"CHANGING GEAR"
Productivity, ICT and Service Industries: Europe and the United States

Bart van Ark
University of Groningen, Netherlands
Economic Growth Center, Yale University
The Conference Board

Robert Inklaar
University of Groningen, Netherlands
The Conference Board

Robert H. McGuckin
The Conference Board

Contact email address: h.h.van.ark@eco.rug.nl

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Abstract

This paper examines cross-country and cross-industry differences in labor productivity performance and their association with ICT. It broadens earlier work with coverage of 49 industries in 16 OECD countries. The analysis suggests that ICT diffusion in Europe is following similar industry patterns to those observed in the U.S., but at a considerably slower pace. The key differences between Europe and the U.S. are in the intensive ICT-using services, with U.S. productivity growth showing a strong acceleration during the second half of the decade, whereas growth stalled in the EU. More specifically, the U.S. showed rapid productivity expansion in retail and wholesale trade and securities, which account for much of the overall U.S.-EU gap in productivity growth since 1995. In the ICT-producing sector, computers and communication equipment showed strong productivity growth and acceleration in virtually all countries, but differences are much bigger across countries for ICT-producing services, such as telecom services.

1. Introduction

A wide variety of recent studies - at firm, industry and macro levels of detail - have assessed the impacts of information and communication technologies (ICT) on productivity growth during the 1990s. In addition, there have been many case studies of the way that ICT influences performance. For the United States, there is widespread agreement that production of ICT goods has strongly contributed to acceleration in productivity growth during the 1990s.[1] Although there are a few dissenters, a consensus is emerging on the proposition that the diffusion of ICT is also a prime contributor to productivity growth elsewhere in the economy. In particular, service sectors are among the main beneficiaries of increased investment in ICT, leading to faster growth in labor productivity and in many cases even in more total factor productivity growth.[2]

In the case of Europe, there is some evidence that ICT investment has contributed to faster output growth, although in most cases to a lesser extent than in the United States.[3] However, it has also been widely noted that European countries generally have not exploited the productivity enhancing potentials to the extent of the United States.[4] In fact, productivity growth in Europe has declined since the mid-1990s, but relatively little is known about how widespread this productivity slowdown was across industries. In our earlier work we found that in most European countries – and in contrast to the United States – the accelerated growth of labor productivity in ICT-producing industries and intensive ICT-using industries was offset by a substantial slowdown in labor productivity growth in less-intensive ICT-users.[5] However, this evidence hides substantial variation within these major groups of industries.

This paper examines international differences in the labor productivity performance across ICT producing industries, intensive ICT-using industries and less intensive users (hereafter, for the sake of simplicity, called "non ICT" industries), with an additional breakdown to manufacturing and service industries. It represents an intermediate step in our efforts to develop full-scale measures of ICT capital and other capital suitable for comprehensive analysis at the industry level. Using evidence on ICT intensity by industry in the U.S. and – on a much more

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[1] See, for example, Jorgenson (2001).
[2] See, for example, Baily and Lawrence (2001) and Jorgenson, Ho and Stiroh (2002). Among the main dissenters are Gordon (2000, 2002) and McKinsey Global Institute (2001).
[3] See, for example, Daveri (2001, 2002), ECB (2001) and Colecchia and Schreyer (2001).
[4] See, for example, OECD (2000, 2001).
[5] See, van Ark (2001) and McGuckin and van Ark (2001). A limited number of country specific studies in Europe have recognized the smaller contribution of ICT to productivity growth in ICT-using industries, mainly in services, including Oulton (2001) for the UK, Jalava and Pohjola (2001) and Niiniinen (2001) for

limited scale – outside the U.S., we examine cross-country and cross-industry differences in labor productivity performance and their association with ICT.

This paper broadens our earlier work in two ways. First, it extends considerably the country and industry coverage by updating and extending the database to include output and employment information for 49 individual industries (ISIC rev 3), of which 20 are in services, for 16 OECD countries. The countries are eleven major European countries (Austria, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Sweden, Spain, Switzerland and the United Kingdom), Canada, Japan and the United States for the period from 1990 to 2000. The database provides the raw material to examine productivity impacts of ICT both within and across countries.

Second, the present analysis moves beyond the standard comparisons of differences in growth rates across groups of industries that we used previously by applying some simple regression models. This extension is possible since, unlike our earlier work we do not exclusively deal with the performance of ICT-producing, ICT-using and the non-ICT industries as a whole. With information on each industry, it is possible to assess the importance and significance of the widely different trends among individual industries. Whether and by how much these trends differ by country is a key issue we consider here. In particular, among service industries we find a very wide variation in productivity performance.

As in our earlier work**,** we still mainly rely on U.S. information on capital by industry to group industries into ICT-producing, ICT-using and specific "non-ICT" industries. We interpret this U.S. industry grouping as a reflection of the opportunities for applying ICT in other countries. In the face of relatively meager direct data for Europe on ICT intensity, it helps us to identify where an ICT-productivity relationship is likely to emerge in Europe. We also look at capital and investment intensity measures for some major European countries to investigate whether this assumption is likely to be violated. While the information on ICT capital by industry outside the U.S. is not suitable for direct econometric work, it offers evidence on differences in the timing and industry pattern of diffusion of ICT in Europe.

Table 1 summarizes our results in terms of labor productivity growth rates and GDP shares for major industry groups for the European Union and the United States. The first impression from the table is a widespread acceleration in U.S. productivity growth, but in particular for ICT-producing manufacturing and ICT-using services. Secondly, in contrast to the U.S., overall

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Finland, van der Wiel (2001) for the Netherlands, Cette, Mairesse and Kocuglu (2001) for France, and De Arcangelis, Jona-Lasinio and Mazocchi (2001) for Italy.

productivity growth in the European Union slowed, except for the ICT-producing sector of the economy where it accelerated. In ICT-using industries services in Europe productivity growth did not improve, whereas growth rates declined in non-ICT industries.

[TABLE 1 about here]

This suggests that differences with the U.S. go beyond differences in the diffusion of new technologies. There are surely many factors involved, among them overall performance of product and labor markets, differences in initial capital-labor ratios and the widespread moderation of initially high wages in Europe since the mid 1990s. Nonetheless, diffusion is a big part of the story. Looking beyond the aggregate numbers there is diffusion of ICT in Europe, in particular during the second half of the 1990s, albeit at a slower pace than in the United States.

First, European countries show rapid increases in labor productivity growth in ICT-producing manufacturing and service industries alike. The contribution of these industries to aggregate productivity growth was slightly lower than in the U.S. due to the smaller size of these industries.

