enhance competition with the economy and in areas relevant to the uptake of ICT are discussed elsewhere in greater detail (OECD, 2001c; 2001d).

ANNEX 1. TABLES AND GRAPHS

Annex Figure 1. **ICT use and GDP per capita**



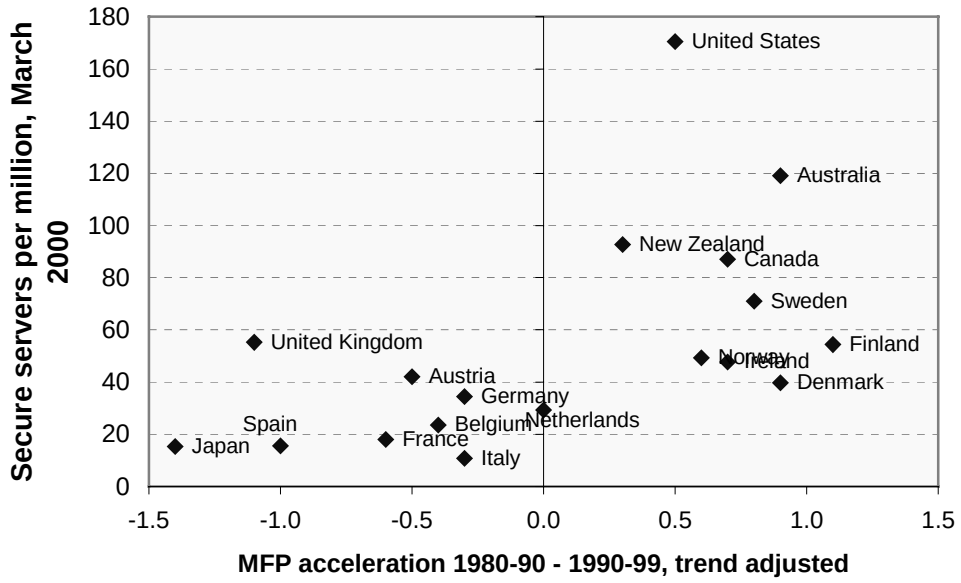
Note: Correlation coefficient = 0.66; T-statistic = 4.48.



Note: Correlation coefficient = 0.83; T-statistic = 7.45.
Source: Annex Table 1.

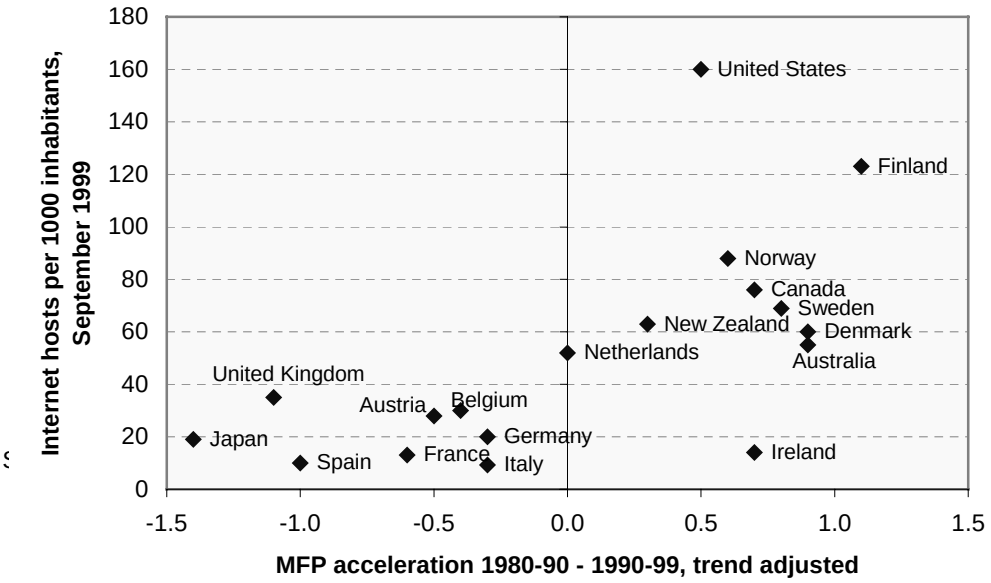
Annex Figure 2. **ICT penetration and MFP growth**

(a) measured by secure servers per million inhabitants



Note: Correlation coefficient = 0.54; T-statistic = 2.57.

(b) measured by Internet hosts per 1000 inhabitants

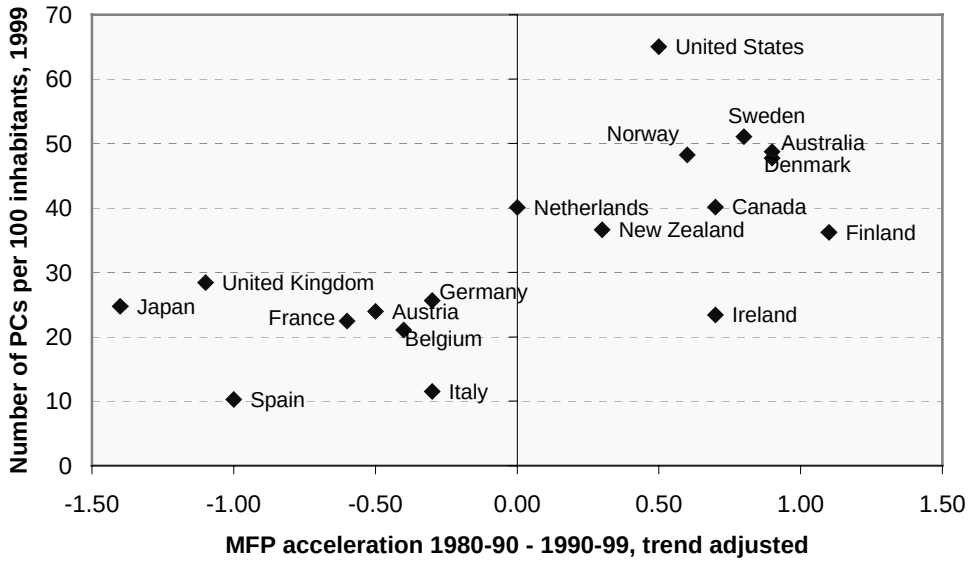


Note: Correlation coefficient = 0.63; T-statistic = 3.27

Source: Annex Table 1 and OECD (2001*a*).

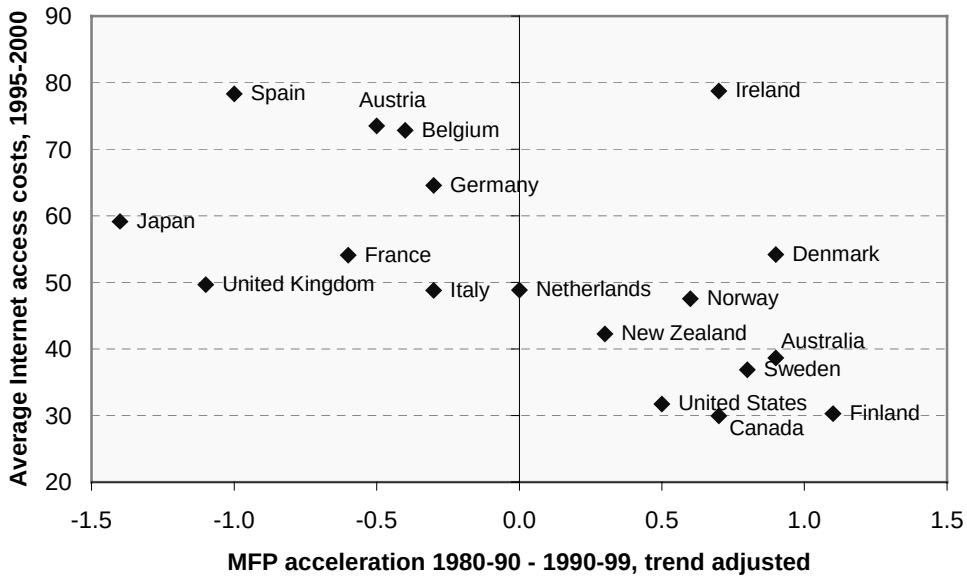
Annex Figure 3. **ICT use and the pick-up in MFP growth**

(a) measured by PC hosts



Note: Correlation coefficient = 0.68; T-statistic = 3.73.

