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The Renewal of the Old Economy: An International Comparative Perspective

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THE RENEWAL OF THE OLD ECONOMY: AN INTERNATIONAL COMPARATIVE PERSPECTIVE

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Abstract

This paper presents international comparisons of the contribution of information and communication technology (ICT) to output and productivity growth during the 1990s. It makes a distinction between ICT-*producing* manufacturing and service industries, intensive ICT-*using* manufacturing and service industries and the rest of the economy (the "non-ICT" sector). The paper presents measures of the contributions of each sector to growth and acceleration of growth in output, employment and labour productivity for ten major OECD countries during the 1990s. The main findings are that the productivity growth differentials between the United States and most European countries are partly explained by a larger and more productive ICT-producing sector in the United States, but also by bigger productivity contributions from ICT-using industries and services in the United States. The main reason for the productivity deceleration in most European countries is due to the under performance of the non-ICT sector. Most of the European employment expansion has taken place in the non-ICT sector but at the cost of a slowdown in productivity growth. These countries have not generated sufficiently large positive employment effects from intensive ICT use. The second part of the paper reviews measurement issues related to ICT as well as recent evidence on the relation between ICT investment, ICT capital and growth.

1 This paper is based on earlier work paper presented at the annual meeting of the Netherlands Royal Economic Society on 8 December 2000 (Van Ark, 2000b). With financial support of the OECD, it has been updated and extended from six to ten countries. I am grateful to Ronald Albers, Lourens Broersma, Robert McGuckin, Dirk Pilat, Marcel Timmer and Henry van der Wiel for data and suggestions. Special thanks go to Colin Webb (OECD) for providing unpublished data from the STAN database (http://www.oecd.org/dsti/sti/stat-ana/stats/).

LE RENOUVELLEMENT DE L'ANCIENNE ECONOMIE : UNE ETUDE COMPARATIVE INTERNATIONALE

Bart van Ark[2]

Résumé

Ce rapport présente des comparaisons internationales concernant la contribution des technologies de l'information et des communications (TIC) à la croissance de la production et de la productivité au cours des années 90. Il opère une distinction entre les branches manufacturières et de services *produisant* des TIC, les branches manufacturières et de services *utilisant* de façon intensive les TIC et le reste de l'économie (le secteur « hors TIC »). On y trouvera des mesures de la contribution apportée par chaque secteur à la croissance ainsi qu'à l'accélération de la croissance de la production, de l'emploi et de la productivité du travail dans dix grands pays de l'OCDE durant les années 90. La principale conclusion qui se dégage de l'étude est que les écarts de progression de la productivité entre les Etats-Unis et la plupart des pays européens s'expliquent en partie par l'existence aux Etats-Unis d'un secteur producteur de TIC plus grand et plus productif, mais aussi par l'apport plus important dans ce pays des branches utilisatrices de TIC à la productivité. Si la hausse de la productivité à fléchi dans la plupart des pays européens, c'est principalement en raison des résultats médiocres du secteur hors TIC. En Europe, la majeure partie des créations d'emplois est intervenue dans le secteur hors TIC, au prix d'un ralentissement de l'accroissement de la productivité. Dans ces pays, il n'y a pas eu d'effets positifs suffisamment importants sur l'emploi induits par l'utilisation intensive des TIC. La deuxième partie de ce rapport examine les problèmes liés à la mesure des TIC, ainsi que des observations récentes concernant les liens entre l'investissement dans les TIC, le capital de TIC et la croissance.

[2] Université de Groninge et The Conference Board. Ce rapport repose sur des travaux antérieurs présentés le 8 décembre 2000 à la réunion annuelle de la Royal Economic Society des Pays-Bas (Van Ark, 2000b). Avec l'aide financière de l'OCDE, ces travaux ont été élargis de 6 à 10 pays. Je tiens à exprimer ma gratitude à Ronald Albers, Lourens Broersma, Robert McGuckin, Dirk Pilat, Marcel Timmer et Henry van der Wiel pour les données et les suggestions qu'ils m'ont communiquées. J'adresse des remerciements particuliers à Colin Webb (OCDE) qui m'a fourni des données non publiées issues de la base de données STAN (http://www.oecd.org/dsti/sti/stat-ana/stats/).

1. Introduction

The recent acceleration of production and investment related to information and communication technology (ICT) is a promising vehicle by which the slowdown in economic growth in the western world during the last quarter of the twentieth century may be reversed. So far, however, the empirical support for this viewpoint comes mainly from the U.S. experience. During the second half of the 1990s there has been a clear acceleration of growth in the American economy. For example, between 1995 and 2000, labour productivity growth in the US was 1.8% per year faster than between 1990 and 1995, and the rise in output was more than 2% faster (Conference Board, 2001). Some argue that the growth acceleration is mainly due to improved productivity growth in the ICT-producing sector (Jorgenson and Stiroh, 2000; Jorgenson, 2001). Others stress the increasingly productive use of ICT-goods and services elsewhere in the economy (Oliner and Sichel, 2000; Baily and Lawrence, 2001). However, there are also critics who argue that ICT does not have the potential to raise growth by as much as the great innovations earluer in the twentieth century, such as the introduction of electricity, the combustion engine, etc. (Gordon, 2000).[3]

For the OECD area excluding the U.S., labour productivity growth accelerated at a modest 0.1% per year during the second half of the 1990s, annual labour productivity growth even halved from 2.4% between 1990 and 1995 to only 1.2 per cent between 1995 and 2000 (Conference Board, 2001). But the diversity in growth performance across OECD countries increased during the 1990s. The causes of this diversity are multifold ranging from different growth rates in investment, varying paces of structural reforms on labour, product and capital markets, differences in demand effects and innovation regimes (Ahn and Hemmings, 2000; Scarpetta *et al.*, 2000; OECD, 2000a). A smaller effect of ICT on growth is therefore only one of many possible explanations for slower growth in many OECD countries compared to the United States.

Earlier studies have documented the growth contribution of ICT in OECD countries on the basis of a growth accounting framework using ICT investment as a separate input (Schreyer, 2000; European Commission, 2000; Goldman Sachs, 2000; Daveri, 2001; Roeger, 2001). However, as ICT investment series are – as yet – not available on a comprehensive basis for all OECD countries, these studies use proxies for ICT investment, usually derived from (private) data sources on ICT expenditures, including consumer expenditure. Moreover none of these studies has gone into the ICT contributions of individual industries to growth. As the data limitations on investment are even more serious at industry level, this paper follows an alternative approach. Section 2 sets out to distinguish the output and employment shares of ICT-producing industries in manufacturing and services ("ICT-producing sector"), intensive ICT-using industries in manufacturing and services ("ICT-using sector") and the rest of the economy (the "non-ICT sector"). Next, the contributions of these sectors to output, employment and labour productivity growth are computed in Section 3.

The detailed comparisons in this paper are for Canada, Denmark, Finland, Germany, France, Italy, Japan the Netherlands, the United Kingdom and the United States from 1990 to 1999. The dataset is based on the new (and as yet unpublished) STAN dataset of the OECD.[4] At some places the STAN database is not detailed enough to distinguish between the three sectors described above exactly. Further refinements are therefore made using information from production statistics and national accounts for individual countries.[5] Appendix B describes the database in some more detail. The series

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3 In addition, Gordon stresses that part of the growth acceleration in the United States is due to the pro-cyclical productivity effect in the upward phase of the business cycle.

4 See http://www.oecd.org/dsti/sti/stat-ana/stats/

5 See Appendix A for definitions of the ICT-producing sector and industries identified as part of the ICT-using sector on the basis of the ISIC rev. 3 classification.

for the ICT-producing, the ICT-using sector and the non-ICT sector are available on the website of the Groningen Growth and Development Centre, and are extended and updated on a regular basis.[6]

Section 4 of the paper reviews the issue of measurement problems in production, inputs and productivity related to ICT. This partly involves the measurement of the ICT-producing sector itself, but at least as important are the problems of measuring the inputs and output of the ICT-using sector, in particular for services, such as the financial sector, business services, etc.. Measurement problems have become bigger partly because of the greater importance of services for which output has always been difficult to measure, but also because of the introduction of new "difficult to measure" products and services within these industries. The greater use of ICT may have contributed to measurement problems, as ICT supports the customization of products and services. Even though a full quantification of the overall measurement error is not attempted, Section 4 takes a systematic look at which parts of the economy generate the largest measurement errors.

Finally, in Section 5 the results on the contribution of ICT to growth from this study are compared with those from other studies which – in contrast to the present paper – have attempted to measure ICT investment and total factor productivity. The conclusions on the role of ICT in economic growth from more aggregated studies as well as from country studies for Finland, France, the Netherlands, the United Kingdom and the United States largely coincide with the conclusions drawn in this paper. Some OECD countries follow the US pattern of a rising contribution of ICT capital to growth quite closely, whereas others are still at a greater distance.

2. The share of ICT in the economy

Expenditure on ICT and the use of ICT products and services has rapidly increased during the past two decades (see, for example, OECD 2000b and 2000c). However, the relation between ICT expenditure and economic growth is not straightforward because part of expenditure is consumption and another part is investment and the shares between these two categories differ across countries. For example, Daveri (2001) shows that 60 per cent of US expenditures on information technology and only 45 per cent of ICT expenditures in the European Union can be counted as investment. Schreyer (2000) treats only 30 per cent of expenditure on telecommunication as investment. On the other hand the data on expenditures on software, for example, are an understatement of investment because in-house software production is not included in the data. Except for some country-specific estimates, investment on ICT by industry is still largely unavailable. One therefore requires alternative approaches to assess the role of ICT in the economy.

Output and Employment Shares of the ICT-Producing Sector

The precise shares of ICT in total output and employment depend on the definition of ICT-producing industries.[7] Figure 1 shows the shares of ICT-producing industries in value added in 1999. Figure 2 shows the employment shares. The ICT-producing sector consist of IT hardware, radio, television and communication equipment, medical appliances and instruments and appliances for measurement (together the ICT industry) and telecommunication and computer services (together ICT services). This definition of the ICT-producing sector more or less matches the classification of the OECD.[8]

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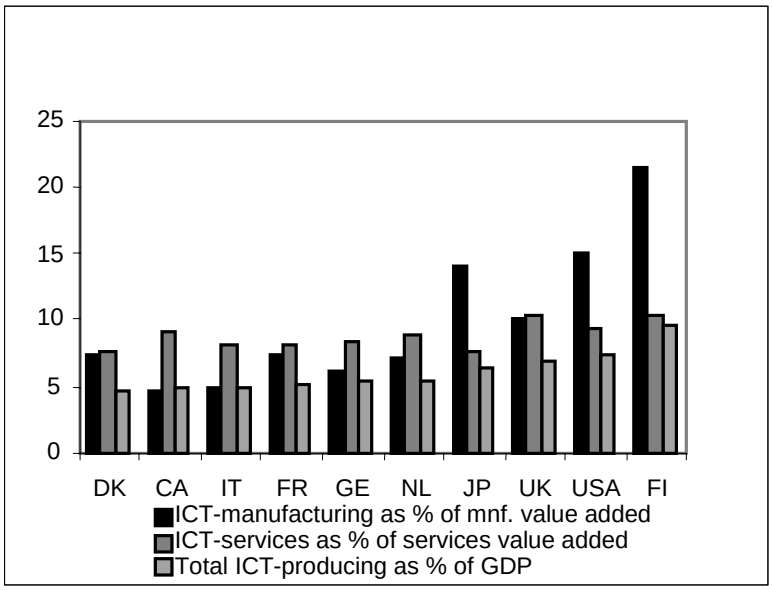
6 The Groningen Growth and Development Centre ICT Database is available from http://www.eco.rug.nl/GGDC/ictdatabase.html

7 Even when ICT industries are defined, the point remains whether one counts the value of all products and services in those industries or only that of ICT products and services. Moreover, ICT products and services can also be produced in industries which are not defined as such.

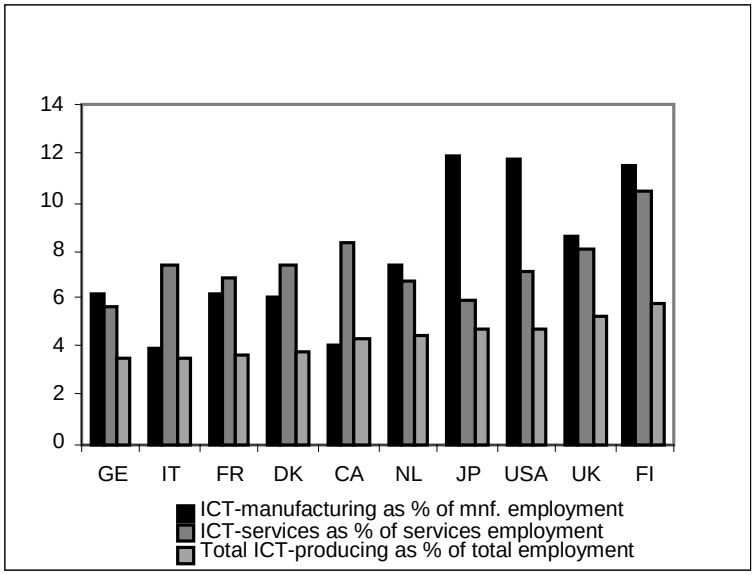
8 See also the top panel of Appendix Table 1. The difference with the OECD classification is that wholesale trade in machinery and equipment and the renting of ICT goods is not included due to lack

Figure 1: ICT-producing sector as % of value added, 1999



Note: France, Germany and Japan are for 1998
Source: See Table A.1

Figure 2: ICT-producing industries as % of total employment, 1999



Note: France, Germany and Japan are for 1998
Source: See Table A.1

The Figures show that the shares of the ICT-producing sector are quite low. Even for the U.S. the percentage shares for the total economy are less than 10 per cent. The differences in output shares are bigger for ICT-manufacturing - with notably larger shares for Japan, the USA and Finland - than for ICT-services. Comparing Figures 1 and 2 shows that the shares of ICT-producing industries are generally higher for GDP than for employment, which suggests higher productivity levels in the ICT-producing sector compared to the rest of the economy.

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of data (OECD, 2000c). It also appeared not possible to separate postal services from telecommunications.

Table A.1 (at the back of this paper) shows the value added and employment shares of ICT-producing industries for 1990 and 1999. For most European countries the share of ICT-producing manufacturing in nominal output remained constant or even declined between 1990 and 1999. Only the UK and in particular Finland experienced substantive increases. For ICT-producing services the output shares slightly increased in all countries and so – with some exceptions – did the employment shares.