Second, since 1995 most countries have shown a significant difference between productivity growth in ICT-using services and non-ICT services and this difference in performance is much larger for the U.S. than for Europe. Of particular importance, the U.S-EU differential in productivity growth is largely associated with much faster productivity growth in three ICT-using service industries, namely in retail and wholesale trade and in securities. Because of their large share in output and employment, these service industries feature prominently in accounting for the aggregate difference. Moreover, compared to the U.S., each of these industries can be linked to restricted opportunities for expansion and implementation of ICT in Europe.

Third, it appears that ICT diffusion in Europe is following similar patterns across industries to that experienced in the U.S. Not only is there a reasonable correlation between the industry distributions of productivity growth in the U.S. during the earlier half of the 1990s and the European industry productivity pattern from 1995-2000, but the industry distributions of ICT capital across countries are similar as well.

The paper is organized as follows. In Section 2 we discuss different measures of ICT intensity by industry, which we use to group our industries into ICT-using and non-ICT industries.[6] Next we examine the distributions of labor productivity between these industry groups and whether and how much they differ across countries using econometric analysis

(Section 3). Within these groups we also focus on differences in growth performance of service industries, which are among the most intensive users of ICT. In Section 4 we look at the dynamics of productivity growth for individual industries – and in particular services industries – classified as ICT-using or non-using. Section 5 concludes with some suggestions for further research.

2. Measures of ICT Use and Industry Grouping by ICT-Categories

While the levels of detail, breadth of coverage and particulars of the measurement methodology of the impact of ICT on productivity vary across studies, they can be grouped into two main types or categories: growth accounting exercises that decompose the growth into various components or sources, and econometric models that seek to "explain" variations in performance by variations in the use of ICT technology.[7] In this paper we use both methods to examine the relationship between ICT use and labor productivity growth.

As a practical matter, we must choose between three possible measures of ICT use by industry, namely the share of ICT investment in total investment, the share of ICT capital in total capital, and the share of the flow of capital services from ICT in total capital services. The latter measure has our preference, as the service flow per unit of ICT capital can be quite different from the flow from a unit of non-ICT capital. Service flows are calculated by estimating a user cost of each type of capital, and these can be relatively high for ICT capital because of high rates of depreciation. Thus a simple measure of ICT's share of total assets may understate the flow of services from it.[8] Unfortunately, except for aggregate studies and industry level analyses for the U.S, the data requirements limit the possibilities for the use of capital services as a measure of ICT use.[9] For example, industry level data on the ICT capital stock are only available for five countries (France, Germany, Netherlands, UK, and U.S.) and are not fully consistent across

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[6] For the grouping of ICT-producing industries we rely on the OECD (2000).

[7] We would include in the econometric category the numerous case studies that explore how ICT operates in particular plants, firms or industries.

[8] In addition user cost measures by industry will also take account of possible high returns on ICT capital in particular industries. For example, in the oil extraction industry a small investment in ICT has fundamentally changed the methods by which this industry explores new oil reserves (Olewiler, 2002). But when using the capital services approach, capital returns can be high even with small amounts of investment in ICT.

[9] Capital services estimates by industry are an integral part of both the growth accounting analyses by Jorgenson and Stiroh (2000) and Oliner and Sichel (2000) for the U.S., Colecchia and Schreyer (2001) for OECD countries, and van Ark *et al.* (2002) for the European Union. Stiroh (2001) and Jorgenson, Ho and

countries. Outside the U.S. there is an almost complete lack of data on ICT capital services by industry.

Faced with these data limitations, we largely base our grouping on the U.S. estimates of capital services by industry for 1995 by Stiroh (2001). The rationale behind our choice of this indicator (in addition to our preference for capital services measures as discussed above) is the assumption that the U.S. distribution of ICT intensity across industries defines the opportunity set for productive use of ICT. Then we use this distribution to study to what extent other countries have used the opportunities ICT provides in these industries. The use of the U.S. distribution of ICT provides an independent standard that helps us identify where to expect differential productivity performance in Europe. For example, the U.S. has shown acceleration of productivity growth in industries like finance, banking and business services that are heavy users of ICT. In addition, case studies of ICT use in industries as diverse as retail trade and trucking support the contention that ICT makes an important contribution to enhanced productivity growth.

A distinction between heavy users of ICT and less intensive ICT-users (non-ICT) is necessarily arbitrary as there are few if any industries that do not use ICT at all, so it requires an arbitrary cut-off point. For example, Stiroh's cutoff point is the median of the 57 industries he studied. In other studies gaps in the proportion of industry capital devoted to IT were used to separate using and non-using industries. However, the limitations of this type of grouping of industries should not be overdrawn. It certainly can have advantages when ICT intensity measures contain substantial noise.[10] Moreover, this type of industry grouping has worked well in several earlier U.S studies to identify the industries with the highest impact from increased ICT use (McGuckin and Stiroh, 2001, 2002; Stiroh, 2001).

The Industry Grouping in ICT-producing, ICT-using and non-ICT groups

Table 2 provides the basic grouping of industries. One important issue is that our industry data largely use the OECD STAN database on national accounts (though with some refinements), which is based on the international ISIC Rev. 3 classification. In contrast, Stiroh's (2001) study, from which we obtained the U.S. capital services measures, uses the U.S. National Income and Product Accounts. They are based on (largely) the 2-digit SIC87 (Standard Industrial

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Stiroh (2002) also use this measure at the industry level. For a limited number of country-specific studies, see footnote 5.

[10] The BEA notes with the capital and investment data by type and industry also suggest that these data are much less reliable than more aggregated figures.

Classification).[11] On the one hand, this reduces some of the industry detail for the U.S. since our database distinguishes 50 industries instead of a maximum for the U.S. of 57 industries.[12] For example, for transport and storage (ISIC rev 60-63) Stiroh distinguishes seven separate industries, of which only two (air transportation and transportation services) are above his median cut-off point of industries with the highest ICT capital intensity. We therefore included all transport and storage in the group of non-ICT industries.

[TABLE 2 about here]

On the other hand, in some cases we use a more refined classification than the US SIC. This is especially true in the area of ICT producing industries (such as computers and other ICT equipment) and for business services. The group of ICT-producing industries (which are also a part of the group of intensive ICT using industries) is derived from a classification by the OECD (2000), that includes industries producing ICT-hardware, software and ICT services.[13] In contrast to Stiroh we therefore distinguish office and computer equipment (US SIC 357) from industrial machinery and equipment (US SIC 35), and radio and TV equipment (US SIC 365-367) from electronic and electric equipment (US SIC 36). We also back out computer services and telecommunication services as ICT-producing service industries. In other ICT-using industries, we distinguish between business services that are clearly part of ICT using industries (i.e., professional business services, including accountants, architects and technical engineering) and those that are clearly not (such as security and cleaning services).