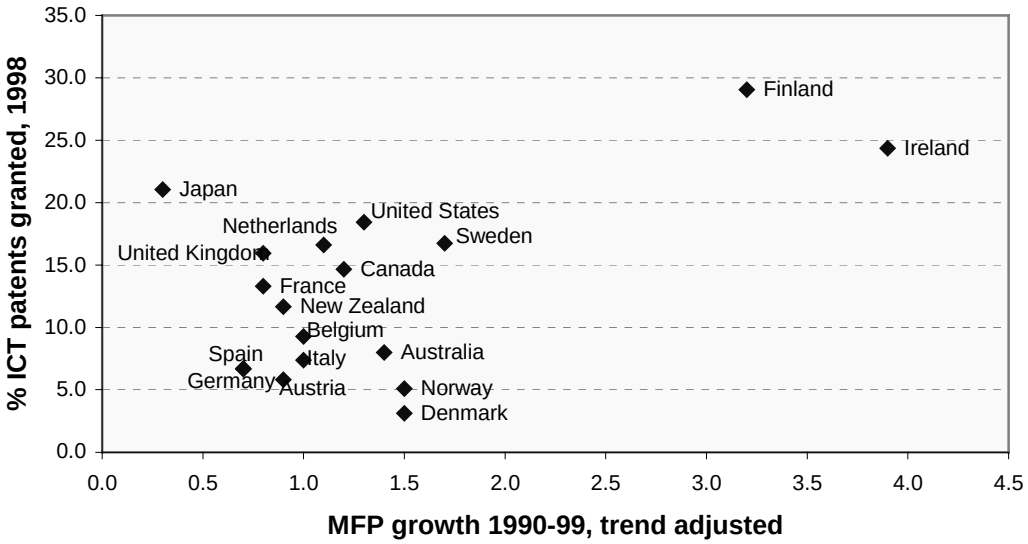
(b) measured by average costs of Internet access, 1995-2000



Note: Correlation coefficient = -0.54; T-statistic = -2.58.
Source: Annex Table 1 and OECD (2001*a*).

Annex Figure 4. **Innovation in ICT and MFP growth**

a. Innovation in ICT and MFP growth



Note: Correlation coefficient = 0.56; T-statistic = 2.69.
Source: Annex Table 1 and OECD (2001*a*).

Annex Table 1. **Summary indicators of ICT production and use in OECD economies and core indicators of economic performance**

	ICT expenditure	***ICT production***		***Penetration of ICT technologies***			***ICT innovation and costs***		***Indicators of economic growth***		
	Average ICT expenditure intensity as a % of GDP, 1992-99	Share of ICT producers in business sector employment, 1998	Share of ICT producers in business sector value added, 1998	Average PC base per 100 inhabitants, 1999	Internet hosts per thousand inhabitants, Sept. 1999	Secure servers per million inhabitants, March 2000	% IT in patents granted by USPTO to the country, 1998	Internet access cost, 1998-99	GDP per capita, 1999 (US=100)	GDP per capita, growth 1990-99, trend adjusted	MFP growth 1990-99, trend adjusted
Australia	**8.0**	2.6	4.1	**49**	55	**119**	8.0	63	76	2.5	1.4
Austria	4.8	4.9	6.8	24	28	42	5.8	172	73	1.7	0.9
Belgium	5.6	4.3	5.8	21	30	24	9.3	168	73	1.9	1.0
Canada	7.5	4.6	6.5	40	**76**	87	14.7	53	79	1.6	1.2
Czech Republic	6.6	3.3	4.7	12	11	13	-	182	40	-	-
Denmark	6.5	5.1	-	**48**	60	40	3.1	93	79	1.8	1.5
Finland	5.6	**5.6**	8.3	36	**123**	54	**29.0**	49	67	2.0	3.2
France	5.8	4.0	5.3	22	13	18	13.3	124	65	1.4	0.8
Germany	5.2	3.1	6.1	26	20	35	6.7	118	70	1.2	0.7
Greece	3.8	-	-	6	7	7	-	103	45	1.7	-
Hungary	4.6	**5.7**	**9.2**	7	12	5	-	108	33	-	-
Iceland	-	4.2	-	-	**97**	**194**	-	72	78	1.4	1.0
Ireland	5.9	4.6	-	23	14	48	**24.4**	138	75	6.3	3.9
Italy	4.2	3.5	5.8	11	9	11	7.4	73	68	1.5	1.0
Japan	6.0	3.4	5.8	25	19	15	**21.0**	89	75	1.5	0.3
Korea	4.9	2.5	**10.7**	16	7	3	**23.4**	82	47	5.1	-
Luxembourg	-	-	-	-	-	87	-	126	-	4.3	-
Mexico	3.7	-	-	5	2	1	2.9	86	25	1.3	-
Netherlands	6.7	3.8	5.1	40	52	29	16.6	108	78	2.4	1.1
New Zealand	**8.7**	2.1	-	37	63	**93**	11.7	80	55	1.0	0.9
Norway	5.8	**5.3**	6.4	**48**	**88**	49	5.1	86	83	2.8	1.5
Poland	2.8	-	-	6	4	3	-	87	26	-	-
Portugal	4.4	2.7	5.6	10	7	9	-	105	49	2.7	-
Spain	3.9	-	-	10	10	16	6.6	72	54	2.5	0.7
Sweden	**8.2**	**6.3**	**9.3**	**51**	69	71	16.8	83	68	1.3	1.7
Switzerland	7.2	**6.0**	-	43	43	**92**	5.7	115	85	0.4	-
Turkey	2.2	0.5	-	2	1	5	-	76	19	2.1	-
United Kingdom	**8.0**	4.8	**8.4**	28	35	55	15.9	120	68	2.0	0.8
United States	**8.0**	3.9	**8.7**	**65**	**160**	**170**	**18.4**	68	100	2.3	1.3

Note: For each indicator related to ICT production or use, the top-5 countries are highlighted in **bold**.

Source: ICT investment based on IDC data; ICT production from OECD (2000c); penetration of ICT technologies from OECD (2000h; 2000i), partly based on Telcordia (www.netsizer.com). Innovation in ICT based on USPTO (www.uspto.gov); Access costs from OECD, at: www.oecd.org\dsti\sti\it\cm; indicators of growth performance from OECD (2001a).

Annex Table 2: Share of the ICT sector in the total business sector, 1998

	Employment				*Value added*			
	Manufacturing ICT	Telecom	Other ICT services	Share of ICT in total business sector (%)	Manufac-turing ICT	Telecom	Other ICT services	Share of ICT in total business sector (%)
Australia (1998-99)	0.13	1.00	1.48	2.62	0.14	2.29	1.71	4.14
Austria[1]	1.17	1.92	1.81	4.90	1.62	2.57	2.59	6.78
Belgium	0.75	0.97	2.54	4.26	1.03	1.97	2.76	5.76
Canada	1.11	1.20	2.27	4.57	1.81	2.56	2.16	6.53
Czech Republic[1]	1.17	0.72	1.41	3.30	0.87	2.08	1.71	4.65
Denmark	1.16	1.02	2.94	5.13	1.37	..	4.88	..
Finland	2.33	1.10	2.14	5.56	3.91	1.84	2.51	8.26
France	1.40	1.00	1.61	4.01	1.44	1.96	1.86	5.26
Germany[2]	1.19	0.71	1.22	3.12	2.05	2.56	1.50	6.11
Greece	..	..	..	..	..	..	..	
Hungary[1]	1.93	0.86	2.93	5.72	2.33	3.28	3.60	9.21
Iceland (1996)	0.10	2.33	1.81	4.24	..	..	..	..
Ireland[2]	2.83	0.97	0.80	4.60	..	..	..	..
Italy	0.97	0.94	1.60	3.50	1.06	3.17	1.59	5.82
Japan[2]	2.01	0.36	1.05	3.43	3.48	1.62	0.71	5.81
Korea[2]	1.80	0.44	0.25	2.48	7.88	2.22	0.62	10.72
Mexico	..	..	..	..	..	..	..	..
Netherlands[2]	1.48	0.78	1.52	3.78	1.45	1.91	1.69	5.05
New Zealand	0.30	0.84	0.94	2.08	0.36	..	2.06	..
Norway (1996)	0.74	1.31	3.22	5.27	0.89	2.00	3.46	6.35
Poland	..	..	..	..	..	..	..	..
Portugal[1]	0.76	0.59	1.35	2.70	1.00	2.88	1.74	5.62
Spain	..	..	..	..	..	..	..	..
Sweden	2.13	1.30	2.83	6.26	3.38	2.32	3.61	9.31
Switzerland (1998)	1.75	1.03	3.25	6.03	..	..	..	..
Turkey[2]	0.12	0.38	0.02	0.51	0.66	..	0.04	..
United Kingdom	1.31	0.84	2.67	4.82	1.90	2.37	4.10	8.36
United States	1.37	1.07	1.47	3.91	2.56	2.76	3.33	8.66
Total OECD[3]	1.39	0.88	1.41	3.59	..	..	..	..