Output and Employment Shares of the ICT-Using Sector

Unlike the ICT-producing sector there is no exact definition of which industries should be marked as being part of the ICT-using sector. Such a distinction between heavy users of ICT and less intensive ICT-users is necessarily arbitrary as there are few if any industries that do not use ICT at all. In this paper the two criteria to distinguish between heavy and light users are ICT intensity (i.e., the share of ICT-investment in industry output) and the industry share in the ICT capital stock. For this purpose evidence was used for two countries, i.e., the Netherlands and the United States. About one third of industries with the highest ICT-intensity and/or the highest shares in the ICT capital stock are defined as ICT-using industries.[9] These industries include publishing and printing, the chemical industry, electrical and electronic machinery and equipment, medical and measurement appliances (together ICT-using manufacturing), wholesale trade, post and telecommunication, the financial sector, the renting of machinery, computer services, research and development and part of business services (accountants, architectural firms, legal offices, consultants and marketing agencies) (together ICT-using services). Although, according to the definition, ICT-producing industries are also ICT-using industries (as the producers themselves also invest heavily in ICT), ICT-producing industries are excluded from the ICT-using sector in the analysis below. It needs to emphasized that, as the same classification is used for all countries, ICT-using industries do not necessarily invest equally heavily in ICT across countries. It only indicates that these are the industries that are the likely candidates to generate substantial output and productivity effects from ICT investment.

Figure 3 shows the shares of ICT-using industries in value added in 1999. As for the ICT-producing sector, the United States is again characterized by larger output shares than other OECD countries (except the Netherlands). However, the relative difference in output shares of ICT-using sectors are smaller than for ICT-producing sectors (compare Figures 1 and 3). For example, the ratio of the lowest to the highest value added share of the ICT-using sector is 0.64 compared to 0.49 for the ICT-producing sector in 1999. The coefficients of variation of percentual output shares of the ICT-using sector is 0.13 compared to 0.25 for the ICT-producing sector. In particular the differences in shares of ICT-using manufacturing are smaller than for ICT-producing manufacturing. In ICT-using services the differences are in fact slightly bigger than for ICT-producing industries. The differences in shares between the ICT-using sectors are due to differences in industry composition across countries. The current output shares for the Netherlands are higher than for the USA, due to the large share of chemicals in ICT-using manufacturing and the large share of business services in ICT-using services.

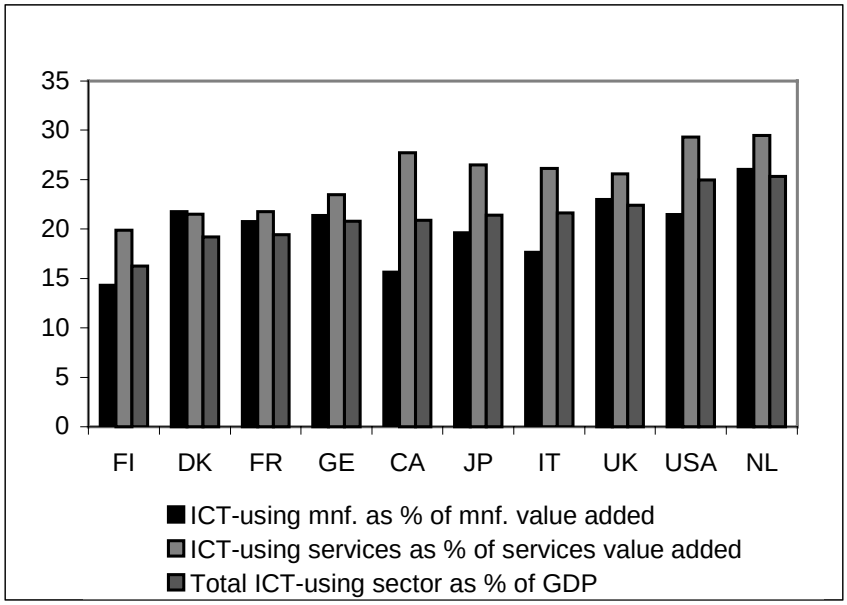
Figure 4 shows the employment shares of ICT-using manufacturing and ICT-using services. Here the differences across countries are in fact somewhat bigger than for the ICT-producing sector (compare Figures 2 and 4). The United States has slightly higher employment shares in the ICT-using sector than in most other countries, but the Netherlands is a clear outlier at the top end. In contrast, Finland has the lowest employment shares in the ICT-using sector, in particular in services. Compared to the output shares the lower employment shares suggest relatively higher labour productivity levels in the ICT-using sector. Table A.2 (at the back of this paper) shows the value added and employment shares of ICT-using sector for 1990 and 1999. As for the ICT-producing sector, the rise in the share of ICT-using sector in GDP and employment is limited and is largely concentrated in ICT-using services.

Two important conclusions emerge from the analysis so far. Firstly, the share of the ICT-producing sector is relatively small in all countries, but the United States is slightly ahead of most other OECD-

[9] See Appendix A.

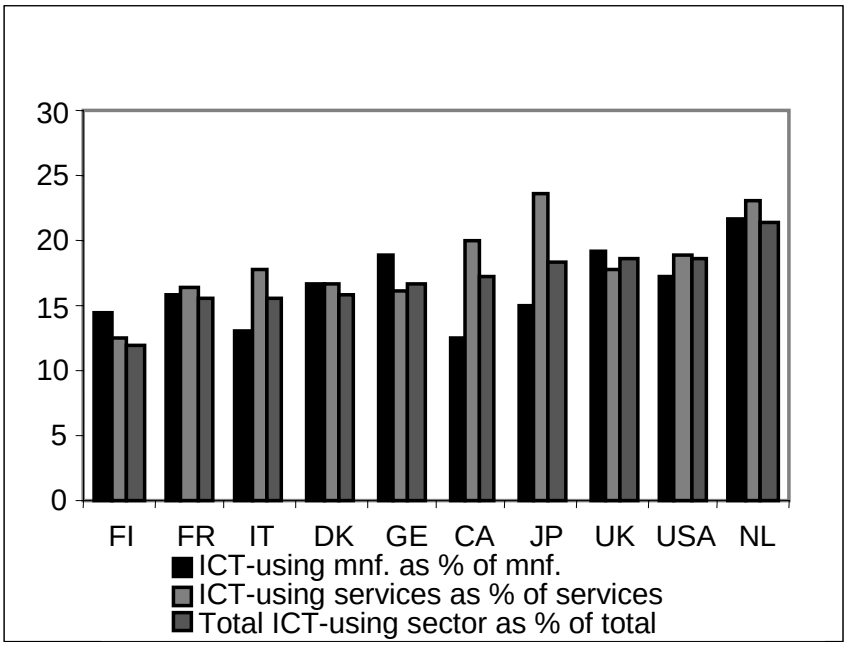
countries (except Finland). Secondly, the relative differences in output shares between the United States and most other OECD countries are bigger for the ICT-producing sector than for the ICT-using sector, which is mainly due to the larger role of ICT-hardware producers. Japan and Finland are also characterized as countries with large ICT-producing output and employment shares. As for ICT-use countries have more of a similar potential to benefit from ICT. However, differences in contributions of ICT use to growth suggest that the realization of the potential is not the same everywhere.

Figure 3: ICT-using sector (excl. ICT-producers) as a percentage of value added, 1999



Note: France, Germany and Japan are for 1998
Source: See Table A.2

Figure 4: ICT-using sector (excl. ICT-producers) as a percentage of employment, 1999



Note: France, Germany and Japan are for 1998
Source: See Table A.2

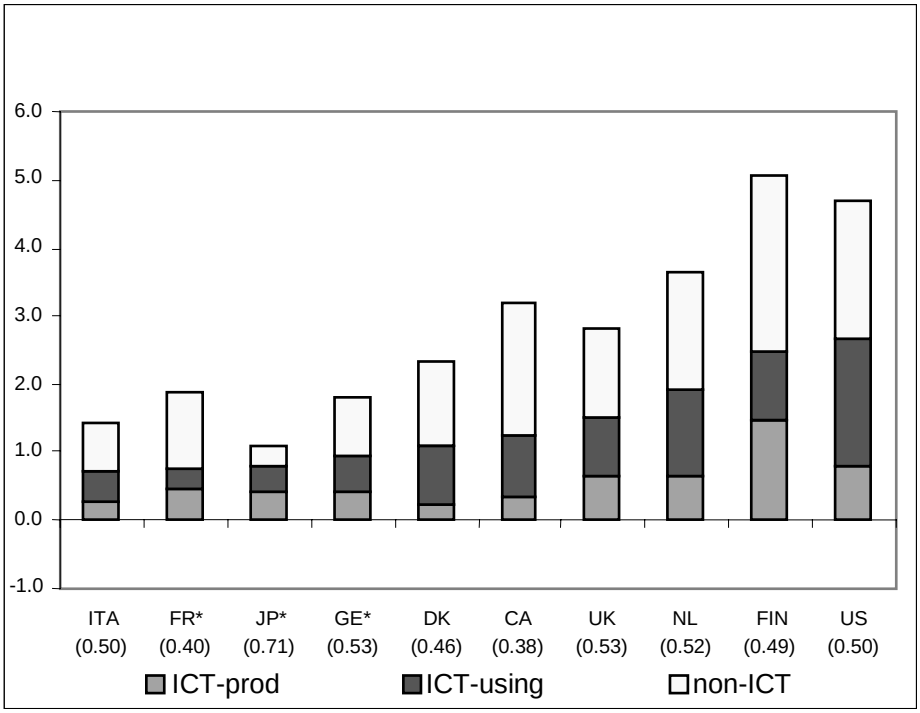
3. The Contribution of ICT to Economic Growth

The Contribution of the ICT-Producing and ICT-Using Sectors to Growth of Output

Figure 5 shows the contribution of the ICT-producing sector, the ICT-using sector and the rest of the economy (the "non-ICT sector") to the growth of GDP from 1995 to 1999.[10] The contributions are computed by weighting the annual change in each sector's GDP at constant prices at the GDP share of that sector of the previous year.[11]

The Figure shows that in absolute terms the contribution of the ICT-sector producing sector to real output growth is higher for the United States than for the other countries, with the exception of Finland. In the case of Finland the large contribution from ICT production (1.4 percentage points out of 5.1 per cent annual GDP growth) is exceptional and mainly due to the large role of communications equipment.[12] In relative terms (see the figures between brackets), the percentage growth contributions of the ICT-producing and ICT-using sectors combined are above those of the U.S. for Japan, Germany and the Netherlands. However, total GDP growth in the latter three countries was much smaller than in the USA in particular in Japan and Germany.

Figure 5: Percentage contribution of ICT-producers and ICT-users to GDP growth 1995-99



* 1995-1998; Figures between brackets are %-contribution of ICT-production and ICT-use to aggregate GDP growth.
Source: See Table A.3

10 For France, Germany and Japan sme data for 1999 were missing, so that the figures refer to 1995-98.

11 The use of annual shifting GDP-weights minimizes the distortion due to deviations of the share in the current year compared to the base year. In fact seven sectors instead of three are distinguished in the weighting scheme, i.e. ICT-producing manufacturing, ICT-producing services, ICT-using manufacturing, ICT-using services, other manufacturing, other services and remaining sectors (such as agriculture, mining, construction and public utilities). See also Appendix A and Table A.3.

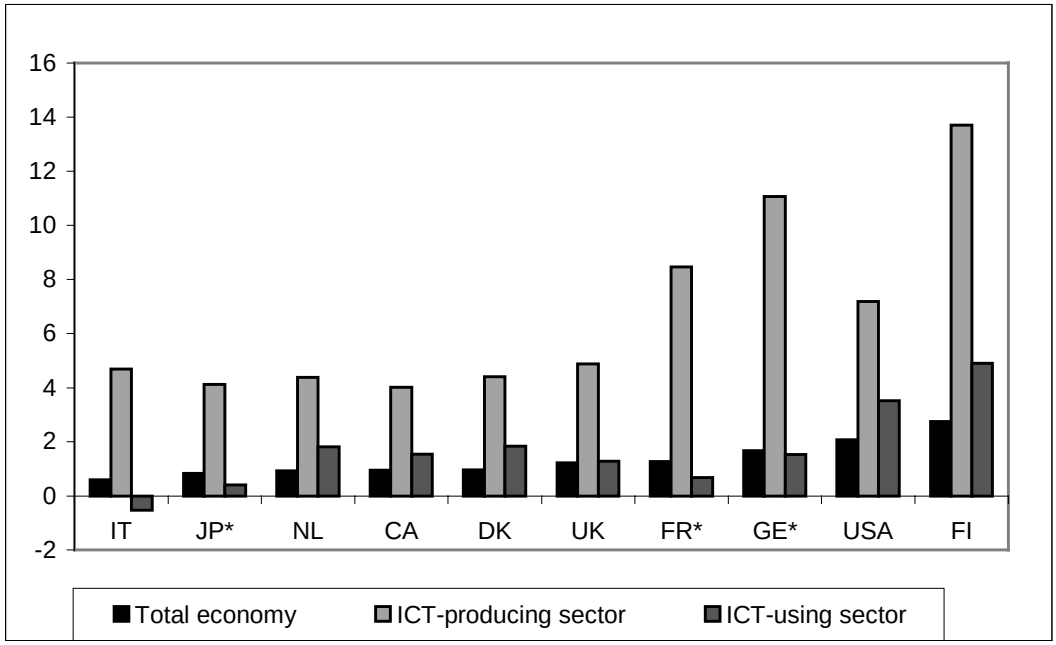
12 According to Forsman (2000) Nokia accounted for 1.2 percentage point of the 4% Finnish GDP growth in 1999.

Table A3 shows more detail on the contribution of ICT-producing and ICT-using sectors to GDP growth for 1990-95 and 1995-99. The acceleration in the contribution of the ICT-producing sector to GDP growth during 1995-99 was highest in the U.S., again with the exception of Finland.[13] The Netherlands was a close runner-up in accelerating the growth contribution from ICT-production to GDP, but like in most other countries that increase largely stems from an expansion of ICT-producing services. Finland, France, Japan and the United States are the only countries with large growth contributions from ICT-producing manufacturing.