In one way we most strongly departed from Stiroh's grouping of industries, i.e., by excluding education, health and social work from the ICT-using group. Even though these industries are above the median of industries with the highest share of ICT capital services the industries use relatively little capital anyway, as value added largely consists of labor income. Indeed, we find that when looking at ICT capital as a percentage of output in education, health and social work, these industries are at the lower end of the distribution of ICT intensive

[11] See Appendix Tables A.1 for a detailed comparison of industries included in ICT-using according to our study and Stiroh's study. Within the ICT-producing, intensive ICT-using groups and non-ICT groups we distinguish further between manufacturing industries and service industries in order to be able to identify specific performance patterns among the latter. Section 3 and Appendix B describe our data sources in more detail.

[12] In the remainder of this paper we in fact only publish data for 49 industries, i.e., excluding "extra-territorial organizations and bodies" for which no data were available

industries. Our preference to exclude these industries from ICT-intensive using industries has some implications for our econometric results, but do not affect our main conclusions outlined above.[14]

Comparisons with other countries' measures of ICT use

One way to crosscheck the sensibility of the industry groupings in Table 2 is to see how they look from the perspective of the industry measures of ICT and IT intensities that we have for some other countries. Appendix Table A.2 provides the average proportion of total investment over the 1993-97 period that is IT (i.e., excluding investment in communication equipment) for France, Germany, the Netherlands, the U.K. and the U.S. We also obtained information on the proportion of the capital stock that represents ICT capital for France and the UK from a recent study by O'Mahony and de Boer (2002), which we compared with information on US ICT capital obtained from the BEA. While the data are spotty, they show wide variation across industries in ICT and IT intensities across countries. Some industries spend a minor percentage of their investment budget on ICT and IT (for example, around respectively 2.5% and 1% in agriculture) while in other industries, like finance, about 50% of investment is in ICT and about 20% in IT. This wide variation is also observed in the U.S. data.

Tables 3 and 4 show the rank correlation for each country pair for our IT investment and ICT capital intensities respectively.[15] All rank correlations for IT intensity in Table 3 are positive and mostly above 0.50.[16] France is the only country where the correlations with other countries appear

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[13] In fact, the OECD classification also includes wholesale and renting of office and computing machinery, which we were not able to back out from the data. Moreover, telecommunication services in our data also still includes postal services.

[14] Our present industry grouping deviates somewhat from what we used in our earlier work, which was based on more limited evidence on ICT investment/output ratios and ICT capital shares for the U.S. and the Netherlands (Van Ark, 2001; McGuckin and van Ark, 2001). First, chemicals were reclassified as a non-ICT industry, based on the fact that it was clearly in the lower half of the distribution. The second change was to add retail trade to the intensive user categories. Retail trade is one of the more intensive ICT users based on the capital service measure, but not when based on the share of the ICT stock. We also reclassified three transport equipment industries (ships, aircraft and other) to ICT-using as well as furniture and miscellaneous manufacturing, since these four industries are above the median ICT intensity according to Stiroh's (2001) measure. The last change we made was to reclassify industrial machinery as an ICT using industry. It is not possible to make this decision solely based on the US intensity measures since industrial machinery under the SIC classification also includes computers. However, in the other countries for which we have intensity measures, this machinery industry (without computers) also shows up as an intensive ICT user.

[15] By comparing the rankings of the industries, we minimize the effects of differences – measurement methodology, data availability and definitions, etc. – that affect the intensity levels estimates across countries.

[16] Real estate is excluded as capital stock measures in this industry also include imputed housing, which distorts the picture..

low. The correlations on ICT capital intensity in Table 4 are somewhat higher for France and somewhat lower for the UK, but still clearly positive.

[TABLES 3 and 4 about here]

Overall, the rankings suggest that the intensive ICT using industries are similar across countries, which in turn implies that the experience in the US defines an opportunity set. This conclusion is also supported by results from the recent study by O'Mahony and de Boer (2002) which shows that – just as in the US – ICT capital shares in French and British service industries, like transport and communication and financial and business services, are higher than in manufacturing – a finding which also emerges from a similar study on the Netherlands (CPB, 2001).[17] However, O'Mahony and de Boer also show that the amount of ICT capital per hour worked in the U.S. is considerably higher than in France and the UK across almost industries. The latter suggests a slower pace of ICT diffusion in European countries, which is confirmed by evidence on ICT capital intensity at the aggregate level from studies such as Daveri (2001) and Colecchia and Schreyer (2001).

3. Does ICT make a Difference for Productivity?

In the remainder of this paper we use the grouping of industries according to ICT use discussed above to examine differences in labor productivity growth. In this section we investigate differences in productivity growth between the groups as a whole. In the next section we undertake a more detailed examination of individual industries within the ICT-using and non-ICT categories. One key issue is whether there is some commonality across countries within the industry groupings concerning productivity growth rates. We begin with a brief overview of our productivity data and related measurement issues.

Data and Adjustments for Deflation of ICT goods[18]

The data for this study are for 16 OECD countries from 1990 to 2000. The database is largely draws on the new STAN database for national accounts from the OECD.[19] STAN includes

[17] However, the study by O'Mahony and de Boer also suggests lower capital intensities than in manufacturing for the distribution sector.

[18] A detailed description of the data and adjustments is given in Appendix B. Data descriptions for individual countries are available from the authors upon request.

industry series of GDP in current basic prices, and constant price series expressed as index numbers. Employment refers to all persons employed, including self-employed. As hours per employee at industry level were only available for a limited number of countries, our computations so far relate only to output per person employed.[20]

For some ICT-producing industries, including insulated wire (ISIC 313) and instruments (ISIC 331), the STAN database is not detailed enough to distinguish between the industries described above. For the U.S. we also had to break out office and computer equipment (ISIC 30) and radio, TV and communication equipment from the aggregate series on industrial machinery and electrical machinery and equipment respectively. In addition, we needed to break out repairs, retail and wholesale trade (ISIC 50-52) and distinguish between ICT-intensive business services (ISIC 741-743) and non-ICT business services (ISIC 749). Although the procedures differed from country-to-country, in most cases output and employment shares for the more detailed industries were obtained from the *OECD Structural Statistics for Industry and Services* and the *OECD Services Statistics on Value Added and Employment* and applied to the more aggregated series from STAN.[21]

To obtain constant price series in national currencies we linked index series for real value added to 1995 GDP levels in current prices. These constant price series were distributed by industry within each of the industry groups distinguished in Section 2 and then aggregated on the basis of chain-weighted Fisher indexes. As a result our aggregated series do not exactly match the original GDP series for each country.

Prior to these procedures, however, we faced a serious methodological problem concerning the deflation of output in ICT-producing industries – a problem already identified in earlier studies (e.g., Schreyer, 2000, 2002, Daveri, 2001). Since many countries develop price indices for ICT goods by matching prices of comparable models between two periods in time, the rapid changes in quality of ICT equipment are not adequately reflected in measured output. Only

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[19] See http://www.oecd.org/EN/document/0,,EN-document-0-nodirectorate-no-1-3245-0,00.html.
Data for Netherlands (pre-1995), Norway and Switzerland are directly obtained from the countries' national accounts. For Austria, Canada, France, Germany, Switzerland and the UK data presently only run up to 1999, and for Japan and Sweden only up to 1998. German data start in 1991. At a later stage we aim to take these estimates further back to 1970 which is the starting date of the STAN database.