Notes: (1) Including all of wholesale of machinery, equipment and supplies (ISIC 5150); (2) Excluding all of wholesale of machinery, equipment and supplies (ISIC 5150); (3) Calculated for the 24 countries for which data where available.

Source: OECD (2000), *Measuring the ICT Sector* , Paris.

Annex Table 3: A Comparison of Hourly-based vs. Employment-based Labour Productivity Growth

(annual average growth rates, in %)

CANADA

Industry		Value added per hour worked				Value added per person employed			
	ISIC Rev.3	1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	1.8	0.9	1.2	0.9	1.2	0.7	1.0	1.0
Total manufacturing	**15-37**	3.1	1.6	2.7	0.9	2.8	1.8	2.8	1.4
Machinary & equipment	**29-33**	4.0	4.4	5.3	..	3.9	4.7	5.3	..
Total services	**50-99**	1.2	0.6	0.8	1.0	0.7	0.3	0.6	1.0

FINLAND

Industry		Value added per hour worked				Value added per person employed			
	ISIC Rev.3	1976-79	1979-89	1989-95	1995-99	1976-79	1979-89	1989-95	1995-99
Total	**01-99**	3.9	3.2	3.3	2.7	3.4	2.8	3.0	2.7
Total manufacturing	**15-37**	5.6	5.0	6.1	5.1	5.4	4.7	5.6	5.2
Machinary & equipment	**29-33**	4.2	5.6	6.7	10.8	4.1	5.5	6.2	10.6
Total services	**50-99**	2.3	2.0	1.6	1.6	1.7	1.7	1.7	1.7

FRANCE

Industry		Value added per FTE				Value added per person employed			
	ISIC Rev.3	1979-89	1989-95	1991-95	1995-98	1979-89	1989-95	1991-95	1995-98
Total	**01-99**	2.5	1.4	1.5	1.3	2.4	1.1	1.2	1.1
Total manufacturing	**15-37**	3.0	3.5	4.6	2.7	2.9	3.3	4.4	2.6
Machinary & equipment	**29-33**	..	..	8.3	6.9	..	..	8.1	6.9
Total services	**50-99**	1.9	0.4	0.4	1.1	1.8	0.2	0.0	0.7

UNITED STATES

Industry		Value added per hour worked				Value added per person employed			
	ISIC Rev.3	1977-79	1979-89	1989-95	1995-99	1977-79	1979-89	1989-95	1995-99
Total	**01-99**	0.4	1.4	1.1	1.8	0.2	1.2	1.1	2.0
Total manufacturing	**15-37**	1.0	3.2	3.0	4.4	0.9	3.4	3.2	4.3
Machinary & equipment	**29-33**	3.2	6.5	7.2	13.5	3.0	6.7	7.4	13.3
Total services	**50-99**	0.9	0.8	0.5	2.2	0.6	0.6	0.6	2.4

Annex Table 4: Labour Productivity Performance of ICT-producing Industries

(annual average growth rates, in %)

Industry		CANADA				DENMARK			
		Value added per hour worked				Value added per person employed			
	ISIC Rev.3	1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	1.8	0.9	1.2	0.9	2.2	1.2	2.0	0.9
Total manufacturing	**15-37**	3.1	1.6	2.7	0.9	4.6	1.8	2.1	-0.6
Machinery and equipment	**29-33**	4.0	4.4	5.3	..	4.7	2.0	3.1	-1.5
Electrical and optical equipment	**30-33**	4.7	7.5	6.7	..	8.0	4.2	5.2	0.8
Total services	**50-99**	1.2	0.6	0.8	1.0	0.8	0.4	1.7	1.1
ICT-producing industries (30+32+64+72)									
Office, accounting and computing machinery	30	4.6	25.8	20.3	..	..	24.3	15.0	21.2
Radio, television and communication equipment	32	7.7	4.0	3.5	..	15.3	8.2	3.7	1.3
Post and telecommunications	64	5.1	3.2	2.3	..	2.9	3.4	5.9	7.0
Computer and related activities	72	..	..	..	..	0.6	3.5	12.6	1.3

Industry		FINLAND				FRANCE			
		Value added per hour worked				Value added per FTE			
	ISIC Rev.3	1976-79	1979-89	1989-95	1995-99	1979-89	1989-95	1991-95	1995-98
Total	**01-99**	3.9	3.2	3.3	2.7	2.5	1.4	1.5	1.3
Total manufacturing	**15-37**	5.6	5.0	6.1	5.1	3.0	3.5	4.6	2.7
Machinery and equipment	**29-33**	4.2	5.6	6.7	10.8	..	..	8.3	6.9
Electrical and optical equipment	**30-33**	2.2	7.3	9.9	16.1	..	..	9.7	10.2
Total services	**50-99**	2.3	2.0	1.6	1.6	1.9	0.4	0.4	1.1
ICT-producing industries (30+32+64+72)									
Office, accounting and computing machinery	30	4.0	14.9	7.6	17.7	..	..	25.5	25.6
Radio, television and communication equipment	32	3.8	7.5	17.3	19.0	..	..	18.4	23.9
Post and telecommunications	64	4.0	5.5	6.0	10.9	6.7	3.5	1.7	6.8
Computer and related activities	72	-0.8	-1.0	-0.9	1.7	..	..	2.9	0.7

Industry		GERMANY		ITALY			
		Value added per person employed		Value added per FTE			
	ISIC Rev.3	1991-95	1995-97	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	2.1	1.7	2.7	1.7	1.9	0.7
Total manufacturing	**15-37**	3.9	2.3	4.6	3.4	2.7	0.7
Machinery and equipment	**29-33**	3.8	3.6	4.4	3.3	2.6	0.2
Electrical and optical equipment	**30-33**	2.9	5.6	..	..	3.2	1.8
Total services	**50-99**	1.2	1.2	1.4	0.3	1.3	0.1
ICT-producing industries (30+32+64+72)							
Office, accounting and computing machinery	30	10.5	12.9	..	..	..	-1.1
Radio, television and communication equipment	32	7.1	10.6	..	..	..	..
Post and telecommunications	64	7.7	12.7	..	..	8.3	9.0
Computer and related activities	72	0.5	8.8	..	..	..	3.2

Industry	ISIC Rev.3	JAPAN Value added per person employed				KOREA Value added per person employed			
		1970-79	1979-89	1989-95	1995-98	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	3.9	3.2	1.2	0.8	4.3	4.8	5.0	2.7
Total manufacturing	**15-37**	5.0	3.5	2.0	2.6	6.2	5.1	8.5	8.6
Machinery and equipment	**29-33**	10.0	8.7	4.9	6.1	13.5	7.9	12.0	13.5
Electrical and optical equipment	**30-33**	28.9	11.6	8.3	9.2	..	..	12.8	17.9
Total services	**50-99**	2.8	2.6	0.8	0.6	2.2	2.1	2.0	0.2
ICT-producing industries (30+32+64+72)									
Office, accounting and computing machinery	30	..	..	..	..	..	..	8.6	17.5
Radio, television and communication equipment	32	..	..	..	..	..	..	14.4	22.8
Post and telecommunications	64	..	..	5.4	6.8	..	..	..	..
Computer and related activities	72	..	..	..	..	..	..	..	..