The Contribution of the ICT-Producing and the ICT-Using Sectors to Labour Productivity Growth

Even though an acceleration of GDP growth, as noted above, might be a first sign of a positive macroeconomic growth effect of the "new economy", only an acceleration in productivity growth may generate a sustainable higher growth path derived from ICT. Figure 6 shows the labour productivity growth rates for the total economy, the ICT-producing sector and the ICT-using sector from 1995 to 1999. The countries are ranked according to aggregate labour productivity growth rates. Labour productivity growth was substantially faster in the ICT-producing sector than elsewhere in the economy, driving a substantial part of the overall productivity growth in particular in Finland, France and the United States. In Germany a greater part of the productivity growth in ICT-production originated from ICT-producing services rather than ICT-producing manufacturing. Table A.4 shows the acceleration or deceleration of labour productivity growth since the middle of the 1990s. Even though the productivity acceleration was especially strong in ICT-producing manufacturing industries in the U.S., it decelerated in ICT-producing services, and increased less than in other countries, except Japan, between 1995 and 1999. However, in the ICT-using service industries the productivity acceleration in the U.S. was quite strong during the second half of the 1990s.[14]

Figure 6: Average Annual Growth Rates Labour Productivity 1995-99



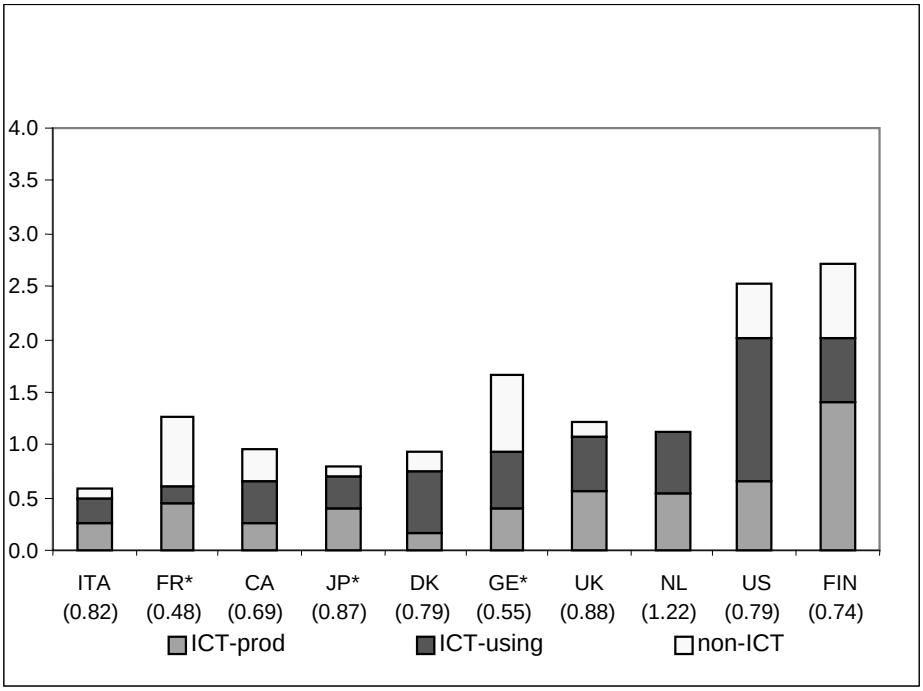
Source: See Table A.4

13 It should be emphasized, however, that Finland experienced a deep economic crisis during the first half of the 1990s, with negative GDP growth (see Table A3).

14 See, for example, Baily and Lawrence (2001)

Figure 7 shows the contribution of the ICT-producing sector, the ICT-using sector and the non-ICT sector to labour productivity growth between 1995 and 1999, using a similar decomposition method as for GDP, using sectoral labour input as weights.[15] The countries are ranked acoording to the combined contribution of the ICT-producing and ICT-using sectors to labour productivity growth. The combined contribution was about the same in Finland and the United States at around three quarters (see the figures between brackets). However, in Finland it was largely accounted for by ICT-production, whereas in the US ICT-use contributed to the largest extent. In other countries, such as Denmark, Italy, Japan, the Netherlands and the United Kingdom the *relative* contribution was sometimes even higher than in the U.S., but overall labour productivity growth in these countries was much slower. Table A.5, shows the effects for each sector for the sub-period 1990-1995 and 1995-1999.

Figure 7: Percentage Contribution of ICT-producers and ICT-users to labour productivity growth 1995-99

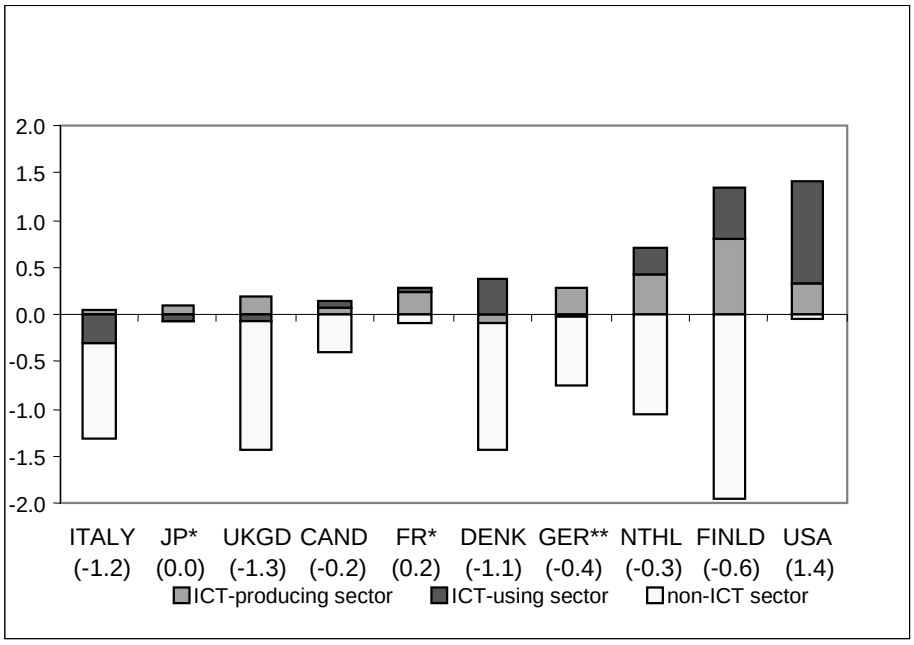


* 1995-1998; figures between brackets are %-contribution of ICT-production and ICT-use to aggregate labour productivity growth
Source: See Table A.5

Figure 8 summarizes the contributions of the ICT-producing sector, the ICT-using sector and the non-ICT sector to the acceleration or deceleration in labour productivity growth for the second half of the 1990s over the first half. The figures between brackets show the overall change in labour productivity growth. In almost all countries ICT-production (with the exception of Denmark) and ICT-use (with the exception of Italy, and to a lesser extent Japan and the United Kingdom) contributed positively to the acceleration in labour productivity growth. However, in several European countries, notably in Denmark, Finland, Germany, Italy, the Netherlands and the United Kingdom, the non-ICT sector contributed negatively to labour productivity offsetting the positive growth contribution from ICT-production and ICT-use.

[15] See Table A.5. The methodological footnote to that Table explains the shift-share method that was used to compute the contributions to labour productivity growth. As for GDP the weighting has taken place for 7 sectors as described under footnote 10.

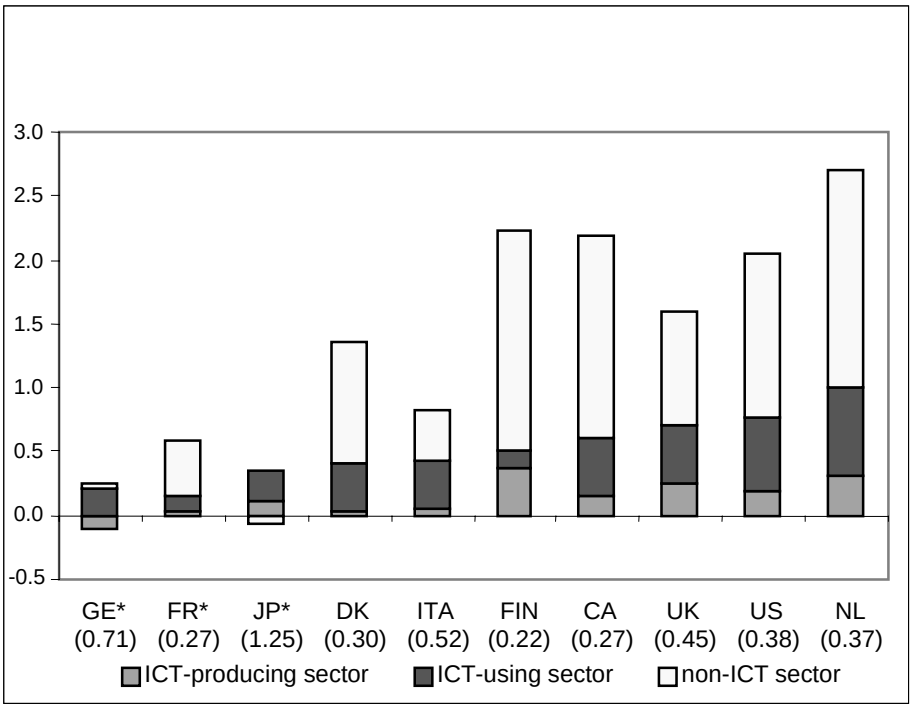
Figure 8: Percentage Contribution of ICT-producers and ICT-users to de-acceleration of labour productivity growth, 1995-99 over 1990-95



* 1995-1998 over 1990-1995; ** 1995-1998 over 1991-1995
Figures between brackets are acceleration of deceleration of labour productivity growth between 1995-1999 over 1990-1995.
Source: See Table A.5

Figure 9 shows the mirror-image of the slowdown in productivity growth in the non-ICT sector. In Denmark, Finland, the Netherlands, the UK and – to a lesser extent – France most of the employment growth actually took place in the non-ICT sector during the period 1995-99. Only for the U.S. employment expansion in the non-ICT sector went together with (a modest) labour productivity acceleration suggesting other additional effects except ICT to support productivity growth. These effects may relate to structural reforms in labour and product markets.

Figure 9: Percentage contribution of ICT-producers and ICT-users to employment growth 1995-99



* 1995-1998
Figures between brackets are %-contribution of ICT-production and ICT-use to aggregate employment growth
Source: See Table A.6

The most important conclusions from this section are that:

1. The acceleration of productivity growth in the United States is partly due to the strong effect from ICT-producing manufacturing but also because of its better performance in the ICT-using sector compared to other OECD countries.

2. Some other OECD countries, in particular Finland, France and Japan have also experienced substantive output growth in ICT-producing manufacturing, whereas some other countries (e.g., Germany and the Netherlands) experienced a relatively large contribution from ICT-producing services.

3. During the period 1995-99 most countries experienced positive contributions to output and productivity growth from the ICT-using sector, but these contrubitions were smaller than in the U.S..

4. In contrast to the U.S., the positive contributions from ICT-production and ICT-use to the acceleration of labour productivity growth in many European countries was more than offset by negative contributions from the non-ICT sector, as most of the employment expansion took place in that part of the economy without generating substantial productivity growth.

4. Measurement Problems

In the past few years there have been increasing concerns about whether the macroeconomic statistics correctly trace the changes in the information society. Griliches (1994) showed a striking difference between the acceleration of labour productivity growth in 'measurable' sectors of the U.S. economy (agriculture, mining, manufacturing, transport and communication, and public utililities) and the slowdown in 'unmeasurable' sectors (like construction, trade, the financial sector, 'other' market services and government). Table A.7 makes a similar distinction for the other countries in this paper. As for the U.S., the table shows the rapid rise in the nominal share of 'difficult to measure' industries. For most European countries and Japan these nominal shares are in between the higher share in the United States and the lower shares in Canada and Finland (both characterized by large natural resource sectors).

Table A.7 also shows that all countries experienced a substantial slower growth in labour productivity growth in the 'unmeasurable' sector of the economy compared to the 'measurable' sector. The differences in growth rates was the biggest for Finland, and also substantial for France and Italy. The differences were smaller for Canada, Germany and the Netherlands. Since 1990 the slowdown in the 'unmeasurable' sector became bigger than for the 1980s in particular for Finland, France, Japan and the Netherlands. However, the longer time perspective in the table including the 1980s is informative as well as it shows that during the 1980s the United States was already plagued by a similar slow growth in services as many European countries during the 1990s.

There are various reasons for slower productivity growth in the 'unmeasurable' sector. As it consists mainly of services, the 'cost-disease' hypothesis of Baumol applies strongly in this sector. The larger size of the service sector as such may therefore be a cause of increased measurement error at the aggregate level. Van Ark (2000a) estimates an increase in measurement error related to the shift of labour towards the 'unmeasurable' sector in France, Germany, Netherlands, the United Kingdom and the United States at 0.2 to 0.4 percentage point per year during the period 1985-96 relative to the period 1960-73.[16] Compared to the period 1973-1985 the rise in measurement error was between 0.1 and 0.2 percentage point per year.

Apart from a rise in measurement error at the aggregate level due to shift towards services, one can also observe an increased difference between the productivity growth rates in the measurable and unmeasurable sectors of the economy. This suggests that larger measurement problems could be an issue as well. Bigger measurement problems may, at least in part, be related to the increased use of ICT.

For a comprehesive view of the role of ICT in increasing the measurement problems concerning output, value added and productivity, one needs to make a distinction between the various sources of measurement problems. These can be divided into four categories, namely measurement problems with regard to output in manufacturing (which is the major industry of the 'measurable' sector of the economy) and output in services (which dominate the 'unmeasurable' sector) vis-à-vis measurement problems concerning the inputs (production factors and intermediate inputs) in manufacturing and services.[17] The diagram below presents a summary of the major problems in each quadrant as well as the most desirable and feasible solutions.

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16 Using a shift-share method, the rise in the output share of those industries is multiplied by a constant measurement error of 2.4 per cent. This estimate of a constant measurement error is based on Sichel (1997) for the United States.

17 A similar analysis was applied by Baily and Gordon (1988) which led them to conclude that the measurement error in relation to the increased use of computers was a minor explanation of the productivity slowdown in the United States during the 1980s. However, the use of computers has strongly increased during the 1990s.

	Manufacturing	Services
Output	Primarily computers and other ICT. Solution primarily through use of hedonic price indices. Feasible provided data availability.	Most services with "customised" production, and non-market services (education, health, etc.) Solutions through detailed surveys on multiple dimensions of output for each industry Difficult in methodological terms as well as in terms of data availability
Input	Primarily semiconductors. Solution primarily through use of hedonic price indices. Feasible given availability of data and use of input-output matrices.	Primarily ICT input Solution through use of real input series adjusted with hedonic price deflators Feasible provided availability of capital-flow matrices

For manufacturing output the problems are relatively straightforward. Nominal output and prices of industrial products are relatively easy to measure. The measurement problems in the northwest quadrant of the diagram are therefore largely confined to measuring ICT output in constant prices. For the construction of price indices, statistical offices mostly use a method that compares prices of identical products in subsequent periods. This 'matched model' approach is difficult to apply for products such as computers (and other ICT goods) because the technical characteristics of these products change very rapidly.[18] Hence it is difficult to adjust for quality changes in the price series of these products. The alternative approach is to develop hedonic price indices, which relates the prices of each good to changes in selected characteristics of the product rather than the product itself. In the case of a personal computer such characteristics involve, for example, the type of processor, memory capacity, disk drives, CD-rom stations, etc. (Triplett, 1989, 1990). Since 1986 this method is used in the US National Income and Product Accounts (NIPA).