[20] Even though the decline in working hours in Europe means that labor productivity grew faster when measured in hours than when measured on a person employed-basis, differences across industries are not strongly affected by these different measures of labor productivity.

[21] In the case of the United States, we also heavily relied on the Economic Censuses for 1992 and 1997, the Annual Survey of Manufactures, detailed series from BEA on value of shipments at 4-digit level for manufacturing industries and gross output at 3-digit level for non-manufacturing industries

a limited number of countries, including the United States, Australia, Canada and France, use hedonic price indexes that capture the quality changes. Therefore, measured prices in these countries typically decline much more rapidly. Some countries in Europe, for example Denmark and Sweden, do not create their own hedonic price indexes, but make use of the U.S. price index for ICT equipment with a correction for the US$ exchange rate.

We adopted a procedure based on Schreyer (2000). The U.S. value added deflators for ICT-producing manufacturing industries were applied to the other countries, after an adjustment with the ratio of the aggregate GDP deflator (excluding the deflators for ICT-producing manufacturing) for each country relative to the U.S. GDP deflator. As the ICT industries ISIC 30, 313, 32 and 331 are not reported separately in the US National Income and Product Accounts, the hedonic price indices for these industries were reconstructed with procedures and data similar to those used by BEA.[22]

A second issue of concern was the measure of real output in services. 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 a quantity component can often not be distinguished. Moreover, changes in the quality of services are also difficult to measure. These problems are not new, and improvement in measurement of service output has been a topic on the agenda of statisticians and academics for a long time.[23]

Despite these measurement problems, as long as the statistical bias remains relatively constant the traditional methods should suffice at least to measure the change in real output (Hulten, 2000). The increasing importance of ICT, however, likely led to understatement of the growth in real output by increasing quality changes in service output, although by how much is not known.[24] Various efforts to improve output measurement in services have been undertaken at statistical agencies across the OECD. But much remains to be done. Unfortunately, the actual steps taken to implement new methodologies in the national accounts are not well documented, particularly outside the United States. Thus, the evidence to claim that the national accounts in

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(http://www.bea.gov/bea/dn2/gpo.htm) and the Input-Output Tables for 1987, 1992 and 1997. See Appendix B.

[22] See Appendix B. We are grateful to Brian Moyer (BEA) for advice. See also Kask and Sieber (2002) for similar procedures to obtain productivity growth rates for high tech industries. However, instead our hedonic deflators refer to value added rather than just gross output.

[23] See, for example, Griliches (1992) and the statistical work of the Voorburg Group on Service Statistics (http://www4.statcan.ca/english/voorburg/). For example, a key measurement issue is that information on inputs (such as labor income) is still used as a proxy for output in many service industries.

[24] See Triplett and Bosworth (2001) and van Ark (2002) for a further discussion. McGuckin and Stiroh (2001) estimate for the U.S. that output understatement could be as high as 1.5 percentage points in individual industries, and productivity growth could be underestimated by up to 20%.

one country reflect better service output measurement than in another is not strong enough to draw any definitive conclusions on the lack of international comparability. We therefore take as our working assumption that the international comparisons between industries we observe reflect differences in productivity growth in the industry or grouping of industries examined. We briefly return to this issue in next section.

In making comparisons between Europe and other countries, we calculated a European Union average based on nine EU member states in our sample (covering more than 80 per cent of EU GDP). The 1995-based value added in each industry was converted to the Euro using the exchange rate between each national currency and the value of the Euro as fixed on January 1, 1999.[25] This procedure follows recommendations of the European Central Bank concerning data for years before 1999. But it also assumes, problematically, that there are no price differences between countries in the EU area – an assumption that incidentally is identical to what is assumed for U.S. states in the output statistics for the U.S.

Productivity Growth and Contributions by Industry Group

Table 5 gives a first impression of the relative importance of seven industry groups in the year 2000 for each country in our sample and the European Union. It shows the proportion of GDP accounted for by ICT-producing industries in manufacturing, ICT-producing industries in services, ICT-using industries in manufacturing (excluding the ICT-producing manufacturing industries), ICT-using industries in services (excluding the ICT-producing service industries), non-ICT industries in manufacturing, non-ICT industries in services and other non-ICT industries (including agriculture, mining, construction and public utilities).

[TABLE 5 about here]

On average ICT-producing industries make up for at most 8 per cent of GDP, with Finland being a notable exception (just over 10 per cent of GDP) because of its large communication equipment industry. Most countries in Europe have lower GDP shares in ICT-producing manufacturing and ICT-producing services than the United States. ICT-using

[25] For Sweden and the UK, which do not participate in the euro, we used their exchange rate to the euro at the same date, i.e. 1 January 1999. For European countries for which we had missing years (e.g., 1990 for Germany and 2000 for Austria, France, Germany and UK, we filled gaps by extrapolating with growth rates for years for which we had data.

industries (other than ICT-producing industries) also account for bigger shares in the United States than in Europe, but there is a clear difference between manufacturing and services.

In ICT-using manufacturing, almost every European country has higher GDP shares than the US, with Germany and Switzerland being notably larger.[26] This partly reflects the lower proportion of the U.S. economy in manufacturing sector, but also the comparative advantage of many European countries in ICT-using (and non-ICT) industries in manufacturing outside the ICT-producing sector. In contrast, ICT-using services in the U.S. clearly account for a higher share of GDP in the U.S. than in Europe, with the exception of Switzerland where the banking sector dominates. In Section 4 we look in more detail at some of the main ICT-using service industries contributing to the American productivity growth advantage over Europe.