Industry	ISIC Rev.3	NETHERLANDS Value added per person employed				UNITED KINGDOM Value added per person employed			
		1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	3.0	1.5	1.2	0.7	1.9	2.7	2.0	1.2
Total manufacturing	**15-37**	4.6	2.9	3.4	1.8	2.1	4.3	3.4	1.1
Machinery and equipment	**29-33**	5.1	2.9	5.0	2.0	1.9	4.6	4.7	2.0
Electrical and optical equipment	**30-33**	..	..	6.4	3.4	..	..	6.8	3.9
Total services	**50-99**	..	..	0.6	0.6	..	1.4	1.4	1.7
ICT-producing industries (30+32+64+72)									
Office, accounting and computing machinery	30	..	..	..	..	..	..	..	..
Radio, television and communication equipment	32	..	..	..	..	..	..	..	..
Post and telecommunications	64	..	..	4.7	8.2	..	4.1	5.9	8.2
Computer and related activities	72	..	..	..	0.4	..	..	5.3	0.9

Industry	ISIC Rev.3	UNITED STATES Value added per hour worked			
		1977-79	1979-89	1989-95	1995-99
Total	**01-99**	0.4	1.4	1.1	1.8
Total manufacturing	**15-37**	1.0	3.2	3.0	4.4
Machinery and equipment	**29-33**	3.2	6.5	7.2	13.5
Electrical and optical equipment	**30-33**	..	..	..	..
Total services	**50-99**	0.9	0.8	0.5	2.2
ICT-producing industries (30+32+64+72)					
Office, accounting and computing machinery	30	..	..	..	..
Radio, television and communication equipment	32	..	..	..	..
Post and telecommunications	64	..	..	..	..
Computer and related activities	72	..	..	..	..

Annex Table 5: Contribution of Labour Productivity Performance of ICT-producing Industries

(in percentage points)

Industry		CANADA				DENMARK			
		Contribution to value added per hour worked				Contribution to value added per person employed			
	ISIC Rev.3	1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	1.8	0.9	1.2	0.9	2.2	1.2	2.0	0.9
Total manufacturing	**15-37**	0.6	0.3	0.5	0.2	0.9	0.3	0.4	-0.1
Machinery and equipment	**29-33**	0.1	0.1	0.1	..	0.2	0.1	0.1	-0.1
Electrical and optical equipment	**30-33**	0.1	0.1	0.1	..	0.1	0.1	0.1	0.0
Total services	**50-99**	0.6	0.2	0.5	0.5	0.6	0.3	1.2	0.8
ICT-producing industries (30+32+64+72)		..	..	..	..	..	..	0.30	0.23
Office, accounting and computing machinery	30	0.01	0.05	0.02	..	..	..	0.01	0.02
Radio, television and communication equipment	32	0.04	0.02	0.02	..	0.06	0.03	0.01	0.01
Post and telecommunications	64	0.16	0.11	0.07	..	0.04	0.06	0.12	0.19
Computer and related activities	72	..	..	..	..	0.00	0.04	0.15	0.01

Industry		FINLAND				FRANCE			
		Contribution to value added per hour worked				Contribution to value added per FTE			
	ISIC Rev.3	1976-79	1979-89	1989-95	1995-99	1979-89	1989-95	1991-95	1995-98
Total	**01-99**	3.9	3.2	3.3	2.7	2.5	1.4	1.5	
Total manufacturing	**15-37**	1.5	1.3	1.4	1.2	0.7	0.7	0.9	..
Machinery and equipment	**29-33**	0.2	0.3	0.3	0.7	..	..	..	..
Electrical and optical equipment	**30-33**	0.0	0.1	0.2	0.5	..	..	..	..
Total services	**50-99**	1.2	1.0	1.1	1.0	1.2	0.3	0.2	..
ICT-producing industries (30+32+64+72)		0.09	0.15	0.26	0.59	..	..	..	..
Office, accounting and computing machinery	30	0.00	0.03	0.02	0.03	..	..	..	..
Radio, television and communication equipment	32	0.02	0.04	0.11	0.36	..	..	..	..
Post and telecommunications	64	0.07	0.11	0.14	0.25	0.16	0.08	0.04	..
Computer and related activities	72	-0.01	-0.02	-0.01	-0.05	..	..	..	..

Industry		GERMANY				ITALY			
		Contribution to value added per person employed				Contribution to value added per FTE			
	ISIC Rev.3			1991-95	1995-97	1970-79	1979-89	1989-95	1995-99
Total	**01-99**			2.1	1.7	2.7	1.7	1.9	0.7
Total manufacturing	**15-37**			1.3	0.6	1.3	0.9	0.7	0.1
Machinery and equipment	**29-33**			0.5	0.3	0.2	0.2	0.1	0.0
Electrical and optical equipment	**30-33**			0.2	0.2	..	..	0.1	0.0
Total services	**50-99**			0.8	0.9	0.8	0.2	0.8	0.1
ICT-producing industries (30+32+64+72)		..	..	0.33	0.49	..	..	..	..
Office, accounting and computing machinery	30	..	..	0.06	0.03	..	..	..	0.00
Radio, television and communication equipment	32	..	..	0.08	0.07	..	..	..	..
Post and telecommunications	64	..	..	0.17	0.27	..	..	0.16	0.19
Computer and related activities	72	..	..	0.02	0.12	..	..	..	0.04

Industry	ISIC Rev.3	JAPAN Contribution to value added per person employed				KOREA Contribution to value added per person employed			
		1970-79	1979-89	1989-95	1995-98	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	3.9	3.2	1.2	0.8	4.3	4.8	5.0	2.7
Total manufacturing	**15-37**	1.5	1.0	0.5	0.6	1.6	1.5	2.4	2.3
Machinery and equipment	**29-33**	0.7	0.6	0.4	0.4	0.4	0.3	0.7	0.9
Electrical and optical equipment	**30-33**	1.1	0.5	0.4	0.4	..	..	0.6	0.9
Total services	**50-99**	1.4	1.4	0.5	0.4	0.3	0.6	0.8	-0.1
ICT-producing industries (30+32+64+72)		..	..	..	..	..	..	..	..
Office, accounting and computing machinery	30	..	..	..	..	..	..	0.02	0.07
Radio, television and communication equipment	32	..	..	..	..	..	..	0.43	0.77
Post and telecommunications	64	..	..	0.08	0.13	..	..	..	..
Computer and related activities	72	..	..	..	..	..	..	..	..

Industry	ISIC Rev.3	NETHERLANDS Contribution to value added per person employed				UNITED KINGDOM Contribution to value added per person employed			
		1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	3.0	1.5	1.2	0.7	1.9	2.7	2.0	1.2
Total manufacturing	**15-37**	1.1	0.6	0.6	0.3	0.7	1.2	0.8	0.2
Machinery and equipment	**29-33**	0.2	0.1	0.2	0.0	0.1	0.3	0.2	0.1
Electrical and optical equipment	**30-33**	..	..	0.1	0.1	..	..	0.2	0.1
Total services	**50-99**	..	..	0.4	0.3	..	0.8	0.9	1.2
ICT-producing industries (30+32+64+72)		..	..	..	..	..	..	..	..
Office, accounting and computing machinery	30	..	..	..	..	..	..	..	..
Radio, television and communication equipment	32	..	..	..	..	..	..	..	..
Post and telecommunications	64	..	..	0.10	0.23	..	..	..	0.23
Computer and related activities	72	..	..	..	-0.06	..	..	.	..

Industry	ISIC Rev.3	UNITED STATES Contribution to value added per hour worked			
		1977-79	1979-89	1989-95	1995-99
Total	**01-99**	0.4	1.4	1.1	1.8
Total manufacturing	**15-37**	0.1	0.7	0.6	0.7
Machinery and equipment	**29-33**	0.1	0.3	0.3	0.6
Electrical and optical equipment	**30-33**	..	..	..	..
Total services	**50-99**	0.6	0.5	0.4	1.6
ICT-producing industries (30+32+64+72)		..	..	..	..
Office, accounting and computing machinery	30	..	..	..	..
Radio, television and communication equipment	32	..	..	..	..
Post and telecommunications	64	..	..	..	..
Computer and related activities	72	..	..	..	..