Wyckoff (1995) was the first to show that the large differences in computer deflators between countries were at least partly due to methodological differences. He applied the US deflator for office and computing equipment to nominal output series in other countries, which led to an upward adjustment of productivity growth of between 5 and 20 per cent relative to the U.S. during the 1980s. More recently hedonic methods were also developed for computers in Canada and France and applied in the national accounts. The Danish national accounts directly apply the U.S. hedonic deflator. Goldman Sachs (2000) and Daveri (2001) also apply hedonic deflators for the U.S. to European countries.[19] Such a method may, however, lead to biases for several reasons. Firstly, as computer hardware production in the United States mainly consists of PCs and semiconductors, an adjustment of nominal ICT output in Europe, which is more strongly dominated by the production of peripheral equipment, with a US deflator may lead to an exaggeration of the price decline. Secondly, the application of hedonic price indices needs to be combined with the use of chain weights in the price index, as is done in the U.S. and France. When fixed weights are used the price decline for computers will be overstated due to the relatively large weight in the base year compared to successive years (Landefeld and Grimm, 2000). Thirdly, it is questionable whether one can assume that the computer hardware producing industry in Europe is as competitive as in the U.S., which implies again that the price decline in Europe might be overstated when using the US index. Schreyer (2000) constructed a 'harmonized' hedonic computer deflator for the G-7 countries assuming that the difference between price changes for ICT capital goods and non-ICT capital goods in the USA was applicable to the non-ICT deflator of other countries.

[18] Except for ICT these deflation problems also apply to some other industrial products, such as pharmaceutical products, large equipment and some durable consumer goods.

[19] European Commission (2000) applied full as well as 50% adjustments of European prices with U.S. deflators.

A comprehensive use of hedonics deflators, however, requires some further considerations. Except adjusting the deflator for computer output, it is also necessary to make an adjustment for the most important ICT inputs in industry (the southwest quadrant of the diagram above). Triplett (1996) showed that between 1974 and 1994 the prices of semiconductors declined almost 3000 times compared to only 20 times for computers over the same period.[20] As semiconductors account for between 15 and 45 per cent of input costs in the computer industry, much to almost all of the productivity increase in the computer industry can be traced to productivity gains in the semiconductor industry. In addition, in many OECD countries semiconductors (or even computers) are hardly domestically produced but imported. It is therefore necessary to make a comprehensive adjustments of output, input and import of ICT products. In addition to ICT hardware, the issue of deflation of software (which up to now is only done in the U.S. for prepackaged software only) and its use as an input in other industries needs to be considered as well.[21]

In contrast to manufacturing, measurement problems in the service sector are perhaps easier to deal with for inputs than for output. The most important technological inputs in the service sector are ICT products. The share of computers and other high tech equipment (mainly communication equipment) in market services in the U.S. was 10.5 per cent of the total capital stock in 1996 (McGuckin and Stiroh, 2000a). In the Netherlands the share of ICT equipment in the capital stock in market services was 12 per cent on average between 1991 and 1995. The share of ICT investment in market services even increased from 12 to 23 per cent of total investment between 1986 and 1995 (CPB, 2000b). However, within market services the distribution of ICT capital is highly unequal. For example, as much as 20 per cent of the capital stock of business services in the United States was accounted by computers only (McGuckin and Stiroh, 2000a).

The largest measurement problems, however, relate to the measurement of output in the service sector. The current methodology of splitting the change in output value into a quantity component and a price component is difficult to apply to many service activities, as no clear quantity component can be distinguished. Moreover possible changes in the quality of services are also difficult to measure. These problems are not new, and improvements in measurement of service output have been a topic on the agenda of statisticians and academics for a long time.[22] In many service industries information on inputs (such as labour income) was and still is used as a proxy for output. As long as the price or cost developments are not too much affected by changes in the quality of the services, the traditional method suffice at least to measure the change in real output as the statistical bias remains relatively constant (Hulten, 2000). However, the increased importance of ICT may have accelerated quality changes in services. Multiple dimensions of a service should be taken into account, including the service concept, the client interface and the service delivery system (den Hertog, 2000). This implies that the real output of a particular service cannot be so easily measured on the basis of one exclusive quantity indicator. For example, improved inventory management in the trade sector makes it possible to differentiate supply of goods in terms of time, place and type of product. The application of ICT has supported the customization of financial products or combinations of those products (like an insurance, an investment fund and a mortgage). Services in the public sector, such as health care, are also increasingly characterized by diversity and differentiation in time, place and type of treatment. Even though such changes have not exclusively led to upward adjustments of real output, on balance the

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20 See also Jorgenson (2001) for updated series.

21 A comprehensive handbook on price indices for ICT products will be published by the OECD in the fall of 2001. Aizcorbe et al. (2000) have argued that the use of the matched model method at a higher frequency than only once a year (e.g., every quarter) mimics the hedonic price index reasonably well. Still high-frequency matched models place a very heavy demand on the intensity of data collection compared to hedonic models.

22 See, for example, Griliches (1992) and the statistical work of the Voorburg Group on Service Statistics (http://www4.statcan.ca/english/voorburg/).

bias is probably towards an understatement of the growth in real service output (Triplett and Bosworth, 2000).[23]

It should be emphasized that statistical offices are doing much to improve measurement methods. In the United States, the U.S. Bureau of Labor Statistics (which is responsible for the development of price indices) and the Bureau of Economic Analysis (which produces the National Income and Product Accounts) have introduced various improvements in measurement methods (Dean, 1999; Gullickson and Harper, 1999, Landefeld and Fraumeni, 2001). In particular the introduction of hedonic price indices and, more recently, chain indices had a strong upward effect on the US measures of real output growth. These continuous adjustments of US series also raise point of criticism concerning ad-hoc changes in measurement methods in the U.S. and suggest that a greater use of comprehensive methodologies, such as input-output tables and capital flow matrices, might be preferable. The use of input-output tables in combination with chain price and quantity indices has been an established practice in some European countries, including France and the Netherlands, for some time.

In a series of reports, Eurostat recently evaluated measurement practices in various service activities, such as financial services and public services, and 'difficult to measure' production of goods, such as computers and large equipment (Eurostat, 1998a, 1998b, 1999a, 1999b, 2000). These reports suggest that many of the desired adjustments put a large demand on data and therefore on the burden for companies to report and on financial resources of statistical office to process the data. An important priority is therefore to develop statistical techniques that make improvements possible on the basis of relative small databases. For example, a recent Eurostat initiative to develop harmonized hedonic deflators for computers across European countries can substantially reduce the cost of such indicators.

The most important conclusion from this section is that the measurement error at macroeconomic level has partly increased because of the greater share of 'difficult to measure' industries in the economy. In addition, there are strong indications that within these industries, in particular in services, measurement errors get bigger because of the increased use of ICT. It also appears that the use of hedonic price indices, which is applied or experimented with by many statistical office, is a promising avenue to improve the measurement of real output and input of computers. The biggest problem area, however, remains the measurement of real output in many service industries. How much of this explains the observed differences in output and productivity growth between countries remains an unanswerec question for the time being.

5. Investment and Innovations of the ICT Sector

The focus of this paper has been on the contributions of ICT-producing industries and ICT-using industries to output, employment and labour productivity growth. Other studies have looked at the impact of ICT investment on total factor productivity, but mostly without introducing industry details. One reason is that that reliable and internationally comparable estimates of ICT investment and ICT capital goods at industry level are still largely unavailable. So far there are only a few international comparisons that make use of actual investment data on ICT, but mostly use information on ICT expenditure. In this section the evidence from these studies is confronted with that of the present study to check for the consistency of the arguments put forward.

[23] For example, Triplett (1999) quotes evidence on the use of automatic teller machines (ATM) in the U.S. which shows that quality changes in the banking sector may be exaggerated. Whereas ATM transactions cost half that of human teller transactions, about twice as many ATM transactions occur for the same volume of money transfered. Hence all the increased quality of ATM transactions must come from greater customer convenience, which is difficult to measure because ATM services typically go uncharged. The same difficulty in assessing customer convenience arises from the greater availability of flights at lower cost to many destinations, but with more time spent at crowded airports, sitting in packed planes, etc.

Table A.8 summarizes some major international comparative studies on contributions of ICT capital and total factor productivity growth in ICT production to GDP and/or labour productivity growth. In a study for the G-7, Schreyer (2000) uses data on ICT expenditures which he reworked to estimates of investment on the basis of various assumptions.[24] The nominal investment figures were converted to real measures by using the difference between the U.S. (hedonic) price index for ICT goods compared to the index for other capital goods, which (after smoothing) is applied to the price index for non-ICT goods for each individual country. Using the perpetual inventory method, Schreyer then cumulated investments which were scrapped on the basis of an age-efficiency pattern that declines slowly in the early years of an ICT capital good's service life and rapidly at the end. The contribution to growth of the services from ICT capital is then computed using a growth accounting technique, as developed by Jorgenson and associates, with user costs as weights. Schreyer's study confirms the U.S. advantage in terms of higher contribution of ICT capital to output growth. However, as the time period of that study goes only up to 1996, more recent studies, such as Goldman Sachs (2000), Daveri (2001) and ECB (2001) have updated and extended Schreyer's study.[25] Daveri made substantial changes to Schreyer's method in reworking ICT-expenditure to ICT-investment data, and by covering more countries than Schreyer he relied more heavily on U.S. evidence to obtain the estimates. A step forward in Daveri's work is that he includes an estimate for software investment. Daveri's estimates of the ICT contribution to growth are therefore substantially higher than those of Schreyer. With software included the contribution of ICT capital to GDP growth in European countries varies from between 0.31 and 0.64 percentage point during the period 1991-99, compared to 0.94 percentage points in the USA. In an earlier version of his paper, Daveri (2000) also showed estimates for non-European countries, including Australia and Canada, which showed ICT contributions as large as those for the leading group of European countries, such as the UK and the Netherlands.

At national level similar studies were carried out for Finland, France, the Netherlands, the United Kingdom and the United States (Table A.9). All these studies used actual investment data instead of reworked expenditure data. For the United States most studies were carried out at an aggregate level, including Oliner and Sichel (1994, 2000), the Council of Economic Advisers (2000), Jorgenson and Stiroh (1999, 2000) and Jorgenson (2001). Jorgenson and Stiroh (2000) distinguish 59 types of investment as well as 13 types of durable consumer goods, land and inventories. Four types of ICT capital goods are distinguished, namely computers, communication equipment, software and consumer expenditures on computers and software. The study shows that the contribution of these four ICT capital categories to real output growth in the market sector increased rapidly during the 1990s. The U.S. studies are largely in agreement in terms of showing substantial increases in terms of ICT capital contributions to output growth, even though the share of ICT capital in labour productivity did not change much between the first and the second half of the 1990s. Jorgenson and Stiroh (2000) and Jorgenson (2001) also showed a substantial acceleration in the TFP contribution from ICT production.[26]

Jorgenson and Stiroh (2000) also caary out a more detailed analysis at industry level. They distinguish 37 market industries, but within these industries ICT capital is not identified as a separate input. Their study shows that the contribution of ICT-producing industries to TFP growth was as much as 60 per cent of total TFP growth during the 1990s, while this sector accounts for only a few percentage points of total output. Computers in the ICT-using industries were primarily used as substitution for other

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24 The expenditure data on IT hardware were equalled to investment by assuming that the expenditure by consumers (which are included in the figures) was offset by the expenditures by unincorporated enterprises (which were not included). Using U.S. evidence, Schreyer assumed that 30 per cent of expenditure on telecommunication was investment.

25 New estimates by the OECD using actual investment on ICT rather than proxy investment derived from data on ICT expenditure will be provided during the fall.

26 The major source of disagreement in the U.S. is between Gordon (2000) and most other authors on the relative importance of the cyclical effect of the productivity acceleration during the late 1990s, thereby reducing in particular the TFP effect from ICT-use.

capital goods without significantly contributing to an acceleration in total factor productivity growth. Nevertheless the contribution to TFP growth of industries outside the ICT-producing sector accelerated during the second half of the 1990s. This might indicate that ICT-using industries also generate more TFP growth through possible spillover effects. However, more research on the driving factors behind TFP growth outside ICT-production is required to substantiate this hypothesis.

Jorgenson and Stiroh (2000) make no calculations of the contribution of ICT capital to productivity within each industry. Stiroh (1998) makes a distinction between ICT-producing and ICT-using sectors, showing that the contribution of computers in the ICT-producing industry was fairly strong during the 1980s. Unfortunately the data in Stiroh's study run only up to 1991. In more recent work, Stiroh extends his data to the 1990s again establishing large productivity contributions from ICT-producing industries but also from intensive ICT-users (Stiroh, 2001). For example, 26 ICT-using industries contribute 0.66 percentage points to the acceleration in aggregate U.S. labour productivity growth during the second half of the 1990s, whereas two ICT-producing industries contribute 0.19 percentage points and the 33 remaining ("non-ICT") industries contributed the remaining 0.08 percentage points. A distinction between IT-capital and non-IT capital at industry level is required to advance these arguments further.

For the Netherlands, which is characterized by a relatively large ICT-using sector compared to other European countries, CPB (2000b) finds that the share of ICT goods in the capital stock in the Netherlands is hardly lower than in the United States. In 1995 the share of ICT in the total capital stock of the market sector was 6¾ per cent for the Netherlands compared to 7.5 per cent for the United States. The contribution of ICT capital to labour productivity growth in the Netherlands during the early 1990s was somewhat lower than in the United States (17 per cent in the Netherlands against 23 per cent in the United States) but considerably higher than for the larger European countries in Schreyer's study (see Table A.10). For the second half of the 1990s (1995-1999) CPB shows a slight decline in the ICT contribution to labour productivity growth to about 15 per cent, but the contribution in absolute terms remains the same. The CPB study also makes a distinction between the contribution of ICT capital to labour productivity growth in industry and in market services, showing a much larger contribution for the latter sector than for the former. This is primarily because of the much slower growth of labour productivity in market services, but in absolute terms ICT does not generate much more productivity growth in services than in industry. Within market services there was a bigger contribution of ICT capital to productivity in ICT-producing services compared to other services during the first half of the 1990s. Strikingly in the most recent period the contribution of ICT capital to productivity growth in ICT-producing services is negative. This, however, is not necessarily a negative sign as the growth contribution of total factor productivity in the ICT producing services has increased.

The analysis on the basis of growth accounts assumes that the contribution of ICT capital to growth is weighted with returns based on the share of ICT capital in total factor income. This does not necessarily have to be the case if as ICT may create external effects. These external effects are not excluded from the studies dealt with above, but are allocated to a larger contribution of total factor productivity growth instead of capital itself. Micro-studies, which are based on data for individual firms obtained from surveys or longitudinal analysis of sttistical information, typically find stronger effects of computer capital on output growth than of other (non-ICT) capital goods. An extensive discussion of the results from micro studies is beyond the scope of this paper.[27] Some general remarks, which are focused on the question to what extent an inconsistency exists between the results from micro and macro studies on the impact of ICT on growth, should therefore suffice. Firstly, there are important differences between the output effectsof different types of ICT-capital. The strongest effects are for personal computers (PC's) while other ICT-capital generates weaker effects (Lehr and Lichtenberg, 1999; Licht and Moch, 1999). The output elasticities of micro studies which use a broader definition of IT capital than only PCs are usually smaller and closer to those of macro studies,

[27] See Van Ark (2000a) for a more detailed review.

in particular those with a disaggregation to industries.[28] Secondly, micro studies are often focused on specific industries or groups of firms in which ICT intensive industries or relative large firms are overrepresented. Moreover it appears that firm specific and industry specific variables have a great impact on the effect of computer capital on performance. Brynjolfsson and Hitt (1995), for example, show that the positive effects of computers are reduced by half when firm specific factors are taken into consideration. Thirdly, and related to what was mentioned above, recent micro studies point in particular at the importance of organizational innovations and intangible investment which are needed to fully exploit the potentially positive effects from ICT investment ICT (Bresnahan, Brynjolfsson and Hitt, 2000).