Table 6 shows the productivity growth rates for the seven industry groupings distinguished above for individual countries and for the EU as a whole for the periods 1990-1995 and 1995-2000. During the first half of the decade, aggregate productivity growth in Europe was considerably faster than in the United States, but since 1995 U.S. productivity growth was 1.1 percentage points faster. But there appear to be some important differences in growth dynamics between industry groups. First, productivity growth in the ICT-producing industries in manufacturing (i.e., office and computer equipment and telecommunication equipment) is much faster than in the rest of the economy for virtually all countries (except Switzerland). Hence once comparable price indexes reflecting the rapid technological change in ICT-producing manufacturing are adopted for all countries – and not just the U.S. – ICT-producing industries exhibit rapid productivity growth in this (small) part of the economy about everywhere.[27]

[TABLE 6 about here]

The clearest and most systematic differences between Europe and the U.S., however, arise in services, particularly in the ICT-producing and ICT-using industries. In ICT-producing services productivity growth in many European countries is faster than in the United States. As we will see in Section 4 this is mainly due to the faster productivity growth in Europe in telecommunication services. In contrast, in ICT-using services (excluding the ICT-producing services), U.S. performance was substantially better than in other countries since 1995. For

[26] Here the exceptions are the Netherlands and Norway, where the non-ICT sector dominated because of large mineral extraction industries (natural gas and oil). In particular in Norway the oil extraction industry accounted for more than 10% of GDP.

example, productivity in ICT-using services grew at 4.8% in the U.S. compared to 0.8% for Europe in the 1995-2000 period. This difference is mainly due to better U.S. productivity performance in the securities and trade sectors.[28]

The impact of each industry group on labor productivity at the aggregate level depends not only on the average productivity growth rate of each industry, but also on the relative size of that industry. Hence labor productivity for the total economy (*P*) can be perceived as the sum of the productivity contributions of each industry group (i) weighted with the labor share ($L_i/L=S_i$):[29]

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

In a time perspective the change in productivity between year *T* (P^T) and year *0* (P^0) can be written as follows:

$$P^T - P^0 = \sum_{i=1}^{n} (P_i^T - P_i^0) \cdot \overline{S}_i + \sum_{i=1}^{n} (S_i^T - S_i^0) \cdot \overline{P}_i \qquad (2)$$

where $\overline{S}_i$ and $\overline{P}_i$ are the average employment share and the average productivity level in year t and t-1 respectively. Thus, aggregate productivity growth is decomposed into intra-group productivity growth (the first term on the right-hand side, called "intra-effect") and the effects of the reallocation of labor (the second term, called the "shift-effect").[30]

Figure 1 shows the contributions by ICT-producing industries, ICT-using industries and the rest of the economy to labor productivity growth for 1990-1995 and 1995-2000.[31] The shift effect is shown separately (it is generally positive but small), so that the contributions of each group refer to the intra effects only. The chart shows that, despite their relatively small share in GDP, ICT-producing manufacturing industries contributed substantially to labor productivity growth, and for most countries this contribution increased during the second half of the 1990s. However,

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[27] In Finland productivity growth in ICT-producing manufacturing is faster than in the U.S. because of the large impact of the telecommunication equipment industry.

[28] We also find that productivity growth in ICT-using manufacturing is higher than the U.S. for many countries.

[29] Based on Fabricant (1942).

[30] See Van Ark (2001), where we also distinguished between a static and dynamic shift effect. However, the latter effect is the product of changes in shares and changes in labor productivity levels and is quite small when using annual data, as is the case here.

[31] For the sake of clarity we lumped the three groups of industries in the non-ICT group together, so that there are only five industry groupings.

the contribution of ICT-producing manufacturing is substantially bigger in the U.S. than in Europe. For some European countries (in particular Denmark, Germany, the Netherlands and Norway) the contribution of ICT-producing services even exceeded that of ICT-producing manufacturing.

While the contribution of ICT-using manufacturing (excluding the producers) has generally been somewhat higher in Europe (and in particular in Germany) than in the U.S., ICT-using services (again excluding the producers) accounts for by far the largest contributions to productivity growth in the U.S.. In contrast, the productivity contribution of the non-ICT group has been smaller in the U.S. than in most other countries. Although the non-ICT contribution to labor productivity growth seriously diminished in almost all countries since 1995, its fall was much greater outside the U.S. As observed in our earlier work the deceleration of productivity contributions from non-ICT sector has accounted for much of the aggregate slowdown that European countries experienced during the second half of the 1990s (van Ark, 2001; McGuckin and van Ark, 2001).

[FIGURE 1 about here]
Source: Appendix C

Are the Differences in Productivity Growth between Industry Groups Significant?

Even though this decomposition suggests substantive differences in growth rates across industry groupings, it is useful to determine the statistical strength of the differences between ICT-producing, ICT-using and other industries while taking account of variations in industry productivity growth associated with each group. For this purpose, we carried out a number of country-specific regressions using a simple difference model for which we progressively increased the number of industry groupings. First we estimated the simplest model, which distinguishes only between ICT-using (including ICT-producing industries) and non-ICT industries:

$$\Delta P_{i,t} = \alpha + \gamma C + \varepsilon_{i,t} \qquad (3)$$

where, $\Delta P_{i,t}$ is the annual productivity growth rate, i denotes the industry group and t is years between 1990 and 2000. With 49 industries, this leads to a maximum of 490 observations per country. C is a dummy that is one if the industry is an ICT-intensive industry (which here means either an ICT-producing or an ICT-using industry). The estimated coefficients in Table 7 have the

following interpretation: α is the average productivity growth rate for non-ICT industries and $\alpha + \gamma$ is the mean growth rate of ICT intensive industries. Hence γ shows the difference between the growth rate of ICT-using industries and non-ICT industries. We ran the regressions for two sub-periods, 1990-1995 and 1995-2000.[32] The left-hand side of Table 7 focuses on the first half of the 1990s. It shows that in all countries (except Austria and Spain) productivity growth was faster in ICT industries than in non-ICT industries. The difference was statistically significant for five of the 16 countries (Canada and U.S. at 1% level, Sweden and Japan at 5% level and Finland at 10% level). The right hand side of Table 7 shows that during the second half of the 1990s the difference in growth between ICT and non-ICT industries became significant for all countries except Austria, Denmark, France, Italy, Spain and Switzerland.

Strikingly, for Canada, Ireland, Japan, Switzerland and the United States productivity growth in the non-ICT sector was not significantly different from zero throughout the decade. In contrast most European countries experienced fairly strong productivity growth in non-ICT during the first half of the 1990s, but much of that disappeared during the second half of the decade (see also Section 4).

[TABLE 7 about here]

It should be noted that the degree (or lack) of significance not only depends on the average growth difference between the two industry groups, but also on the variation within each group. Using a slight modification of equation (3) we allow for differential effects between ICT-producing and ICT-using industries (excluding ICT-producing):

$$\Delta P_{i,t} = \alpha + \gamma_1 P + \gamma_2 U + \varepsilon_{i,t} \quad (4)$$

where the dummy variable *P* is one if the industry is an ICT-producing industry and *U* is one if it is an ICT-using industry. Table 8 shows that the ICT-producing industry group accounts for much of the difference in productivity growth rates relative to the non-ICT industry. Between 1990-1995, all countries (except Ireland and Italy) showed significantly higher growth rates in ICT-producing. Only Canada and the United States showed significantly faster growth in other ICT-using industries as well. For the second half of the 1990s the difference between productivity growth in ICT-producing and non-ICT increased and is significant at the 1%-significance level

[32] All our parameters are estimated with weighted least-squares (WLS), where the weight of each industry is its employment in the relevant year (this multiplies the dependent and the independent variable by the

for 13 of the 16 countries (exceptions were Austria, Ireland and Switzerland). Moreover, the coefficient on the differences is higher in all but five countries. Still, apart from the United States, only Norway, Sweden and the EU as a whole showed significantly higher growth for ICT-using industries as well.[33]