Annex Table 6: Multi-Factor Productivity Performance of ICT-producing Industries

(annual average growth rates, in %)

Industry		CANADA				FINLAND			
		MFP growth (per hour worked)				MFP growth (per hour worked)			
	ISIC Rev.3	1970-79	1979-89	1989-95	1995-99	1976-79	1979-89	1989-95	1995-99
Total	**01-99**	1.2	0.3	0.6	0.8	2.0	2.0	1.1	3.2
Total manufacturing	**15-37**	2.5	0.9	2.0	1.9	4.3	3.5	4.4	5.5
Machinery and equipment	**29-33**	3.6	3.2	4.5	..	2.9	4.3	6.1	10.7
Electrical and optical equipment	**30-33**	4.0	5.9	5.7	..	0.2	5.5	9.6	14.7
Total services	**50-99**	1.1	0.2	0.4	0.7	1.0	1.3	-0.1	2.1
ICT-producing industries (30+32+64+72)		..	..	..	..	..	..	..	..
Office, accounting and computing machinery	30	3.9	23.3	19.0	..	3.9	11.2	6.3	19.1
Radio, television and communication equipment	32	6.4	2.5	3.0	..	-0.7	7.0	19.0	17.2
Post and telecommunications	64	4.8	2.8	1.1	5.2	1.5	4.5	4.0	10.1
Computer and related activities	72	..	..	..	..	0.8	-1.7	-2.4	4.2

Industry		ITALY				JAPAN			
		MFP growth (per person employed)				MFP growth (per person employed)			
	ISIC Rev.3	1983-89	1989-95	1995-97	1995-99	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	1.4	0.9	0.4	0.2	1.5	1.3	-0.5	-0.6
Total manufacturing	**15-37**	2.5	1.8	0.3	..	1.6	1.6	-0.1	0.4
Machinery and equipment	**29-33**	3.2	1.7	-0.3	..	7.2	6.8	2.2	4.0
Electrical and optical equipment	**30-33**	4.6	2.0	1.7	..	26.2	9.2	5.0	6.6
Total services	**50-99**	0.5	0.4	0.3	-0.3	0.4	-0.1	-1.2	-1.0
ICT-producing industries (30+32+64+72)		..	..	..	..	..	..	..	..
Office, accounting and computing machinery	30	..	..	..	..	..	..	..	..
Radio, television and communication equipment	32	..	..	..	..	..	..	..	..
Post and telecommunications	64	..	..	..	..	..	..	..	..
Computer and related activities	72	..	..	..	..	..	..	..	..

Annex Table 7: Contribution to MFP by ICT-producing industries

(in percentage points)

Industry		CANADA				FINLAND			
		MFP growth (per hour worked)				MFP growth (per hour worked)			
	ISIC Rev.3	1970-79	1979-89	1989-95	1995-99	1976-79	1979-89	1989-95	1995-99
Total	**01-99**	1.21	0.32	0.65	0.84	2.00	2.03	1.11	3.18
Total manufacturing	**15-37**	0.51	0.17	0.34	0.35	1.10	0.89	0.97	1.33
Machinery and equipment	**29-33**	0.09	0.07	0.09	..	0.14	0.20	0.29	0.68
Electrical and optical equipment	**30-33**	0.06	0.08	0.07	..	0.00	0.10	0.20	0.50
Total services	**50-99**	0.64	0.14	0.24	0.46	0.50	0.72	-0.07	1.38
ICT-producing industries (30+32+64+72)		..	..	..	..	0.03	0.14	0.22	0.63
Office, accounting and computing machinery	30	0.00	0.04	0.02	..	0.00	0.02	0.01	0.03
Radio, television and communication equipment	32	0.04	0.01	0.02	..	0.00	0.03	0.14	0.33
Post and telecommunications	64	0.13	0.08	0.03	0.16	0.03	0.09	0.09	0.23
Computer and related activities	72	..	..	..	..	0.00	-0.01	-0.02	0.04

Industry		ITALY				JAPAN			
		MFP growth (per person employed)				MFP growth (per person employed)			
	ISIC Rev.3	1983-89	1989-95	1995-97	1995-99	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	1.44	0.92	0.43	0.17	1.54	1.31	-0.46	-0.64
Total manufacturing	**15-37**	0.63	0.40	0.05	..	0.50	0.43	-0.01	0.10
Machinery and equipment	**29-33**	0.17	0.08	-0.01	..	0.48	0.51	0.17	0.28
Electrical and optical equipment	**30-33**	0.11	0.04	0.03	..	0.97	0.40	0.22	0.28
Total services	**50-99**	0.28	0.27	0.21	-0.21	0.20	-0.04	-0.70	-0.62
ICT-producing industries (30+32+64+72)		..	..	..	..	..	..	..	..
Office, accounting and computing machinery	30	..	..	..	..	..	..	..	..
Radio, television and communication equipment	32	..	..	..	..	..	..	..	..
Post and telecommunications	64	..	..	..	..	..	..	..	..
Computer and related activities	72	..	..	..	..	..	..	..	..

Annex Table 8: Labour Productivity Performance of ICT-using industries

(annual average growth rates, in %)

Industry	ISIC Rev.3	CANADA				DENMARK			
		Value added per hour worked				Value added per person employed			
		1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	1.8	0.9	1.2	0.9	2.2	1.2	2.0	0.9
Total manufacturing	**15-37**	3.1	1.6	2.7	0.9	4.6	1.8	2.1	-0.6
Total services	**50-99**	1.2	0.6	0.8	1.0	0.8	0.4	1.7	1.1
ICT-using industries (50-52; 65-74)									
Wholesale and retail trade; repairs	50-52	2.1	1.9	0.8	4.0	1.5	0.4	2.8	2.2
Finance, insurance, real estate and business services	65-74	-1.6	-1.2	1.6	-0.8	1.0	-0.7	1.1	0.8
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	*-1.0*	*0.6*	*-1.1*	*3.3*
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	*3.4*	*2.6*	*-3.2*	*7.5*
- Activities related to financial intermediation	*67*	..	..	..	..	*-2.6*	*5.7*	*5.3*	*-13.5*
- Research and development	*73*	..	..	..	..	*2.5*	*1.2*	*-1.9*	*4.8*
- Other business activities	*74*	..	..	..	..	*0.9*	*2.6*	*-0.1*	*1.5*
Transport and storage	60-63	2.3	1.1	0.8	1.5	0.7	1.1	2.5	1.2

Industry	ISIC Rev.3	FINLAND				FRANCE			
		Value added per hour worked				Value added per person employed			
		1976-79	1979-89	1989-95	1995-99	1979-89	1989-95	1991-95	1995-98
Total	**01-99**	3.9	3.2	3.3	2.7	2.5	1.4	1.5	1.3
Total manufacturing	**15-37**	5.6	5.0	6.1	5.1	3.0	3.5	4.6	2.7
Total services	**50-99**	8.1	4.7	6.5	4.1	..	..	1.3	1.4
ICT-using industries (50-52; 65-74)									
Wholesale and retail trade; repairs	50-52	2.0	3.7	0.9	2.5	3.2	2.4	1.7	1.6
Finance, insurance, real estate and business services	65-74	1.7	0.4	3.0	0.3	1.1	-0.9	0.1	-0.7
- Financial intermediation, except insurance and pension funding	*65*	*1.1*	*3.6*	*2.2*	*11.7*	*7.8*	*-2.7*	*-1.3*	*-1.9*
- Insurance and pension funding, except compulsory social security	*66*	*-2.3*	*4.3*	*0.7*	*5.6*	..	..	*-0.4*	*-3.6*
- Activities related to financial intermediation	*67*	..	..	*-4.1*	*13.2*	..	..	*6.2*	*4.2*
- Research and development	*73*	*4.1*	*1.0*	*-0.2*	*-0.7*	..	..	*-1.0*	*-1.7*
- Other business activities	*74*	*1.6*	*0.3*	*1.1*	*-1.1*	..	..	*-1.0*	*-0.1*
Transport and storage	60-63	3.6	2.1	3.8	2.6	3.4	0.6	1.2	2.6