Most importantly, however, is that the most recent macro studies which are discussed above, show stronger effects from ICT on output and productivity growth since the second half of the 1990s than before. This suggests that the positive effects of ICT might begin to diffuse across the economy. The observed acceleration of productivity growth in ICT-using industries in some countries (including Finland, France, the Netherlands, the United Kingdom and the United States) are indicative of such changes.

6. Conclusions and Further Considerations

This paper documented the contribution of the ICT-producing sector, the ICT-using sector and the rest of the economy to economic growth. An important goal was to analyse to what extent differences in performance of these sectors accounted for slower productivity growth in various OECD countries – and in particular European countries – compared to the United States during the 1990s. This study confirmed the view that an important part of the productivity growth acceleration in the United States could be ascribed to ICT-producing industries. However, even though the differences in the output and employment shares of the ICT-using sector tend to be smaller than for the ICT-producing sector, part of the U.S. advantage during the late 1990s can also be ascribed to greater productivity gains from the ICT-using sector. Indeed European countries have not succeeded to extend their increase in employment sufficiently to ICT-using industries. Various reasons may explain these differences, but lack of structural reforms in product and labour markets may be one reason for Europe's lack of employment and productivity growth in the ICT-using sector.

This paper suggests that there are clear indications that the growth contribution of ICT increased during the second half of the 1990s. This may be related to the fact that the characteristics of ICT as a general purpose technology are becoming increasingly strong. These characteristics include the growing impact of ICT across the economy, the broad range of applications in production processes, the complementarity of ICT with other technological developments and innovations, and the evolutionary nature of the technology so that new applications and cost reductions are realised on a continuous basis (Bresnahan and Trajtenberg, 1995; Helpman, 1998; CPB 2000a). These characteristics also explain why the effects of ICT on productivity occur with a certain delay (David, 1990). This means that the present productivity advantage in the USA over the European countries could erode when European firms make a larger and more effective use of ICT (European Commission, 2000). The renewal of the old economy is then reality and the term ‘new economy’ can then be stalled until a new major technological breakthrough occurs.

[28] McGuckin and Stiroh (2000b) show that effects are indeed weaker in studies that focus exclusive on the aggregate economy because of the strong influence of aggregation effects.

Table A1: GDP and Employment Shares of ICT-producing industries, 1990 and 1999

	ICT-producing manufacturing as % of total manufacturing		ICT-producing services as % of total business services		ICT-producing industries as % of total economy	
	1990	1999	1990	1999	1990	1999
	As % of GDP at current basic prices					
Canada (a)	5.0	4.7	8.0	9.1	4.2	4.8
Denmark	6.0	7.3	7.4	7.6	4.3	4.7
Finland	7.2	21.4	7.6	10.2	4.6	9.6
France (c)	7.4	7.4	7.4	8.1	5.0	5.3
Germany (b)	7.8	6.2	7.9	8.4	5.4	5.3
Italy	5.7	4.9	6.8	8.1	4.4	5.0
Japan (c)	13.6	13.9	6.2	7.6	6.0	6.3
Netherlands	8.6	7.1	6.8	9.0	4.5	5.5
United Kingdom	8.1	10.0	9.0	10.4	5.7	7.0
United States	13.1	14.9	9.0	9.4	6.5	7.3
	as % of employment					
Canada	4.7	4.0	6.2	8.3	3.4	4.3
Denmark	6.2	6.0	8.3	7.3	4.1	3.7
Finland	5.0	11.6	8.7	10.5	3.8	5.8
France (c)	6.2	6.2	7.0	6.9	3.8	3.7
Germany (b)	7.9	6.2	7.1	5.7	4.6	3.5
Italy	3.8	3.9	7.8	7.3	3.6	3.6
Japan (c)	11.6	11.9	4.2	5.9	4.3	4.7
Netherlands	8.9	7.3	5.3	6.7	4.0	4.5
United Kingdom	8.1	8.5	6.8	8.1	4.6	5.2
United States	11.5	11.7	6.2	7.1	4.4	4.7

(a) For Canada, value added at current prices for 1999 is derived by extrapolating 1996 current price estimate to 1999 with index in constant prices and using average deflators for 1990-1996.

(b) For Germany for 1991 and 1998

(c) For France and Japan for 1998

Source: Groningen Growth and Development Centre ICT database (see appendix B).

Table A2: GDP and Employment Shares of ICT-using industries (excluding ICT-producing industries), 1990 and 1999

	ICT-using manufacturing as % of total manufacturing		ICT-using services as % of all services (c)		ICT-using industries as % of total economy	
	1990	1999	1990	1999	1990	1999
	as % of GDP at current basic prices					
Canada (a)	17.7	15.6	26.5	27.7	20.3	20.9
Denmark	19.9	21.7	21.4	21.5	18.5	19.2
Finland	14.5	14.3	21.3	19.9	16.3	16.3
France (c)	18.9	20.7	23.2	21.8	19.6	19.4
Germany (b)	22.3	21.4	24.0	23.5	21.0	20.8
Italy	15.9	17.6	27.2	26.2	21.2	21.6
Japan (c)	18.6	19.6	29.0	26.5	22.0	21.4
Netherlands	26.3	26.0	27.3	29.5	22.9	25.4
United Kingdom	21.8	23.0	26.0	25.6	21.6	22.4
United States	21.3	21.5	25.0	29.3	21.0	25.0
	as % of employment					
Canada	15.4	12.3	19.2	19.8	17.0	17.2
Denmark	16.1	16.6	17.6	16.8	15.5	15.8
Finland	15.3	14.5	15.3	12.3	12.6	12.0
France (c)	15.2	15.8	17.7	16.4	15.6	15.6
Germany (b)	19.2	19.0	16.6	16.2	15.8	16.6
Italy	12.8	12.9	18.1	17.9	14.3	15.6
Japan (c)	14.2	15.0	23.3	23.5	17.6	18.4
Netherlands	23.1	21.7	22.9	22.9	20.7	21.3
United Kingdom	17.3	19.1	16.7	17.8	16.8	18.5
United States	17.5	17.2	18.1	19.0	17.8	18.6

(a) For Canada, value added at current prices for 1999 is derived by extrapolating 1996 current price estimate to 1999 with index in constant prices and using average deflators for 1990-1996.

(b) For Germany for 1991 and 1998

(a) For France and Japan for 1998

Source: Groningen Growth and Development Centre ICT database (see appendix B).

Table A.3 - %-point contribution by sector to aggregate GDP growth 1990-1995 and 1995-1999

	ICT-producing sector			ICT-using sector			non-ICT sector	Total GDP Growth
	Total	ICT-prod. Manuf.	ICT-prod. Services	Total	ICT-using manuf.	ICT-using services		
Canada								
1990-1995	0.21	0.04	0.17	0.43	-0.04	0.48	1.07	1.71
1995-1999	0.35	0.07	0.28	0.88	0.14	0.74	1.95	3.18
acceleration	0.14	0.04	0.10	0.44	0.18	0.26	0.88	1.46
Denmark								
1990-1995	0.24	0.04	0.20	0.10	0.10	0.00	1.17	1.50
1995-1999	0.23	0.03	0.20	0.84	0.13	0.71	1.27	2.34
acceleration	-0.01	-0.01	-0.01	0.74	0.04	0.71	0.10	0.83
Finland								
1990-1995	0.29	0.24	0.05	-0.48	0.02	-0.50	-0.34	-0.53
1995-1999	1.48	0.97	0.51	1.02	0.22	0.80	2.57	5.06
acceleration	1.19	0.73	0.46	1.50	0.20	1.30	2.90	5.59
France								
1990-1995	0.17	0.08	0.09	0.12	0.09	0.03	0.63	0.92
1995-1998	0.45	0.20	0.25	0.30	0.14	0.16	1.11	1.86
acceleration	0.28	0.12	0.16	0.18	0.05	0.13	0.48	0.94
Germany								
1991-1995	0.06	-0.10	0.16	0.40	-0.07	0.47	0.94	1.40
1995-1998	0.40	0.05	0.35	0.56	0.03	0.53	0.86	1.82
acceleration	0.34	0.15	0.19	0.16	0.10	0.06	-0.08	0.42
Italy								
1990-1995	0.17	0.03	0.15	0.41	0.06	0.36	0.71	1.29
1995-1999	0.28	0.01	0.27	0.43	0.10	0.33	0.71	1.41
acceleration	0.11	-0.01	0.12	0.01	0.04	-0.03	0.00	0.12
Japan								
1990-1995	0.32	0.15	0.17	0.55	0.12	0.43	0.65	1.52
1995-1998	0.40	0.19	0.21	0.38	0.08	0.30	0.31	1.09
acceleration	0.09	0.05	0.04	-0.17	-0.04	-0.13	-0.34	-0.43
Netherlands								
1990-1995	0.12	0.02	0.10	0.50	0.11	0.39	1.43	2.05
1995-1999	0.63	0.03	0.59	1.29	0.14	1.15	1.74	3.66
acceleration	0.50	0.02	0.49	0.79	0.03	0.76	0.31	1.61
United Kingdom								
1990-1995	0.32	0.09	0.24	0.39	0.11	0.28	0.99	1.69
1995-1999	0.63	0.11	0.53	0.87	0.07	0.80	1.32	2.82
acceleration	0.31	0.02	0.29	0.49	-0.04	0.53	0.33	1.13
United States								
1990-1995	0.37	0.19	0.19	0.56	0.03	0.53	1.38	2.31
1995-1999	0.78	0.46	0.32	1.89	0.18	1.71	2.02	4.68
acceleration	0.41	0.27	0.14	1.32	0.15	1.18	0.64	2.37

Source: Groningen Growth and Development Centre ICT database (see appendix B).

Table A.4: Labour Productivity Growth by Sector 1990-1995 and 1995-1999

	Canada	Denmark	Finland	France*	Germany*	Italy	Japan*	Nether-lands	United Kingdom	United States
Total economy										
1990-1995	1.2	2.0	3.4	1.1	2.1	1.9	0.7	1.3	2.5	1.2
1995-1999	0.9	1.0	2.8	1.3	1.7	0.6	0.8	0.9	1.2	2.1
Acceleration	-0.3	-1.1	-0.6	0.2	-0.4	-1.3	0.1	-0.3	-1.2	0.8
ICT-producing sector										
1990-1995	0.9	7.5	7.8	4.1	6.8	5.1	4.2	4.0	6.8	4.8
1995-1999	4.0	4.4	13.7	8.5	11.1	4.7	4.1	4.4	4.9	7.2
Acceleration	3.1	-3.1	5.9	4.3	4.3	-0.4	-0.1	0.4	-1.9	2.4
ICT-producing manufacturing										
1990-1995	6.0	6.2	10.9	8.6	4.9	3.9	5.8	7.3	8.9	10.0
1995-1999	10.1	2.4	17.6	16.2	7.3	0.4	6.3	2.4	4.4	16.8
Acceleration	4.1	-3.9	6.7	7.5	2.5	-3.4	0.5	-4.9	-4.4	6.8
ICT-producing services										
1990-1995	-0.2	7.9	4.7	2.4	6.2	5.5	1.4	1.8	5.7	2.1
1995-1999	2.9	5.0	8.3	5.4	12.1	6.0	1.3	4.4	5.0	1.5
Acceleration	3.1	-2.9	3.6	3.0	6.0	0.5	-0.1	2.5	-0.7	-0.6
ICT-using sector, excl. producing										
1990-1995	1.7	1.7	0.5	0.9	2.2	2.1	1.5	1.3	1.3	1.3
1995-1999	1.5	1.8	4.9	0.7	1.5	-0.5	0.4	1.8	1.3	4.4
Acceleration	-0.1	0.1	4.4	-0.2	-0.7	-2.6	-1.1	0.5	0.0	3.0
ICT-using manufacturing, excl. producing										
1990-1995	0.9	4.5	4.0	4.7	4.3	3.2	3.0	4.7	3.9	1.6
1995-1999	5.6	2.8	6.0	4.1	2.5	2.3	2.0	4.0	1.7	4.7
Acceleration	4.7	-1.7	2.0	-0.6	-1.8	-0.9	-1.0	-0.7	-2.2	3.1
ICT-using services, excl. producing										
1990-1995	2.0	1.1	-0.4	0.0	1.0	1.7	1.2	0.5	0.7	1.4
1995-1999	1.0	1.6	4.5	-0.1	1.1	-1.2	0.0	1.5	1.3	4.5
Acceleration	-1.0	0.6	5.0	-0.2	0.1	-2.9	-1.1	1.0	0.6	3.1
Non-ICT sector										
1990-1995	1.1	1.5	3.4	0.6	1.7	1.2	0.3	0.9	2.0	0.8
1995-1999	0.5	0.2	0.7	0.8	0.8	-0.1	1.0	0.2	0.9	1.1
Acceleration	-0.6	-1.3	-2.7	0.2	-0.9	-1.4	0.7	-0.8	-1.2	0.3

Source: ICT database (see appendix B).