[TABLE 8 about here]

Table 9 provides estimates of a model that focuses on the distinction between manufacturing and services. The model in equation (4) was modified to:

$$\Delta P_{i,t} = \alpha_1 + \gamma_3 Q + \gamma_4 R + \gamma_2 S + \varepsilon_{i,t} \qquad (5)$$

where α_1 represents the average productivity growth rate for non-ICT using services industries, dummy *Q* is one if the industry is an ICT-using industry in manufacturing, dummy *R* is one if the industry is ICT-using and in services, and dummy *S* is one when the industry a non-ICT and a non-services industry. So the differences in productivity growth estimated in equation (5) are all relative to the non-ICT using services group. The results provide more support for the hypothesis that ICT use is driving productivity growth. Between 1990 and 1995, seven countries showed significantly faster growth in ICT-using services than in non-ICT using services, and between 1995 and 2000, that number went up to ten countries. For the EU average the difference between ICT-using and non-ICT services was not significant between 1990-1995 but became significant at the 1% level from 1995-2000. But a comparison of the left and right hand sides of Table 9 shows that despite an increasing spread in productivity growth between ICT-using and non-ICT services from 1995-2000, productivity growth in ICT-using services was still somewhat slower compared to 1990-1995 for five European countries. For the U.S. there was substantial increase in both the spread between ICT and non-ICT services and in the productivity growth of the ICT-using services group itself.

[TABLE 9 about here]

Finally, we assessed the possibility that productivity growth accelerated between the second half and the first of the 1990s due to increased use of ICT. Such acceleration is found in the

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square root of employment).

[33] The significant result for the EU as a whole is caused by the fact that industries within the ICT-using group showed less volatility in productivity growth than for individual EU member countries.

aggregate results for the United States, as well as in industry-specific work such as McGuckin and Stiroh (2001, 2002) and Stiroh (2001). For this purpose we transformed equation (5) by adding specific dummies to pick up differences in growth rates between the pre- and post 1995 period:

$$\Delta P_{i,t} = \alpha + \beta D + \gamma_3 Q + \gamma_4 R + \gamma_2 S + \delta_1 Q \cdot D + \delta_2 R \cdot D + \delta_3 S \cdot D + \varepsilon_{i,t} \qquad (6)$$

where the parameter β is the acceleration in productivity growth of non-ICT industries after 1995, $\beta + \delta_1$ is the acceleration for ICT-using industry in manufacturing, $\beta + \delta_2$ is the acceleration for ICT-using services, $\beta + \delta_3$ is the acceleration for other non-ICT industries, and δ_1, δ_2 and δ_3 are the additional accelerations of each industry group beyond the acceleration in non-ICT services. Table 10 confirms the earlier contribution analysis. Non-ICT services experienced decelerating growth during the second half of the 1990s compared to the first half for most European countries, but not for Canada and the United States. Still only United States showed an acceleration of productivity in ICT-using services that was significantly different from that in non-ICT services. In fact in Austria, Canada, Finland, France, Italy, Japan, Sweden, Switzerland and the U.K., ICT-using services showed deceleration relative to non-ICT services, even though none of these differences are statistically significant.

[TABLE 10 about here]

In summary, the regressions show that the difference in productivity growth between ICT-using and non-ICT industries is in part linked to ICT-production. Quite apart from that, a sizeable number of countries also have shown significantly faster growth in ICT-using services compared to non-ICT services since 1995. This suggests that the diffusion of ICT in Europe is proceeding but at a slower pace than in the U.S. The U.S. stands out since it it is the only country that also shows a significantly faster acceleration in ICT-using services compared to non-ICT services. In turn, this suggests that the diffusion of ICT in Europe has been "too slow" to accommodate the rapid improvement in employment growth in Europe since the 1990s.

4. Productivity Growth in Services: Is Diffusion is Europe Slower than in the U.S?

Even though grouping industries based on ICT intensity is useful, it hides much of the variation within each of these groups. In this section we focus on individual industry performance for 48 of the 49 industries in our database.[34] Since we now deal with 16 countries and 48 industries for two sub-periods (1990-1995 and 1995-2000), most of our discussion centers on comparisons of industry averages for the eleven EU member states and the U.S. In addition, the discussion naturally concentrates on services industries, which are among the largest users of ICT and because of their sheer size are major contributors to aggregate productivity growth.[35]

Productivity Growth Rates by Industry

Table 11 shows the labor productivity growth rates by industry for 1990-1995 and 1995-2000, the accelerations between the two sub-periods, and the differential between the United States and the EU. Within each of the seven industry groupings, individual industries are ranked by the U.S. productivity growth rates from 1995-2000.

[TABLE 11 about here]

ICT-Producing Industries

In the ICT producing sector, both the U.S. and the EU showed very strong productivity growth. Turning first to the ICT producing manufacturing industries, our attention is drawn to the very rapid productivity growth in the office and computer equipment and radio, TV and communication equipment. These manufacturing industries clearly benefited from the rapid technological progress in ICT that lowered prices and led to increased adoption of these technologies. It is striking that the labor productivity growth rates in these industries for both the EU and the U.S are relatively close, but the acceleration of productivity growth in ICT-producing manufacturing in the second half of the decade has been faster in the U.S. mainly because of a larger improvement in the office and computer equipment industry.

While the ICT producing services industries showed clearly slower growth than the ICT producing manufacturing industries, these two industries clearly stand out compared to other services industries. This can be mainly attributed to the strong productivity growth in the telecommunications sector. While this industry had fast productivity growth in both the EU and

[34] We excluded Private Households (ISIC 95) because of missing data for many countries.
[35] See Appendix D for numbers for individual countries including the numbers for manufacturing industries.

the U.S., the EU had a clear advantage over the United States in particular because of the rapid take off of the wireless market.[36] From 1995-2000 Europe showed positive productivity growth rates in computer services, whereas negative growth rates were reported for the U.S.

ICT-using Industries

The ICT-using sector (excluding the ICT-producing industries) was the sector in which the U.S. showed the most clear-cut performance advantage over the EU. Most U.S. manufacturing and service industries in this group showed a faster acceleration in productivity growth than the EU after 1995.

In ICT-using manufacturing productivity growth accelerated faster in the U.S., with the exception of the aircraft and railroad industries and "miscellaneous manufacturing". However, these widespread gains come against the backdrop of generally lower productivity growth in U.S. ICT-using manufacturing in the 1990-95 period and improved, but still lower productivity growth than in Europe during the 1995-2000 period.