Industry	ISIC Rev.3	GERMANY		ITALY			
		Value added per person employed		Value added per person employed			
		1991-95	1995-97	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	2.1	1.7	2.7	1.7	1.9	0.7
Total manufacturing	**15-37**	3.9	2.3	4.6	3.4	2.7	0.7
Total services	**50-99**	2.2	3.2	5.5	3.5	2.0	2.1
ICT-using industries (50-52; 65-74)							
Wholesale and retail trade; repairs	50-52	0.8	-1.0	..	..	3.0	1.0
Finance, insurance, real estate and business services	65-74	-0.9	0.6	0.1	-2.5	0.0	-2.8
- Financial intermediation, except insurance and pension funding	*65*	*1.3*	*9.3*	..	..	..	*3.1*
- Insurance and pension funding, except compulsory social security	*66*	*2.9*	*-2.5*	..	..	..	*-5.6*
- Activities related to financial intermediation	*67*	*-2.2*	*1.5*	..	..	..	*-5.0*
- Research and development	*73*	*0.3*	*2.9*	..	..	..	..
- Other business activities	*74*	*-2.2*	*-2.7*	..	..	..	*-4.0*
Transport and storage	60-63	4.9	4.7	..	..	2.9	-1.7

Industry	ISIC Rev.3	JAPAN Value added per person employed				KOREA Value added per person employed			
		1970-79	1979-89	1989-95	1995-98	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	3.9	3.2	1.2	0.8	4.3	4.8	5.0	2.7
Total manufacturing	**15-37**	5.0	3.5	2.0	2.6	6.2	5.1	8.5	8.6
Total services	**50-99**	0.0	2.4	-1.1	1.5	5.7	7.6	5.0	3.0
ICT-using industries (50-52; 65-74)									
Wholesale and retail trade; repairs	50-52	6.0	4.1	2.4	-0.8	..	..	..	-0.3
Finance, insurance, real estate and business services	65-74	..	..	2.2	2.2	-0.6	-2.0	-0.6	-0.6
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	..	..	..	..
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	..	..	..	..
- Activities related to financial intermediation	*67*	..	..	..	..	..	..	..	..
- Research and development	*73*	..	..	..	..	..	..	..	..
- Other business activities	*74*	..	..	..	..	..	..	..	..
Transport and storage	60-63	..	..	-1.7	-0.7	..	..	..	..

Industry	ISIC Rev.3	NETHERLANDS Value added per person employed				UNITED KINGDOM Value added per person employed			
		1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	3.0	1.5	1.2	0.7	1.9	2.7	2.0	1.2
Total manufacturing	**15-37**	4.6	2.9	3.4	1.8	2.1	4.3	3.4	1.1
Total services	**50-99**	..	..	2.4	2.4	..	2.7	1.3	0.0
ICT-using industries (50-52; 65-74)									
Wholesale and retail trade; repairs	50-52	..	..	0.6	2.2	..	2.6	1.3	0.9
Finance, insurance, real estate and business services	65-74	..	..	-1.3	-1.8	..	0.1	0.7	1.4
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	*-1.2*	..	..	*2.4*	*3.4*
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	*-1.1*	..	..	*2.6*	*-0.6*
- Activities related to financial intermediation	*67*	..	..	..	*3.2*	..	..	*1.8*	*1.1*
- Research and development	*73*	..	..	..	*-2.7*	..	..	*1.7*	*-7.0*
- Other business activities	*74*	..	..	..	*-0.4*	..	..	*0.2*	*4.5*
Transport and storage	60-63	..	..	3.4	2.1	..	3.4	2.4	1.8

Industry	ISIC Rev.3	UNITED STATES Value added per person employed			
		1977-79	1979-89	1989-95	1995-99
Total	**01-99**	0.2	1.2	1.1	2.0
Total manufacturing	**15-37**	0.9	3.4	3.2	4.3
Total services	**50-99**	0.8	-0.1	-1.9	0.3
ICT-using industries (50-52; 65-74)					
Wholesale and retail trade; repairs	50-52	0.6	1.6	1.5	6.1
Finance, insurance, real estate and business services	65-74	-1.4	-1.2	0.1	1.0
- Financial intermediation, except insurance and pension funding	*65*	*-0.3*	*-0.8*	*2.0*	*1.3*
- Insurance and pension funding, except compulsory social security	*66*	*-1.7*	*-5.3*	*1.7*	*0.6*
- Activities related to financial intermediation	*67*	*-3.7*	*1.8*	*1.8*	*13.8*
- Research and development	*73*	..	..	..	..
- Other business activities	*74*	..	..	..	..
Transport and storage	60-63	0.5	1.3	2.2	1.7

Annex Table 9: Contribution to Labour Productivity Performance by ICT-using industries

(in percentage points)

Industry	ISIC Rev.3	CANADA: Contribution to value added per hour worked				DENMARK: Contribution to value added per person employed			
		1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	1.75	0.86	1.18	0.91	2.16	1.23	1.99	0.95
Total manufacturing	**15-37**	0.63	0.30	0.46	0.23	0.94	0.32	0.37	-0.10
Total services	**50-99**	0.61	0.22	0.49	0.54	0.64	0.25	1.23	0.79
ICT-using industries (50-52; 65-74)		0.30	0.21	0.50	0.41	0.79	0.21	0.52	0.73
Wholesale and retail trade; repairs	50-52	0.16	0.16	0.08	0.36	0.25	0.07	0.37	0.22
Finance, insurance, real estate and business services	65-74	0.14	0.06	0.42	0.05	0.53	0.14	0.15	0.52
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	*0.05*	*0.05*	*-0.09*	*0.10*
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	*0.03*	*0.02*	*-0.02*	*0.07*
- Activities related to financial intermediation	*67*	..	..	..	..	*0.00*	*0.01*	*0.01*	*-0.03*
- Research and development	*73*	..	..	..	..	*0.01*	*0.01*	*-0.01*	*0.01*
- Other business activities	*74*	..	..	..	..	*0.01*	*0.10*	*0.00*	*0.04*
Transport and storage	60-63	0.12	0.05	0.03	0.06	0.04	0.06	0.14	0.07

Industry	ISIC Rev.3	FINLAND: Contribution to value added per hour worked				FRANCE: Contribution to value added per person employed			
		1976-79	1979-89	1989-95	1995-99	1979-89	1989-95	1991-95	1995-98
Total	**01-99**	3.89	3.23	3.30	2.72	2.51	1.41	1.50	..
Total manufacturing	**15-37**	1.46	1.28	1.38	1.23	0.74	0.73	0.93	..
Total services	**50-99**	0.39	0.26	0.33	0.23	..	..	0.03	..
ICT-using industries (50-52; 65-74)		0.60	0.72	0.47	0.71	0.86	0.15	0.27	..
Wholesale and retail trade; repairs	50-52	0.25	0.42	0.13	0.23	0.31	0.26	0.19	..
Finance, insurance, real estate and business services	65-74	0.35	0.30	0.35	0.47	0.56	-0.12	0.08	..
- Financial intermediation, except insurance and pension funding	*65*	*0.03*	*0.10*	*0.03*	*0.30*	..	..	*-0.06*	..
- Insurance and pension funding, except compulsory social security	*66*	*-0.01*	*0.02*	*0.01*	*0.04*	..	..	..	..
- Activities related to financial intermediation	*67*	..	..	*0.00*	*0.02*	..	..	..	..
- Research and development	*73*	*0.01*	*-0.01*	*0.00*	*-0.02*	..	..	..	..
- Other business activities	*74*	*0.02*	*-0.06*	*0.04*	*-0.14*	..	..	..	..
Transport and storage	60-63	0.24	0.15	0.23	0.22	0.14	0.02	0.05	..