Table A.5 - %-point contribution by sector to labour productivity growth 1990-1995 and 1995-1999

	ICT-producing sector			ICT-using sector			non-ICT sector	Total
	Total	ICT-prod. manuf.	ICT-prod. services	Total	ICT-using manuf.	ICT-using services		
Canada (1990-1995)								
intra	0.04	0.05	-0.01	0.36	0.02	0.34	0.91	1.31
static	0.15	-0.01	0.16	-0.03	-0.07	0.04	-0.22	-0.10
dynamic	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02
total	0.19	0.04	0.15	0.33	-0.05	0.37	0.69	1.20
Canada (1995-1999)								
intra	0.20	0.09	0.11	0.36	0.18	0.18	0.37	0.93
static	0.06	-0.03	0.09	0.05	-0.11	0.16	-0.07	0.05
dynamic	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	-0.01
total	0.26	0.06	0.20	0.41	0.07	0.34	0.29	0.96
Denmark (1990-1995)								
intra	0.32	0.07	0.26	0.30	0.15	0.15	1.43	2.05
static	-0.05	-0.02	-0.04	-0.09	-0.02	-0.07	0.12	-0.02
dynamic	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01
total	0.26	0.05	0.22	0.20	0.12	0.08	1.55	2.01
Denmark (1995-1999)								
intra	0.20	0.02	0.17	0.36	0.11	0.26	0.35	0.91
static	-0.03	-0.01	-0.02	0.22	-0.02	0.23	-0.16	0.04
dynamic	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
total	0.17	0.02	0.15	0.58	0.09	0.50	0.20	0.95
Finland (1990-1995)								
intra	0.30	0.15	0.15	0.10	0.12	-0.02	2.72	3.12
static	0.28	0.24	0.04	-0.03	0.02	-0.05	-0.06	0.19
dynamic	0.02	0.02	0.00	0.01	0.00	0.01	-0.01	0.02
total	0.60	0.41	0.19	0.07	0.14	-0.07	2.65	3.33
Finland (1995-1999)								
intra	0.95	0.66	0.29	0.79	0.22	0.57	0.82	2.56
static	0.40	0.26	0.13	-0.17	-0.09	-0.08	-0.12	0.11
dynamic	0.07	0.05	0.01	-0.01	-0.01	-0.01	-0.01	0.05
total	1.41	0.98	0.43	0.61	0.12	0.49	0.70	2.72
France (1990-1995)								
intra	0.21	0.12	0.08	0.18	0.18	0.00	0.72	1.11
static	-0.02	-0.03	0.02	-0.02	-0.07	0.05	0.05	0.01
dynamic	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.03
total	0.18	0.09	0.10	0.15	0.10	0.05	0.75	1.09
France (1995-1998)								
intra	0.42	0.22	0.20	0.14	0.16	-0.02	0.70	1.26
static	0.01	-0.02	0.04	0.05	-0.04	0.09	-0.04	0.02
dynamic	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
total	0.43	0.20	0.23	0.18	0.12	0.06	0.65	1.27

Table A.5 - %-point contribution by sector to labour productivity growth 1990-1995 and 1995-1999 (continued)

	ICT-producing sector			ICT-using sector			non-ICT sector	Total
	Total	ICT-prod. manuf.	ICT-prod. services	Total	ICT-using manuf.	ICT-using services		
Germany (1991-1995)								
intra	0.31	0.09	0.22	0.40	0.25	0.15	1.36	2.08
static	-0.20	-0.16	-0.03	0.14	-0.26	0.40	0.12	0.06
dynamic	-0.01	-0.01	0.00	-0.01	-0.01	0.01	-0.02	-0.04
total	0.10	-0.08	0.18	0.53	-0.02	0.56	1.46	2.10
Germany (1995-1998)								
intra	0.53	0.10	0.43	0.29	0.13	0.17	0.76	1.58
static	-0.12	-0.05	-0.07	0.22	-0.10	0.33	-0.01	0.10
dynamic	-0.01	0.00	-0.01	0.00	0.00	0.00	-0.01	-0.02
total	0.40	0.05	0.35	0.52	0.02	0.50	0.74	1.66
Italy (1990-1995)								
intra	0.21	0.04	0.16	0.41	0.11	0.30	1.13	1.76
static	-0.02	-0.01	-0.01	0.11	-0.03	0.14	0.00	0.09
dynamic	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
total	0.19	0.03	0.16	0.52	0.08	0.44	1.12	1.83
Italy (1995-1999)								
intra	0.22	0.00	0.22	-0.13	0.09	-0.21	0.32	0.42
static	0.03	0.00	0.03	0.38	-0.01	0.39	-0.20	0.20
dynamic	0.00	0.00	0.00	-0.02	0.00	-0.02	-0.01	-0.03
total	0.25	0.00	0.25	0.23	0.07	0.16	0.11	0.59
Japan (1990-1995)								
intra	0.22	0.18	0.04	0.33	0.13	0.20	0.14	0.69
static	0.06	-0.05	0.11	0.05	-0.04	0.09	-0.02	0.09
dynamic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
total	0.28	0.13	0.15	0.38	0.09	0.29	0.12	0.77
Japan (1995-1998)								
intra	0.24	0.20	0.04	0.10	0.10	0.01	0.31	0.65
static	0.15	-0.01	0.16	0.21	-0.02	0.23	-0.20	0.16
dynamic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total	0.39	0.20	0.20	0.31	0.07	0.24	0.10	0.81
Netherlands (1990-1995)								
intra	0.17	0.11	0.06	0.32	0.22	0.10	0.87	1.35
static	-0.07	-0.09	0.02	0.01	-0.13	0.14	0.00	-0.06
dynamic	-0.01	-0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.03
total	0.09	0.01	0.08	0.32	0.08	0.24	0.86	1.27
Netherlands (1995-1999)								
intra	0.21	0.03	0.18	0.48	0.19	0.29	0.20	0.89
static	0.30	-0.03	0.33	0.14	-0.16	0.30	-0.39	0.04
dynamic	0.01	0.00	0.01	-0.01	-0.01	0.00	-0.01	0.00
total	0.52	0.00	0.52	0.61	0.02	0.59	-0.20	0.93

Table A.5 - %-point contribution by sector to labour productivity growth 1990-1995 and 1995-1999 (continued)

	ICT-producing sector			ICT-using sector			non-ICT sector	Total
	Total	ICT-prod. manuf.	ICT-prod. services	Total	ICT-using manuf.	ICT-using services		
United Kingdom (1990-1995)								
Intra	0.37	0.14	0.23	0.31	0.17	0.14	2.14	2.83
Static	0.01	-0.03	0.04	0.26	-0.02	0.28	-0.56	-0.28
Dynamic	-0.01	-0.01	0.00	-0.01	0.00	0.00	-0.05	-0.07
Total	0.38	0.10	0.28	0.56	0.15	0.41	1.53	2.48
United Kingdom (1995-1999)								
intra	0.31	0.09	0.22	0.31	0.08	0.22	0.42	1.04
static	0.24	-0.01	0.25	0.20	-0.09	0.28	-0.24	0.20
dynamic	0.01	0.00	0.01	0.00	0.00	0.00	-0.03	-0.02
total	0.56	0.08	0.48	0.50	0.00	0.51	0.15	1.21
United States (1990-1995)								
Intra	0.33	0.24	0.09	0.29	0.06	0.23	0.63	1.25
Static	-0.02	-0.06	0.05	0.00	-0.07	0.07	-0.07	-0.09
Dynamic	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01
Total	0.31	0.17	0.13	0.29	-0.01	0.30	0.55	1.15
United States (1995-1999)								
intra	0.51	0.43	0.08	1.10	0.18	0.92	0.83	2.45
static	0.14	-0.01	0.15	0.25	-0.08	0.33	-0.31	0.08
dynamic	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.01
total	0.65	0.42	0.23	1.37	0.10	1.27	0.52	2.54

Methodological note: in this table the "shift-share" method is used to measure the contribution of each sector to overall labour productivity growth. This method implies that productivity for the total economy (P) can be perceived as the sum of the productivity contributions of individual industries (i) weighted with the labour share ($L_i/L=S_i$):

$$P = \frac{Y}{L} = \sum_{i=1}^{n}\left(\frac{Y_i}{L_i}\right)\left(\frac{L_i}{L}\right) = \sum_{i=1}^{n}\left(P_i S_i\right)$$

In a time perspective this equation can be rewritten as:

$$\Delta P_{(t)} = \sum_{i=1}^{n}\left(\Delta P_{i(t)} * S_{i(t-1)}\right) + \sum_{i=1}^{n}\left(P_{i(t-1)} * \Delta S_{i(t)}\right) + \sum_{k=1}^{n}\left(\Delta P_{i(t)} * \Delta S_{(t)}\right)$$

The first term on the right hand side of the equation is the "within-effect", which measures the contribution of growth *within* individual industries to the growth of the aggregate labour productivity. The labour shares for the previous year are used as weights. The second and third terms together represent the contribution of a *shift* in shares of ICT producing or ICT using sectors on labour productivity growth. The second term, which may also be called the static effect, weights the changes in labour shares with the *level* of productivity in the previous year. A net shift in labour shares to industries with a high labour productivity level will have a positive static effect. The third term, which is called the dynamic effect, weights the changes in labour shares with the *growth* of labour productivity. A net shift in labour shares to industries with an above average labour productivity growth will lead to a positive contribution. An increased share of industries with a below average labour productivity growth will lead to a negative contribution to the aggregate. Similarly a decreasing share of industries with productivity growth below the average causes also a positive dynamic shift effect, whereas a decline in labour shares in industries with an above average productivity growth causes a negative dynamic effect.

Source: See Appendix B.

Table A.6 - %-point contribution by sector to employment growth 1990-1995 and 1995-1999

	ICT-producing sector			ICT-using sector			non-ICT sector	Total
	Total	ICT-prod. manuf.	ICT-prod. services	Total	ICT-using manuf.	ICT-using services		
Canada								
1990-1995	0.15	-0.01	0.15	0.06	-0.05	0.11	0.29	0.50
1995-1999	0.16	-0.01	0.16	0.44	-0.02	0.47	1.59	2.18
acceleration	0.01	0.00	0.01	0.38	0.02	0.36	1.29	1.68
Denmark								
1990-1995	-0.07	-0.02	-0.05	-0.17	-0.04	-0.13	-0.28	-0.52
1995-1999	0.02	0.01	0.02	0.39	0.03	0.37	0.96	1.37
acceleration	0.09	0.03	0.06	0.56	0.07	0.49	1.24	1.89
Finland								
1990-1995	0.03	0.10	-0.07	-0.49	-0.10	-0.39	-3.32	-3.78
1995-1999	0.36	0.17	0.18	0.15	-0.01	0.16	1.74	2.24
acceleration	0.33	0.08	0.25	0.64	0.09	0.55	5.06	6.03
France								
1990-1995	-0.02	-0.03	0.01	-0.04	-0.06	0.02	-0.12	-0.18
1995-1998	0.03	-0.01	0.04	0.13	-0.01	0.15	0.42	0.58
acceleration	0.05	0.02	0.03	0.17	0.04	0.13	0.54	0.76
Germany								
1991-1995	-0.21	-0.18	-0.03	-0.05	-0.25	0.19	-0.44	-0.70
1995-1998	-0.11	-0.06	-0.05	0.21	-0.10	0.31	0.04	0.14
acceleration	0.10	0.12	-0.02	0.27	0.15	0.12	0.48	0.85
Italy								
1990-1995	-0.03	-0.01	-0.02	-0.02	-0.05	0.03	-0.50	-0.55
1995-1999	0.05	0.01	0.05	0.38	0.01	0.36	0.39	0.82
acceleration	0.09	0.02	0.07	0.39	0.06	0.33	0.89	1.37
Japan								
1990-1995	0.05	-0.03	0.08	0.18	-0.01	0.19	0.51	0.74
1995-1998	0.11	0.00	0.11	0.25	-0.01	0.25	-0.07	0.28
acceleration	0.05	0.03	0.03	0.07	0.00	0.07	-0.58	-0.46
Netherlands								
1990-1995	-0.05	-0.09	0.04	0.17	-0.09	0.26	0.63	0.76
1995-1999	0.31	0.00	0.31	0.69	-0.03	0.72	1.69	2.70
acceleration	0.36	0.09	0.27	0.52	0.06	0.46	1.06	1.94
United Kingdom								
1990-1995	-0.05	-0.05	0.01	0.06	-0.05	0.11	-0.81	-0.79
1995-1999	0.25	0.02	0.24	0.46	-0.01	0.46	0.88	1.59
acceleration	0.30	0.07	0.23	0.39	0.04	0.35	1.68	2.38
United States								
1990-1995	0.03	-0.03	0.06	0.21	-0.02	0.23	0.90	1.14
1995-1999	0.19	0.03	0.16	0.59	0.00	0.59	1.29	2.06
Acceleration	0.16	0.06	0.10	0.37	0.02	0.36	0.39	0.92

Source: ICT database (see appendix B).

Table A.7: Labour Productivity Growth and Nominal Output Share of Measurable and Non-Measurable Sectors of the Economy, 1980-1998

	Canada		Denmark		Finland		France		West Germany		Italy		Japan		Netherlands		United Kingdom		United States	
	MS	UMS	MS	UMS	MS	UMS	MS	UMS	MS	UMS	MS	UMS	MS	UMS	MS	UMS	MS	UMS	MS	UMS
Share of sector in current GDP																				
1980	42	58	33	67	49	51	39	61	44	56	59	81	40	60	37	63	45	55	37	63
1985	41	59	34	66	45	55	37	63	41	59	40	60	40	60	39	61	43	57	34	66
1998 (a)	38	62	31	69	41	59	30	70	33	67	34	66	32	68	32	68	32	68	28	72
GDP per hour worked (1980=100) (b)																				
1980 (c)	100	100	*100*	*100*	100	100	100	100	100	100	*100*	*100*	100	100	100	100	100	100	100	100
1985	115	104	*114*	*105*	120	109	125	115	116	106	*116*	*99*	122	110	125	114	128	111	121	104
1990	123	103	*129*	*108*	161	120	155	124	134	121	*141*	*103*	152	133	136	119	153	116	138	107
1995	138	107	*157*	*115*	217	130	190	127	164	132	*173*	*106*	171	143	163	124	194	131	159	110
1998 (d)	143	109	*166*	*116*	258	134	209	129	178	137	*181*	*107*	187	144	176	126	203	139	172	115

MS = measurable sector (agriculture, mining, manufacturing, utilities, transport and communication)
UMS = unmeasurable sector (construction, wholesale and retail trade, finance, insurance and business services, other services and government)

(a) Canada refers to 1996

(b) Denmark and Italy are in terms of persons employed

(c) Italy=100 for 1982

(d) West Germany goes up to 1997

Source: Groningen Growth and Development Centre Sectoral database, NIESR Sectoral Database, and STAN new database.

Table A.8 – Summary Table of Major International Studies on Contribution of ICT Capital and TFP in ICT Production to Growth in GDP and Labour Productivity, 1990s

Author	Country coverage	Time period	Contribution of I(C)T capital to		Contribution of TFP in ICT production to	
			Annual GDP growth	Annual labour productivity growth	Annual GDP growth	Annual labour Productivity Growth
Schreyer (2000)	Canada	1990-96	0.28 out of 1.7			
	France	1990-96	0.17 out of 0.9			
	Germany1	1990-96	0.19 out of 1.8			
	Italy	1990-96	0.21 out of 1.2			
	Japan	1990-96	0.19 out of 1.8			
	UK	1990-96	0.28 out of 2.1			
	USA	1990-96	0.42 out of 3.0			
European	EU	1991-95		0.2-0.3 out of 2.0		0.1 out of 2.0
Commission (2000)	EU	1995-99		0.3-0.5 out of 1.5		0.2 out of 1.5
Daveri (2001)	Ireland	1991-99	0.64 out of 6.9			
	Denmark	1991-99	0.52 out of 2.9			
	Netherlands	1991-99	0.68 out of 2.8			
	UK	1991-99	0.76 out of 2.7			
	Portugal	1991-99	0.43 out of 2.5			
	Austria	1991-99	0.45 out of 2.3			
	Spain	1991-99	0.36 out of 2.3			
	Greece	1991-99	0.34 out of 2.3			
	Finland	1991-99	0.45 out of 2.1			
	Belgium	1991-99	0.48 out of 1.9			
	Sweden	1991-99	0.50 out of 1.9			
	Germany	1991-99	0.49 out of 1.7			
	France	1991-99	0.41 out of 1.6			
	Italy	1991-99	0.31 out of 1.4			
Goldman Sachs (2000)	OECD	1990-95		0.38 out of 1.8		0.39 out of 1.8
	OECD	1996-99		0.73 out of 2.1		0.63 out of 2.1
	USA	1990-95		0.35 out of 1.7		0.41 out of 1.7
	USA	1996-99		0.79 out of 2.7		0.83 out of 2.7
	Japan	1990-95		0.55 out of 1.2		0.48 out of 1.2
	Japan	1996-99		1.14 out of 1.9		0.55 out of 1.9
	UK	1990-95		0.37 out of 3.4		0.22 out of 3.4
	UK	1996-99		0.84 out of 1.8		0.40 out of 1.8
	Euroland	1990-95		0.28 out of 2.1		0.33 out of 2.1
	Euroland	1996-99		0.38 out of 1.4		0.69 out of 1.4
European Central Bank	Euroland	1991-95	0.22 out of 1.5	0.26 out of 2.4		
(2001)	Euroland	1996-99	0.42 out of 1.9	0.39 out of 1.3		

All estimates refer to total economy GDP, except for Daveri (2001) and Goldman Sachs (2001) which refers to business sector GDP.