The story is much different for ICT-using services (other than ICT-producing) where the EU experienced a negligible improvement in productivity growth of 0.2 %-point compared to an increase of 3.2 %-points in the U.S. Some individual industries of course show bigger differences. For example, the United States experienced the strongest productivity growth in securities trade, and wholesale and retail trade. In fact all ICT-using services but one (insurance) show acceleration in labor productivity growth in the United States, whereas in the European Union all these industries (except banks and professional services) experienced a decelerating growth performance.

The strong acceleration of productivity in trade is recognized in the U.S. literature.[37] Europe's very slow productivity growth in this sector is a key factor in explaining the economy-wide differences in productivity acceleration in the late 1990s. In fact, as we will see below, the trade sector and securities together account for the largest part of the whole difference in productivity growth between Europe and the United States since 1995.

The banking sector was the only ICT-using service industry (excluding ICT-producing) for which the EU showed acceleration in productivity growth after 1995, which was also higher than in the United States. The higher productivity growth in banking for the EU reflects the experience of most EU member states, except Austria, France and the Netherlands (see Appendix

[36] Recently concerns have surfaced concerning the still too fragmented market structure of the European telecom market. See, for example, Isern and Rios (2002).
[37] See, for example, McKinsey Global Institute (2001)

D). Part of Europe's higher growth rate in banking is due to restructuring of the sector, which led to a continuous fall in employment with little offset in measured output. In contrast, employment in U.S. banking increased since 1995. In banking, measurement issues are of major concern. Strikingly, the Netherlands is among the few countries that (like the United States) recently shifted from measuring real output in the banking sector based on deflated interest receipts and service charges to genuine volume measures of banking output. Hence, some of the differences across countries may reflect measurement procedures.

Non-ICT Industries

In the "non-ICT" sector (representing the less intensive users of ICT) there are substantial differences in productivity growth across industries, with mostly better productivity performance in manufacturing industries (such as chemicals and textiles) than in service industries, particularly in the 1990-95 period. The differences between the manufacturing and service non-ICT sectors narrowed considerably in the 1995-2000 period in both the U.S. and the EU. There was also a narrowing of the differences in productivity growth rates between the EU and the U.S. as U.S. productivity growth slowed less in non-ICT manufacturing and even modestly accelerated in non-ICT services. Nonetheless, compared to the ICT-using sector both the EU and the U.S. showed slower productivity growth throughout the non-ICT sector.

Given their sheer size, services industries are mainly responsible for the overall slower growth of productivity in the non-ICT sector compared to the ICT-using sector. Unfortunately, measurement issues cloud interpretation of the differences. While measurement of service sector output is a problem in the ICT-using sector, for some of the non-ICT service sectors they may be even bigger. One of the major issues is that the real output of services sectors is still largely based on information on inputs (such as employment input and labor income). While in both in Europe and the United States improvements in measurement of non-market services output are discussed, for example, in health and education, details on the actual implementation of improved measurement methods in the national accounts are often missing.[38] Since it is likely that the problems in developing suitable output measures are similar across countries, we can only assume that progress towards solutions is not all that different.

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[38] 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 a series of reports, Eurostat recently evaluated measurement practices in various service activities, such as financial services and public services (Eurostat, 1998a, 1998b, 2000).

Table 11 shows that the average productivity growth for non-ICT services in the U.S. was lower than in the EU, particularly in health, repairs, education, and personal and social services. The latter may simply reflect faster growth of nominal wages in Europe (i.e., it is a measurement problem), but there may also be explanations of a more economic nature. For example, employment in education, health, personal and social services and government has increased much more slowly in Europe than in the United States since 1995, although the difference in employment growth rates for these industries diminished as European employment growth at least turned positive since 1995. There is also some scattered – and partly anecdotal – evidence of greater efficiency in terms of output per person in European health and education services.[39] At the same time, productivity in some non-ICT services in the United States (in particular health – though still negative – and non-ICT business services) improved much more since 1995 than in the EU. But clearly all these measures are unlikely to take adequate account of quality improvements so that these arguments should not be pushed too far.

What is clear, however, is that the largest part of the observed difference in productivity performance between Europe and the U.S. arises from the much better performance of ICT-using services relative to non-ICT services in the U.S. While ICT-using services performed better than the non-ICT services in both the U.S. and the EU in 1995-2000, the differential was greater in the U.S. (0.5% in the EU versus 4.6% in the U.S.) Moreover, U.S. productivity accelerated in both sectors, though by substantially more in ICT-using (3.1 % in ICT-services versus 0.5% in non-ICT services). At the same time European productivity growth more or less stalled in ICT-using services, and decelerated in non-ICT services (from 0.9% to0.3%).

Industry Contribution to the U.S. - EU Productivity Growth Differential

While the differences in performance between ICT and non-ICT services is a primary factor in accounting for the aggregate productivity growth differential between the U.S. and the EU since 1995, it is largely driven by a limited number of industries. In order to examine the importance of particular industries accounting for the rise in the productivity gap between Europe and the United States between 1995 and 2000, we returned to our decomposition analysis – introduced by equations (1) and (2) in Section 3. Using this decomposition aggregate productivity was allocated to the 48 industries used in the industry-by-industry analysis. This provided a measure of the contribution of each industry to the aggregate productivity growth of the U.S. (2.4

[39] But in health services, some countries (Austria, Germany and the Netherlands) showed an even faster decline in labor productivity than the United States since 1995.

per cent) and Europe (1.3 per cent) from 1995-2000. This procedure provides a weighted measure of the contribution to aggregate productivity for each industry that takes account of both within and reallocation effects.

We then broke down the U.S.-EU difference in the overall productivity growth rate of 1.1 percentage points into the differences in the calculated industry contributions for the EU and the U.S. The results of this exercise are displayed in Figure 2. Figure 2a shows the contribution to the U.S.-EU productivity differential from ICT-using services (including ICT-producing services). Figure 2b provides the same information for non-ICT services. The analysis is extended to ICT-using manufacturing in Figure 2c.

Figure 2a shows that securities, retail, and wholesale trade contributed more than 0.95 percentage points less to aggregate productivity growth in Europe than in the United States. This number is close to the overall productivity differential of 1.1 percentage points between the U.S. and the EU.

[FIGURES 2a to 2c about here]
Source: See Appendix Table D.3

The productivity contribution of these ICT-using service industries is the result of two factors: productivity growth in these industries and the industry structure of the economies.[40] This means, for example, that the smaller contribution of retail trade in Europe may be associated with lower productivity, a smaller size of this industry or a decline in the employment share of this industry compared to the United States. We therefore decomposed the contribution to the US-EU productivity differential further into a "productivity effect" and "structure effect". These components are shown between the brackets behind each industry label in Figure 2a.