Industry	ISIC Rev.3	GERMANY: Contribution to value added per person employed		ITALY: Contribution to value added per person employed			
		1991-95	1995-97	1970-79	1979-89	1989-95	1995-99
Total	**01-99**	2.10	1.74	2.68	1.69	1.87	0.74
Total manufacturing	**15-37**	1.27	0.65	1.29	0.92	0.66	0.15
Total services	**50-99**	0.05	0.06	0.07	0.05	0.03	0.03
ICT-using industries (50-52; 65-74)		0.47	0.62	..	..	0.52	-0.02
Wholesale and retail trade; repairs	50-52	0.08	-0.12	..	..	0.36	0.16
Finance, insurance, real estate and business services	65-74	0.40	0.74	0.32	0.06	0.16	-0.17
- Financial intermediation, except insurance and pension funding	*65*	*0.05*	*0.31*	..	..	..	*0.15*
- Insurance and pension funding, except compulsory social security	*66*	*0.03*	*-0.02*	..	..	..	*-0.02*
- Activities related to financial intermediation	*67*	*-0.01*	*0.01*	..	..	..	*-0.04*
- Research and development	*73*	*0.00*	*0.01*	..	..	..	..
- Other business activities	*74*	*0.01*	*-0.09*	..	..	..	*-0.11*
Transport and storage	60-63	0.19	0.17	..	..	0.16	-0.10

Industry	ISIC Rev.3	JAPAN Contribution to value added per person employed				KOREA Contribution to value added per person employed			
		1970-79	1979-89	1989-95	1995-98	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	3.86	3.18	1.20	0.83	4.29	4.78	5.00	2.70
Total manufacturing	**15-37**	1.54	0.97	0.50	0.62	1.57	1.54	2.45	2.31
Total services	**50-99**	0.00	0.04	-0.03	0.03	0.04	0.08	0.06	0.07
ICT-using industries (50-52; 65-74)		..	..	0.93	0.55	..	..	..	0.05
Wholesale and retail trade; repairs	50-52	0.82	0.54	0.31	-0.11	..	..	..	-0.02
Finance, insurance, real estate and business services	65-74	..	..	0.62	0.65	0.10	0.06	0.36	0.07
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	..	..	..	..
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	..	..	..	..
- Activities related to financial intermediation	*67*	..	..	..	..	..	..	..	..
- Research and development	*73*	..	..	..	..	..	..	..	..
- Other business activities	*74*	..	..	..	..	..	..	..	..
Transport and storage	60-63	..	..	-0.10	-0.04	..	..	..	..

Industry	ISIC Rev.3	NETHERLANDS Contribution to value added per person employed				UNITED KINGDOM Contribution to value added per person employed			
		1970-79	1979-89	1989-95	1995-99	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	3.01	1.52	1.24	0.68	1.92	2.74	2.02	1.21
Total manufacturing	**15-37**	1.11	0.56	0.64	0.29	0.71	1.20	0.81	0.22
Total services	**50-99**	..	..	0.06	0.05	..	0.07	0.03	0.00
ICT-using industries (50-52; 65-74)		..	..	0.01	0.16	..	..	..	0.74
Wholesale and retail trade; repairs	50-52	..	..	0.09	0.26	..	..	..	0.10
Finance, insurance, real estate and business services	65-74	..	..	-0.08	-0.10	..	0.19	0.27	0.64
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	*-0.06*	..	..	..	..
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	*0.00*	..	..	..	..
- Activities related to financial intermediation	*67*	..	..	..	*0.03*	..	..	..	..
- Research and development	*73*	..	..	..	*-0.02*	..	..	..	..
- Other business activities	*74*	..	..	..	*-0.21*	..	..	..	..
Transport and storage	60-63	..	..	0.16	0.10	..	..	..	0.08

Industry	ISIC Rev.3	UNITED STATES Contribution to value added per person employed			
		1977-79	1979-89	1989-95	1995-99
Total	**01-99**	0.19	1.19	1.10	2.03
Total manufacturing	**15-37**	0.04	0.70	0.58	0.72
Total services	**50-99**	0.01	-0.01	-0.04	0.01
ICT-using industries (50-52; 65-74)		0.55	0.44	0.48	1.72
Wholesale and retail trade; repairs	50-52	0.12	0.28	0.25	1.05
Finance, insurance, real estate and business services	65-74	0.43	0.16	0.23	0.67
- Financial intermediation, except insurance and pension funding	*65*	*0.00*	*-0.01*	*0.07*	*0.08*
- Insurance and pension funding, except compulsory social security	*66*	*-0.03*	*-0.06*	*0.02*	*0.01*
- Activities related to financial intermediation	*67*	*-0.03*	*0.01*	*0.02*	*0.28*
- Research and development	*73*	..	..	..	..
- Other business activities	*74*	..	..	..	..
Transport and storage	60-63	-0.01	0.04	0.06	0.04

Annex Table 10: Multi-Factor Productivity Performance of ICT-using industries

(annual average growth rates, in %)

Industry	ISIC Rev.3	CANADA MFP growth (per hour worked)				FINLAND MFP growth (per hour worked)			
		1970-79	1979-89	1989-95	1995-99	1976-79	1979-89	1989-95	1995-99
Total	**01-99**	1.2	0.3	0.6	0.8	2.0	2.0	1.1	3.2
ICT-using industries (50-52; 65-74)									
Wholesale and retail trade; repairs	50-52	2.1	1.9	0.3	3.3	1.3	2.8	-1.2	3.8
Finance, insurance, real estate and business services	65-74	-3.2	-3.6	0.7	-1.7	-0.3	0.7	-0.5	2.7
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	*-0.1*	*4.1*	*-1.3*	*16.1*
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	*-4.7*	*3.9*	*-0.3*	*4.9*
- Activities related to financial intermediation	*67*	..	..	..	..	..	..	*-5.7*	*23.2*
- Research and development	*73*	..	..	..	..	*3.8*	*0.8*	*-0.7*	*-0.3*
- Other business activities	*74*	..	..	..	..	*1.4*	*-0.2*	*0.9*	*-0.5*
Transport and storage	60-63	2.4	0.9	0.8	1.3	1.9	1.5	1.8	2.7

Industry	ISIC Rev.3	ITALY MFP growth (per person employed)				JAPAN MFP growth (per person employed)			
		1983-89	1989-95	1995-97	1995-99	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	1.4	0.9	0.4	0.2	1.5	1.3	-0.5	-0.6
ICT-using industries (50-52; 65-74)									
Wholesale and retail trade; repairs	50-52	1.1	1.5	-0.3	..	3.6	2.7	1.1	-1.4
Finance, insurance, real estate and business services	65-74	0.0	-0.6	-0.3	-1.4	..	..	-2.4	-1.7
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	..	..	..	..
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	..	..	..	..
- Activities related to financial intermediation	*67*	..	..	..	..	..	..	..	..
- Research and development	*73*	..	..	..	..	..	..	..	..
- Other business activities	*74*	..	..	..	..	..	..	..	..
Transport and storage	60-63	..	..	..	..	..	..	..	..

Annex Table 11: Contribution to MFP Growth by ICT-using industries

(percentage points)

Industry	ISIC Rev.3	CANADA MFP growth (per hour worked)				FINLAND MFP growth (per hour worked)			
		1970-79	1979-89	1989-95	1995-99	1976-79	1979-89	1989-95	1995-99
Total	**01-99**	1.21	0.32	0.65	0.84	2.00	2.03	1.11	3.18
ICT-using industries (50-52; 65-74)		-0.24	-0.41	0.17	-0.01	0.10	0.42	-0.22	0.93
Wholesale and retail trade; repairs	50-52	0.24	0.22	0.03	0.36	0.15	0.32	-0.13	0.38
Finance, insurance, real estate and business services	65-74	-0.48	-0.62	0.14	-0.37	-0.04	0.10	-0.09	0.54
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	*0.00*	*0.12*	*-0.05*	*0.50*
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	*-0.02*	*0.02*	*0.00*	*0.03*
- Activities related to financial intermediation	*67*	..	..	..	..	..	..	*-0.01*	*0.03*
- Research and development	*73*	..	..	..	..	*0.01*	*0.00*	*0.00*	*0.00*
- Other business activities	*74*	..	..	..	..	*0.02*	*0.00*	*0.03*	*-0.02*
Transport and storage	60-63	0.13	0.04	0.03	0.06	0.13	0.10	0.12	0.20