All estimates on the contribution of ICT capital include software except for Schreyer (2000) and European Commission (2000).

Table A.9 - Summary Table of Major National Studies on Contribution of ICT Capital and TFP in ICT Production to Growth in GDP and Labour Productivity, 1990s

Author	Country coverage	Time period	Contribution of I(C)T Capital to		Contribution of TFP in ICT production to	
			annual GDP growth	annual labour productivity growth	annual GDP growth	annual labour productivity growth
Oliner and Sichel (2000)	USA	1991-95	0.57 out of 2.8	0.51 out of 1.5		
		1996-99	1.10 out of 4.8	0.96 out of 2.6		
Jorgenson (2001)	USA	1990-95		0.43 out of 1.2		0.25 out of 1.2
				0.89 out of 2.1		0.50 out of 2.1
CPB (2000b)	Neth.	1991-95		0.2 out of 1.5		
		1996-99		0.2 out of 1.3		
Mairesse, Cette and Kocoglu (2000)	France	1989-95	0.16 out of 1.3			
		1995-99	0.27 out of 2.2			
Oulton (2001)	UK	1989-94		0.39 out of 2.6		
		1994-98		0.62 out of 1.6		
Jalava and Pohjola (2001)	Finland	1990-95	0.3 out of -0.3	0.5 out of 4.4	0.7 out of -0.3	0.7 out of 4.4
		1995-99	0.7 out of 5.6	0.6 out of 3.2	1.2 out of 5.6	1.2 out of 3.2

All estimates refer to total economy GDP, except for Oliner and Sichel (2000) which refers to business sector GDP.

All estimates on the contribution of ICT capital include software except for CPB (2000b)

Table A.10 - Contribution of ICT Capital to Labour Productivity Growth in the Netherlands, 1980-1999

	Market Sector	Industry	Market Services	ICT services	Other market Services
	labour productivity growth rates (annual average, %)				
1980-90	2.7	3.7	1.6		
1991-95	1.2	3.4	0.4	1.8	0.3
1996-99	1.3	2.5	1.5	4.0	0.8
	%-point contribution of ICT capital				
1980-90	0.1	0.1	0.1		
1991-95	0.2	0.1	0.2	1.0	0.25
1996-99	0.2	0.2	0.3	-1.0	0.25
	%-contribution to labour productivity growth				
1980-90	3	2	6		
1991-95	17	3	50	57	100
1996-99	15	8	20	-25	33

Source: CPB (2000b), Table 3.3 and p. 28

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Appendix A – Classification of ICT producing and ICT using industries

Appendix Table 1 – Classification of ICT producing, ICT using and other sectors of the Economy

ISIC Rev. 3 **ICT-producing industries**

30	Office, Accounting and Computing Machinery
313	Insulated Wire and Cable
32	Radio, Television and Communication Equipment
331	Medical Appl. & Instruments & Appl. for Measurement, etc.
64	Post and Telecommunications
72	Computer and Related Services

ISIC Rev. 3 **ICT-using industries**

		Netherlands		**United States** according to	
		IT investment as % of production value	IT capital as % of total IT capital	McGuckin and Stiroh (1999)	NSF (2000), Table 9.3
22	Publishing	0.9	3.0	x	
24	Chemicals and Chemical Products	0.1	3.1		x
30	Office, Accounting and Computing Machinery	0.6	2.2	x	x
31, 313	excl. Electrical Machinery, Apparatus, nec	0.3	a)	x	x
32	Radio, Television and Communication Equipment	1.0	a)	x	x
33, 331	excl. Medical, Precision and Optical Instruments	0.4	b)	x	x
51	Wholesale Trade	0.7	11.0	x	x
64	Post and Telecommunications	1.2	8.0 c)		x
65	Financial Intermediation	4.4	17.4	x	x
66	Insurance and Pension Funding	1.2	4.2	x	x
67	Activities Related to Financial Intermediation	1.6	1.8	x	
71	Renting of Machinery and Equipment	1.0	0.7		
72	Computer and Related Services	2.6	9.0		x
73	Research and Development	0.8	12.2		
741-743	Other Business Services	b)	b)	x	x
	All ICT-using industries	1.2	72.6		
	Total Economy	0.6	100.0		

a) included in Office, Accounting and Computing Machinery
b) not shown separately
c) included in Transportation
Source: Netherlands based on CPB (2000b)

Appendix B – ICT Database

The database for this paper is primarily based on the renewed "STAN industrial database" of the OECD, which is still under development and as yet not published (see http://www.oecd.org/dsti/sti/stat-ana/stats/). The ICT database is available online and will be extended and updated over time (see http://www.eco.rug.nl/GGDC/ictdatabase.html). In most cases the data in STAN are based of the new system of national accounts introduced during the 1990s, i.e. the System of National Accounts 1993 or the European System of Accounts 1995. For the Netherlands, for which no STAN data were available as yet, use is made of the *Nationale Rekeningen 1997* (1990-1995) to which the trends from the *Nationale Rekeningen 1998* (1995-1998) were linked (hence the levels of GDP in the Netherlands were still based on the old system of national accounts). The figures on value added in current prices are expressed in basis prices, and the series on real value added are linked to the price level of 1995. Employment includes self employed persons, except for the UK where it related to employees only. An adjustment for working hours per person appeared not possible at this stage.

Industry

In some cases, in particular for the classifying of ICT producing industries, the STAN data were too aggregated. For example, to splitt off insulated wire and cable and medical appliances and instruments shares on production, value added and employment were obtained from OECD *Industrial Structure Statistics* (1999 edition). This source was also used to distinguish between paper, etc. (not part of the ICT using sector) and printing and publishing (which is part of the ICT using sector). Constant price estimates for insulated wire and cable and medical appliances were obtained by using current price shares, assuming the same deflator as for the aggregate. For Canada medical appliances and instruments are not included separately.

Wholesale and retail trade

The estimates for wholesale trade (part of the ICT using sector) and retail trade (not part of the ICT using sector) are split off with the help of OECD *Statistics on Services* (2000 edition). These two sources, together with Eurostat, *Services in Europe* (1999), was also used to distinguish between business services that were or were not part of the ICT-using sector. In the case of Japan we estimated the share of employment in wholesale trade in total trade on the basis of assuming that the productivity level in wholesale trade was 25% higher than in total trade.[29]

Business services

In a number of cases business services could not be correctly split into ICT-using and non-using industries because of lack of data. For Canada and Japan even a figure for total business services (including renting of machinery and equipment, computer services, research and development and other business services) was lacking, which we obtained on the basis of merging the Labour Force Survey and National Accounts employment estimates. For Japan and the United States detailed information total business services were further subdivided by using a constant share of 0.1 for production and value added and 0.05 for

[29] A similar assumption was applied to distinguish post and telecommunication from total transport and communication, assuming that the productivity level in post and telecommunication was 50% higher than in total trade. In all other cases post and telecommunication was based on actual estimates.

employment for renting of machinery and equipment, 0.2 for production and value added and 0.15 for employment for computer services, 0.2 for production, value added and employment for research and development, and 0.6 for production, value added and employment for "other business services". For Korea I used a constant share of 0.25 for production, value added and employment for computer services, 0.25 for production, value added and employment for research and development, and 0.5 for production, value added and employment for "other business services". In the case of Denmark, Germany, Korea and Japan a 50% split of ICT-using and ICT non-using "other business services" was used. For Canada and the United States a 75% split was used, based on the actual ratio of two other countries which were relatively advanced in ICT applications, namely Finland and the Netherlands.

Appendix Table B.1: CANADA

Year	ICT-producing manufacturing	ICT-producing services	ICT-using manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. Canadian $ (1995 prices)								
1990	4648	21520	23262	101598	92582	289998	109131	642738
1991	4501	22560	21014	102720	86082	288335	107118	632331
1992	4775	23274	21028	103763	87183	293445	102802	636270
1993	4635	24083	21745	106032	92385	298533	104317	651730
1994	5140	25824	24238	112571	98501	307281	107641	681196
1995	5892	27417	22060	116215	106247	313177	108678	699686
1996	5539	28334	23290	119844	107658	314414	111195	710273
1997	6325	30091	24472	126822	114944	321254	115959	739867
1998	7006	33217	25301	132596	119056	328362	115787	761324
1999	8337	37085	26163	136713	126250	339548	118796	792893
GDP in in mln. Canadian $ (current prices)								
1990	5227	19616	18356	101711	80176	263002	103685	591772
1991	4926	20822	15883	104883	75864	273936	97274	593588
1992	5060	21903	15542	104905	75581	283433	97853	604278
1993	5208	21969	16349	109615	81775	290733	100019	625669
1994	5441	22838	19579	115434	93796	302078	105208	664374
1995	5892	24126	22060	121872	106247	310811	108678	699686
1996	5705	25222	22056	127548	109956	314900	117765	723152
1997	6427	26687	23996	136371	120717	327148	125121	766466
1998	7022	29349	25687	144055	128571	339996	127285	801966
1999	8242	32645	27503	150064	140196	357478	133051	849178
Employment (1000)								
1990	95	359	307	1984	1590	7311	1826	13471
1991	89	370	291	1972	1479	7294	1718	13212
1992	90	371	281	1959	1416	7340	1676	13134
1993	85	405	280	1966	1443	7502	1676	13358
1994	86	440	276	1983	1505	7618	1711	13619
1995	90	461	278	2057	1554	7678	1695	13812
1996	89	479	277	2126	1582	7737	1713	14004
1997	88	490	273	2173	1639	7904	1738	14305
1998	87	532	268	2237	1740	8029	1751	14645
1999	86	556	264	2322	1805	8252	1773	15059

Appendix Table B.2: DENMARK

Year	ICT-producing manufacturing	ICT-producing services	ICT-using Manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. kronor (1995 prices)								
1990	7768	22283	27964	134578	106204	445744	93271	837811
1991	8126	22034	27949	140393	104131	445534	94012	842180
1992	8377	25054	28217	130310	101496	450989	96801	841243
1993	7414	26088	26622	133809	97914	453946	93764	839558
1994	9015	28454	29878	136170	106927	468858	97566	876868
1995	9378	30126	32418	134830	112299	480844	102886	902780
1996	10593	30670	32469	144073	104340	491951	109614	923710
1997	10810	33100	34734	149674	105657	502277	112036	948288
1998	11214	35186	36226	150606	107504	516773	112680	970189
1999	10536	37669	37550	161410	101756	529928	111308	990156
GDP in mln. kronor (current prices)								
1990	7750	24583	25549	111848	95155	387380	91649	743915
1991	7934	25215	26516	117559	97109	405315	92805	772453
1992	8348	26905	28246	117014	101159	422850	94100	798623
1993	8137	27047	27018	122563	99983	440667	90112	815527
1994	9321	29300	30217	134274	106025	462988	94486	866610
1995	9378	30126	32418	135055	112299	480619	102886	902780
1996	10512	30054	33124	142279	110902	499462	114717	941049
1997	11072	33014	34363	147934	113645	521329	119884	981241
1998	11884	36300	35649	155476	122125	545859	113327	1020620
1999	12528	37764	37167	168702	121320	576964	117297	1071741
Employment (1000)								
1990	296	772	770	3270	3729	14077	3142	26057
1991	290	780	742	3247	3671	14125	3052	25908
1992	279	772	711	3187	3606	14143	2984	25681
1993	272	739	693	3090	3494	14143	2875	25307
1994	260	744	697	3078	3441	14177	2808	25207
1995	264	713	717	3106	3512	14243	2833	25388
1996	271	668	737	3217	3492	14540	2802	25727
1997	271	695	743	3299	3461	14774	2796	26040
1998	278	717	768	3404	3528	15073	2819	26587
1999	270	733	744	3485	3463	15299	2815	26808

Appendix Table B.3: FINLAND

Year	ICT-producing manufacturing	ICT-producing services	ICT-using Manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. Finnish marks (1995 prices)								
1990	5918	14038	18110	75633	88600	243382	109131	554812
1991	5192	14004	16956	62589	77292	240405	107118	523556
1992	6397	14217	17250	53034	76852	234023	102802	504576
1993	8378	14384	17826	56932	79664	230274	104317	511775
1994	11052	14895	19747	57094	87745	234370	107641	532544
1995	14320	15606	18724	59603	94279	243424	108678	554633
1996	16712	17313	21152	64483	93213	251200	111195	575269
1997	20316	19869	22646	68507	101056	259775	115959	608128
1998	29140	24339	22804	71142	105695	268311	115787	637218
1999	38896	27020	23335	76051	106323	274601	118796	665022
GDP in in mln. Finnish marks (current prices)								
1990	7585	13954	15304	61012	82382	211207	103685	495129
1991	5068	14351	12960	55490	69787	222146	97274	477076
1992	6519	14628	14248	48085	69062	222738	97853	473133
1993	8244	14452	15564	53611	75789	221135	100019	488813
1994	10242	14724	17554	56907	83136	228821	105208	516592
1995	14320	15606	18724	59603	94279	243424	108678	554633
1996	15616	17460	19389	65409	88746	256365	117765	580750
1997	20356	19847	20578	70878	95801	271050	132513	631024
1998	27574	24554	21914	76418	103552	288643	145457	688112
1999	33248	28113	22187	81969	99905	302026	167145	734593
Employment (1000)								
1990	251	701	773	2351	4015	12074	1826	21991
1991	229	679	733	2188	3640	11689	1718	20876
1992	224	637	682	1978	3254	11155	1676	19606
1993	240	619	650	1859	3027	10596	1676	18667
1994	285	601	639	1877	3033	10525	1711	18672
1995	363	618	656	1894	3122	10698	1695	19046
1996	388	638	645	1928	3134	10966	1713	19412
1997	409	665	645	1997	3240	11319	1738	20013
1998	459	732	649	2030	3313	11543	1751	20477
1999	515	777	647	2025	3298	11837	1773	20872

Appendix Table B.4: FRANCE

Year	ICT-producing manufacturing	ICT-producing services	ICT-using Manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. French francs (1995 prices)								
1990	74143	224574	242399	1102313	944322	3491897	782841	6862489
1991	78469	236378	248978	1100284	940066	3529716	789857	6923747
1992	80147	245493	250852	1113490	945828	3580594	822225	7038628
1993	82429	269924	249979	1102006	889956	3611253	763827	6969375
1994	85940	244596	257732	1112801	937383	3683933	763662	7086047
1995	98663	256165	274059	1111561	969970	3694542	778797	7183757
1996	111348	267231	277960	1132017	950985	3735839	780655	7256035
1997	136545	285141	292650	1127498	976480	3796049	762338	7376701
1998	150205	312510	304802	1144832	1003890	3904893	771382	7592516
1999								
GDP in in mln. French francs (current prices)								
1990	92902	216001	238210	975200	928955	3012588	721948	6185804
1991	93374	231296	243986	1000938	940762	3166055	750441	6426853
1992	96285	242136	246694	1032787	952674	3318339	789068	6677983
1993	92607	266982	245732	1061340	902988	3450441	748076	6768166
1994	91445	245544	253592	1096338	935597	3593102	766130	6981748
1995	98663	256165	274059	1111561	969970	3694542	778797	7183757
1996	100400	266149	277685	1158785	962109	3793726	771832	7330686
1997	103729	284073	294248	1185957	1015856	3912604	763463	7559930
1998	107509	306005	300685	1224499	1041879	4095549	777573	7853699
1999								
Employment (1000)								
1990	278	586	678	2886	3505	11730	3228	22891
1991	277	596	674	2913	3433	11867	3161	22921
1992	263	601	657	2903	3311	12000	3064	22801
1993	244	590	635	2876	3150	12107	2919	22521
1994	242	593	615	2880	3048	12285	2847	22509
1995	245	594	609	2907	3041	12481	2812	22689
1996	239	578	600	2922	3020	12643	2750	22752
1997	238	588	596	2934	2968	12800	2699	22822
1998	238	619	601	3006	2970	12973	2681	23087
1999								

Appendix Table B.5: GERMANY

Year	ICT-producing manufacturing	ICT-producing services	ICT-using manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. D-marks (1995 prices)								
1990								
1991	55514	97660	173155	457685	573541	1428625	330640	3116820
1992	52657	102710	174642	479485	557101	1476255	345610	3188460
1993	47686	108490	164994	499465	512840	1478595	345190	3157260
1994	48917	111570	169698	500920	527885	1512270	355470	3226730
1995	45033	116660	165512	513835	537115	1561945	355330	3295430
1996	43994	125290	167269	527821	514907	1600469	352300	3332050
1997	49206	137010	169377	547090	531987	1617080	342950	3394700
1998	50128	155160	168221	567038	543231	1654422	340310	3478510
1999								
GDP in in mln.D-marks (current prices)								
1990								
1991	58713	91160	168584	411675	529973	1211935	287530	2759570
1992	56247	99970	170392	447345	538081	1332225	319900	2964160
1993	49251	107390	161871	483150	506147	1398440	329430	3035680
1994	49136	111640	164746	506230	521207	1467230	349750	3169940
1995	45033	116660	165512	513835	537115	1561945	355330	3295430
1996	44532	117110	169664	521631	534484	1623079	349850	3360350
1997	49265	126150	169569	542478	549116	1664422	340010	3441010
1998	49733	139340	170258	567401	577209	1710929	332670	3547540
1999								
Employment (1000)								
1990								
1991	832	928	2029	4066	7720	17788	5091	38454
1992	735	930	1879	4190	7180	18061	4903	37878
1993	658	929	1751	4257	6701	18200	4869	37365
1994	597	909	1672	4312	6373	18517	4924	37304
1995	558	873	1638	4382	6243	18784	4904	37382
1996	520	844	1592	4457	6100	19090	4667	37270
1997	513	815	1558	4527	6018	19276	4488	37194
1998	502	824	1545	4682	6073	19541	4373	37540
1999								

Appendix Table B.6: ITALY

Year	ICT-producing manufacturing	ICT-producing services	ICT-using Manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in bln. Italian lires (1995 prices)								
1990	16430	43074	57637	268104	271507	736271	184493	1577516
1991	16725	45971	57493	271074	271149	741755	190725	1594893
1992	17135	50212	57561	273221	272988	747448	191700	1610265
1993	16063	51948	56208	282949	263395	746099	184675	1601337
1994	16460	51826	58790	289948	280756	758009	183186	1638975
1995	18481	54228	62489	296520	291917	771234	187050	1681919
1996	18288	57883	63471	317004	284848	767739	192072	1701304
1997	18672	60599	65365	314702	291923	790216	188193	1729671
1998	18784	64155	67205	321528	297964	796137	191399	1757171
1999	19324	73141	69579	318682	297773	800708	199920	1779127
GDP in in bln. Italian lires (current prices)								
1990	7585	13954	15304	61012	82382	211207	103685	495129
1991	5068	14351	12960	55490	69787	222146	97274	477076
1992	6519	14628	14248	48085	69062	222738	97853	473133
1993	8244	14452	15564	53611	75789	221135	100019	488813
1994	10242	14724	17554	56907	83136	228821	105208	516592
1995	14320	15606	18724	59603	94279	243424	108678	554633
1996	15616	17460	19389	65409	88746	256365	117765	580750
1997	20356	19847	20578	70878	95801	271050	132513	631024
1998	27574	24554	21914	76418	103552	288643	145457	688112
1999	33248	28113	22187	81969	99905	302026	167145	734593
Employment (1000)								
1990	251	701	773	2351	4015	12074	1826	21991
1991	229	679	733	2188	3640	11689	1718	20876
1992	224	637	682	1978	3254	11155	1676	19606
1993	240	619	650	1859	3027	10596	1676	18667
1994	285	601	639	1877	3033	10525	1711	18672
1995	363	618	656	1894	3122	10698	1695	19046
1996	388	638	645	1928	3134	10966	1713	19412
1997	409	665	645	1997	3240	11319	1738	20013
1998	459	732	649	2030	3313	11543	1751	20477
1999	515	777	647	2025	3298	11837	1773	20872

Appendix Table B.7: JAPAN

Year	ICT-producing manufacturing	ICT-producing services	ICT-using Manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in bln. yen (1995 prices)								
1990	11853	10132	18749	67514	70204	188337	69151	435940
1991	13571	11055	20014	71953	72525	192678	70808	452605
1992	12847	11722	20487	74033	71300	196000	71818	458207
1993	12501	12438	20336	72595	67655	199539	71991	457054
1994	13042	13227	20501	74248	66237	201526	72846	461628
1995	15032	13835	21376	76257	68835	204321	70513	470170
1996	17807	15766	23042	76858	70835	212998	72743	490049
1997	19887	16156	24050	80274	72289	215142	69715	497512
1998	18080	16834	22526	80223	67819	214002	66297	485780
1999								
GDP in in bln. yen (current prices)								
1990	14742	10663	20134	72533	73346	167047	63435	421898
1991	15737	11553	21246	78531	78832	176933	67707	450540
1992	14274	12047	21222	80131	78294	185178	69401	460548
1993	13331	12555	20610	77829	73946	192774	71066	462112
1994	13122	13037	20375	78827	70056	197687	72448	465552
1995	13867	13835	20894	79475	70482	201103	70513	470170
1996	14863	15486	21374	79835	71518	209460	71911	484446
1997	15098	15670	21412	83686	72955	213523	69980	492323
1998	14102	15812	19853	82445	67246	212891	65748	478097
1999								
Employment (1000)								
1990	1791	965	2195	9114	11429	26436	12334	64264
1991	1834	1028	2296	9475	11778	26814	12320	65545
1992	1851	1075	2333	9630	11901	27143	12308	66241
1993	1771	1138	2317	9697	11656	27625	12295	66499
1994	1761	1190	2230	9651	11430	27945	12374	66581
1995	1711	1230	2164	9717	11161	28283	12421	66687
1996	1723	1340	2151	9775	11072	28543	12385	66989
1997	1721	1403	2167	10090	11036	28804	12500	67721
1998	1712	1439	2149	10207	10481	29068	12196	67253
1999								

Appendix Table B.8: NETHERLANDS

Year	ICT-producing manufacturing	ICT-producing services	ICT-using manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. guilders (1995 prices)								
1990	7792	16842	27446	107935	67855	255830	76776	560477
1991	7705	17566	27171	110507	68588	263603	78420	573559
1992	7534	18178	27248	113527	67888	269624	78410	582409
1993	7676	18007	27442	112320	65933	276062	78187	585627
1994	7983	18451	29759	116285	69566	281613	79884	603541
1995	8367	19984	30975	119453	71602	286205	83679	620264
1996	8283	21913	30773	126300	72497	293396	85391	638553
1997	9036	26168	31307	135080	74088	303926	82930	662535
1998	9287	31097	32789	141291	76026	312768	85372	688630
1999	9287	36915	35047	149130	77558	319619	88513	716069
GDP in in mln. guilders (current prices)								
1990	8435	14311	25734	89977	63507	225013	77978	504955
1991	8425	15195	25018	95229	66060	238700	83128	531754
1992	8159	16440	24730	102056	66722	253658	80943	552708
1993	8078	17091	25049	106649	66571	266455	78940	568833
1994	8145	18251	27913	116703	68932	277390	82292	599625
1995	8367	19984	30975	120117	71602	285540	83679	620264
1996	8137	22267	30029	126162	72768	295149	87907	642419
1997	8646	25765	31176	135676	75726	311831	88613	677433
1998	8873	29394	31398	146639	81696	330059	89443	717501
1999	8873	32974	32680	159237	84017	347834	91193	756808
Employment (1000)								
1990	105	144	271	1029	796	3128	794	6266
1991	99	151	270	1062	800	3183	792	6357
1992	92	155	270	1078	800	3236	793	6423
1993	87	153	260	1083	782	3267	793	6425
1994	79	151	251	1086	750	3318	780	6416
1995	79	156	243	1113	747	3392	779	6508
1996	80	173	237	1156	735	3483	788	6651
1997	82	192	240	1190	745	3606	809	6864
1998	80	220	234	1241	762	3701	804	7042
1999	80	243	235	1310	771	3794	806	7239

Appendix Table B.9: UNITED KINGDOM

Year	ICT-producing manufacturing	ICT-producing services	ICT-using manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. pounds (1995 prices)								
1990	9594	19806	28461	106682	95545	273901	73740	607727
1991	9317	19983	28171	104722	89410	274992	72671	599265
1992	9562	20485	28798	102094	88539	278185	72456	600119
1993	10209	21473	29549	106662	88918	284551	72480	613842
1994	11583	23752	30807	111409	92302	297637	75744	643234
1995	12370	26475	32030	115007	92344	306432	76339	660996
1996	12787	29766	32494	120930	92010	312122	78424	678532
1997	13285	33769	32731	128104	93053	321752	79523	702217
1998	14236	37469	32921	134587	92596	331827	80451	724088
1999	15339	42557	33993	136883	90420	338100	81547	738840
GDP in in mln. pounds (current prices)								
1990	9279	20605	25075	87513	80457	228615	69275	520820
1991	9313	22769	25602	89924	76421	245603	69334	538965
1992	9227	23575	26973	99643	77501	261361	68203	566484
1993	10181	24130	28018	105486	80521	275803	69264	593403
1994	11539	25684	29772	115115	86894	290521	72607	632131
1995	12370	26475	32030	115007	92344	306432	76339	660996
1996	13063	27980	33526	122406	96892	323626	82093	699585
1997	13896	32016	34074	132508	100647	346270	81394	740804
1998	14839	37284	34508	143745	101850	371242	79561	783030
1999	14818	42445	33942	149229	98939	391899	86525	817797
Employment (1000)								
1990	387	682	824	3112	3544	12851	1965	23366
1991	344	676	768	3075	3232	12775	1834	22704
1992	308	654	748	3103	3058	12822	1706	22399
1993	289	656	725	3065	2932	12797	1570	22034
1994	298	666	737	3110	2927	12877	1507	22122
1995	326	690	766	3245	2973	13029	1425	22455
1996	336	738	778	3310	2992	13165	1386	22705
1997	340	787	783	3455	3039	13363	1486	23253
1998	351	849	783	3579	3005	13510	1610	23688
1999	340	912	760	3671	2884	13722	1624	23913

Appendix Table B.10: UNITED STATES

Year	ICT-producing manufacturing	ICT-producing services	ICT-using manufacturing	ICT-using services	non-ICT manufacturing	non-ICT services	Other	Total
GDP in mln. US$ (1995 prices)								
1990	111442	243230	251656	1106093	702164	2933887	618774	5967247
1991	112303	246735	245030	1132171	673182	2949887	601965	5961274
1992	117029	257208	247011	1161868	684561	3023931	606795	6098402
1993	119055	272039	241465	1202714	724697	3058114	610727	6228811
1994	134992	284837	258007	1239147	772461	3145414	647575	6482432
1995	165242	300840	261895	1277135	814469	3218725	651107	6689413
1996	190337	317485	271447	1358506	810079	3321139	674428	6943421
1997	222782	331150	281465	1487419	836425	3429760	691584	7280585
1998	266782	352943	288471	1635369	842626	3551999	714902	7653093
1999	330074	393433	312681	1760999	835290	3652052	748217	8032746
GDP in in mln. US$ (current prices)								
1990	130591	219695	214489	913541	659355	2528250	593591	5259512
1991	130908	227563	219979	964042	651744	2650847	565232	5410315
1992	135363	243112	227973	1037380	675400	2796692	570189	5686110
1993	136199	262267	231245	1104185	719266	2921133	590999	5965294
1994	149879	280258	252490	1172319	774983	3075218	631745	6336892
1995	165242	300840	261895	1277135	814469	3218725	651107	6689413
1996	177225	321776	272432	1385961	816986	3379879	713420	7067679
1997	192598	343465	286010	1557918	850723	3573301	738615	7542631
1998	202735	371744	296049	1719270	883084	3795739	765287	8033908
1999	215864	415093	310330	1843717	918534	4027341	822700	8553579
Employment (1000)								
1990	2253	3458	3439	19317	13946	72219	11831	126464
1991	2180	3402	3360	19022	13415	72455	11380	125215
1992	2100	3417	3287	19101	13190	73272	11077	125445
1993	2059	3550	3305	19547	13257	74920	11350	127989
1994	2056	3680	3310	20168	13491	76571	11702	130978
1995	2075	3858	3308	20823	13648	78107	12009	133826
1996	2115	4045	3277	21418	13595	79475	12259	136184
1997	2209	4298	3291	22301	13696	80993	12572	139360
1998	2216	4532	3319	23325	13818	82402	12857	142469
1999	2228	4749	3286	24095	13536	83987	13308	145190