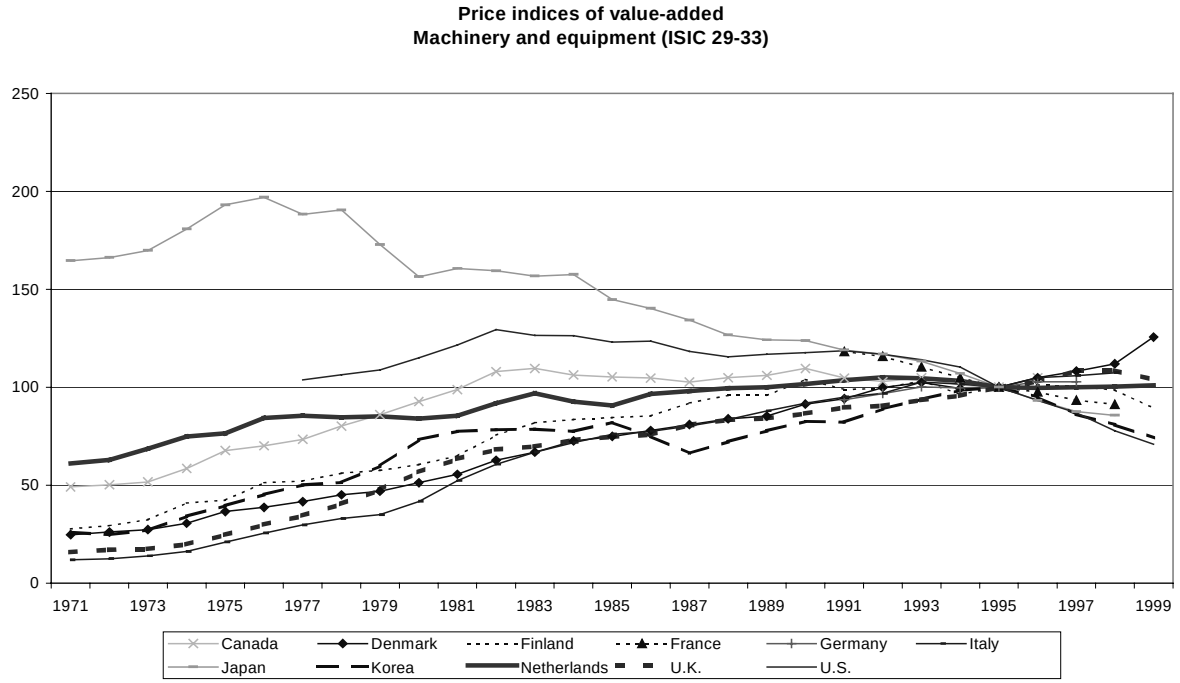
Industry	ISIC Rev.3	ITALY MFP growth (per person employed)				JAPAN MFP growth (per person employed)			
		1983-89	1989-95	1995-97	1995-99	1970-79	1979-89	1989-95	1995-98
Total	**01-99**	1.44	0.92	0.43	0.17	1.54	1.31	-0.46	-0.64
ICT-using industries (50-52; 65-74)		0.16	0.07	-0.10	..	..	..	-0.39	-0.58
Wholesale and retail trade; repairs	50-52	0.15	0.21	-0.04	..	0.50	0.37	0.14	-0.16
Finance, insurance, real estate and business services	65-74	0.01	-0.14	-0.06	-0.34	..	..	-0.53	-0.41
- Financial intermediation, except insurance and pension funding	*65*	..	..	..	..	..	..	..	..
- Insurance and pension funding, except compulsory social security	*66*	..	..	..	..	..	..	..	..
- Activities related to financial intermediation	*67*	..	..	..	..	..	..	..	..
- Research and development	*73*	..	..	..	..	..	..	..	..
- Other business activities	*74*	..	..	..	..	..	..	..	..
Transport and storage	60-63	..	..	..	..	..	..	..	..

ANNEX 2. SENSITIVITY ANALYSIS BASED ON THE U.S. DEFLATOR

In order to analyse the sensitivity of using different deflators on labour productivity, the U.S. machinery and equipment value-added deflator is applied to estimate labour productivity across ten other OECD countries. Annex Figure 5 plots value-added deflators for the eleven countries. It shows that Japan experienced a substantial decline in its price in machinery and equipment in terms of the implicit value-added index since the late 70s. The U.S. implicit deflator remained more or less steady whereas other countries' implicit price index increased over the same period. As alluded earlier, these differences reflect methodological differences in measuring prices in output and input as well as differences in goods produced in machinery and equipment.

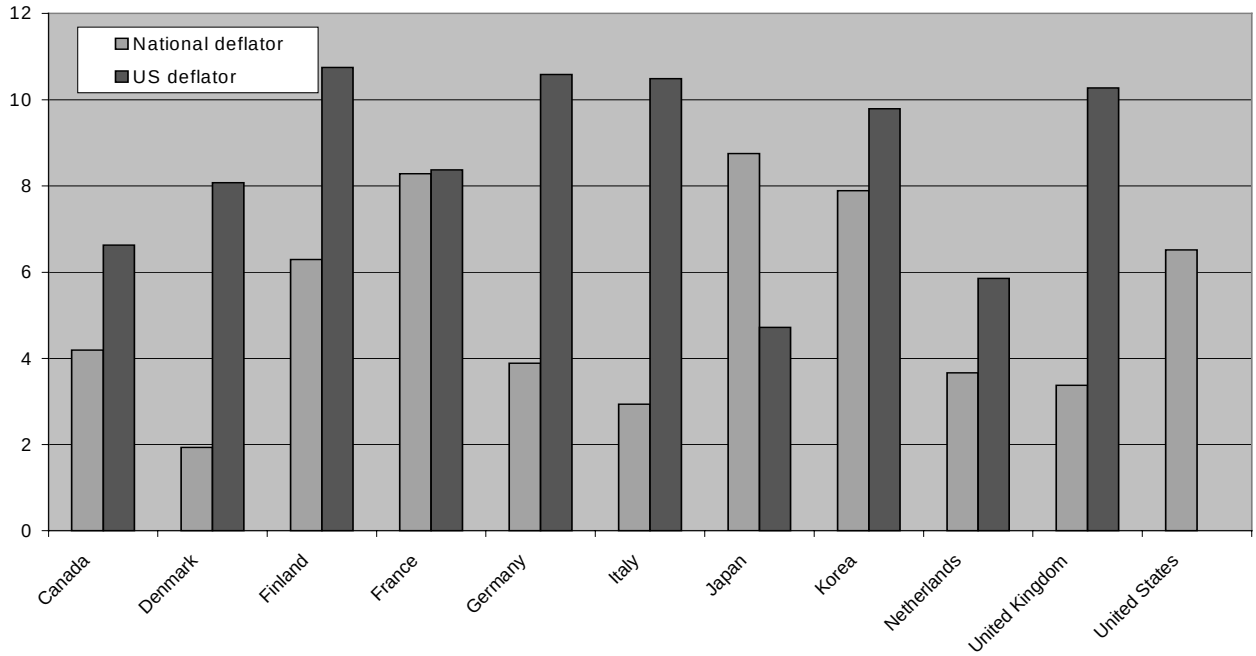
The sensitivity of using the U.S. deflator on labour productivity growth is illustrated in Annex Figure 6 (Wyckoff, 1995). Labour productivity growth based on the U.S. deflator is higher than that based on national deflators in every country except Japan. In addition, the magnitude of the difference between the two measurements is quite large changing qualitative results as well. For example, Finland's labour productivity is fastest over the last twenty years whereas it was in the middle of the pack based on its own deflator. This exercise illustrates the sensitivity of labour productivity estimates to the choice of deflators. It should to be noted that this sensitivity analysis does not claim that the U.S. deflator is the appropriate one to use in comparing labour productivity across OECD countries. It instead argues that further research is needed in investigating the differences in product mix across countries in this industry, before one can reach a more definite conclusion.

Annex Figure 5. Implicit value-added indexes for the machinery and equipment industry



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

Annex Figure 6. Sensitivity of using the US deflator on labour productivity growth in machinery and equipment, 1977-98



Note: 1991-97 for Germany, 1991-98 for France and 1977-96 for Canada.
Source: OECD calculations on the basis of the new STAN database.

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