This decomposition into productivity and structure effect involves an extension of the shift-share decomposition given in equations (1) and (2). We identify the productivity effect with the intra or within-industry productivity growth contribution from the shift-share analysis, but with weights from the U.S. in the case of the EU and from the EU in the case of the U.S. We calculate the contributions to productivity growth in the EU using the U.S. employment weights. This provides an estimate of the aggregate productivity contribution under the assumption that the EU had the same industry structure as the U.S. Using the same procedure, we calculate contributions for the U.S., that is, under the assumption that the U.S. size structure is the same as the EU. The

[40] The industry structure can influence the productivity contribution in two ways: an industry can be larger in employment terms in one country than in the other, or it can expand its employment share in the economy faster in one country than in another.

average of these two measures isolates the effect of productivity growth on the difference in aggregate productivity growth.[41] We identify the effect of structure as the difference in the productivity contributions of the "between" effect under the same counterfactual exercise. [42]

The estimates show that the productivity effects dominate the industry contributions to the U.S.-EU differential in productivity growth. Despite the substantially larger size of retail trade (8 per cent of employment in the EU and 11 per cent of employment in the U.S.) and securities (0.5 per cent EU employment and 1.2 per cent of US employment) in the U.S., the productivity effect is the primary factor explaining differences in industry contributions. Nevertheless, the structure effect contributes significantly to the differential in the case of securities.

Figure 2b shows that in non-ICT services the contributions of individual industries generally have a smaller effect on the aggregate US-EU productivity differential. The largest positive impact on the U.S.-EU gap is real estate, ..267 percentage points. In this case a much lower productivity growth rate in the EU (-.8% versus 1.7%) has a reduced impact because of the smaller size of the industry in the EU. The majority of industries in this grouping in fact narrow the gap between the EU and the U.S.. As mentioned above, although the productivity differentials have become smaller relative to the 1990-1995 period, most non-ICT services have shown faster productivity growth in the EU than in the US between 1995-2000.

Figure 2c shows that ICT-using manufacturing industries (including ICT-producing) also account for part of the aggregate productivity differential. But the effect is much smaller than for ICT-using services. This is mainly due to a smaller productivity effect. Differences in productivity growth rates between the U.S. and the EU are not as large as those found in ICT-using services. But unlike the ICT-using services, in ICT-producing manufacturing the size effects are quite important as these industries are substantially larger than in the U.S. than in the EU.

Testing the "Lagging Diffusion" Hypothesis for Europe

While so far we have presented some evidence from industry labor productivity data supporting the idea that diffusion rates for ICT have been slower in the Europe than in the U.S., the direct evidence is relatively sparse. But the evidence that labor productivity growth, and

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[41] The productivity effect contribution to the U.S.-EU productivity differential is the average of the within contributions in the standard shift-share analysis calculated with the counterfactual structural assumption that the employment shares in the EU are those of the U.S. and vice versa.

[42] The structure effect involves weighting up the differences in employment shares with productivity growth weights. It depends on both the relative size of the industries in each country and changes in these shares over the period for which productivity growth is calculated.

changes in growth rates, are linked to ICT-using and ICT-producing industries extend to Europe. Moreover, the differences in productivity performance between the EU and the U.S. are strongly associated with major ICT-using industries, particularly trade and securities. We conclude this line of reasoning by looking at the patterns of productivity growth across the entire distribution of industries.

Table 12 provides correlations of productivity growth between the E.U. and the U.S. for all industries, for all industries with the two major ICT-producing industries (office and computer equipment, and radio, TV and communication equipment) omitted, and for service industries only. The first column shows Spearman rank correlation coefficients for productivity growth rates and the second and third provide Pearson correlations on productivity growth rates and productivity contributions, respectively. The calculations are carried out on productivity growth in EU and U.S. between 1995 and 2000, on acceleration in productivity growth in 1995-2000 relative to 1990-1995, and on EU productivity growth from 1995-2000 relative to US growth from 1990-1995. The latter type of correlation comes closest to the "lagging diffusion" hypothesis as it tests whether the EU growth pattern during the second period resembles the US growth pattern during the first period.

[TABLE 12 about here]

Reading across the top panel of Table 12, which shows the correlations when all industries are included, suggests that the relationships are positive and, when the productivity growth measure (in column 2) is used, quite strong. However, as is shown in the second panel, the originally high correlation coefficients in column (2) drop significantly once the office and computer equipment (ISIC 30) and radio, TV and communication equipment (ISIC 32) are dropped from the sample. While the Spearman coefficient (column 1) drops somewhat, the Pearson correlations on productivity contributions in column (3) (which take account of the relative size of industries) hold up fairly well. In particular the correlation between EU and US productivity growth rates in the 1995-2000 period, and the comparison of the EU productivity growth rates in 1995-2000 with those in the U.S. in the earlier period, 1990-1995, remain strongly significant.[43]

[43] The acceleration test performs badly across the board, which is no surprise given the slowdown of productivity growth in many European industries and the acceleration in many US industries since 1995 (see Table 11)

In the third panel of Table 12 we concentrate on the services industries only, and find again that the results support the argument that Europe's diffusion process is ongoing but lagging behind that of the U.S. In particular, the correlations are uniformly positive and follow a reasonable pattern for comparisons of EU growth from 1995-2000 with U.S. growth from 1990-1995. For example, while not as high as the .853 for all industries, the .556 value for services alone (column 2) is still quite high and significant.

5. Concluding Comments and Further Research

The main conclusion from this paper is that the diffusion of ICT in Europe is underway. It is following patterns similar to those experienced in the U.S., but the pace is considerably slower overall.

ICT production, particularly the computers and communication equipment industries, showed strong productivity growth and acceleration in virtually all countries. The contribution of these industries to aggregate productivity growth was slightly higher in the U.S. due to their larger size. But in many European countries ICT-producing services industries (in particular telecommunication services) performed better than in the U.S., which suggests plenty of support for countries that are primarily users – even without a major computer-producing industry.

The key differences between Europe and the U.S. are in the services sector, in particular in intensive ICT-using services. Productivity growth in the U.S. strongly accelerated during the second half of the decade, whereas it more or less stalled in the EU. While there was great diversity among industries and countries, a couple of patterns stand out. The U.S., in contrast to Europe, showed strong productivity improvements in retail and wholesale trade and securities. Moreover, even though these sectors were larger in the U.S., it was productivity, not size differences that explained most of the difference in the aggregate productivity growth rates between the U.S. and the EU since 1995. In addition, there were almost universal productivity gains in banking but very mixed performances in insurance and securities services, with the larger countries, including the U.S., doing poorly in the former.

Strong patterns in particular industries were less obvious among the non-ICT industries. Productivity performances were very mixed across industries, but Europe showed higher productivity growth in both 1990-95 and 1995-2000. The gap narrowed, however, as the U.S. was one of the few countries to show some improvement in productivity growth for the aggregate of non-ICT services.

These results raise several questions that deserve further research. First, how important are measurement issues as contrasted with economic explanations in explaining our findings? We cannot be sure how much of the differences we observe are the result of inadequate measurement of services output and differences across countries in measurement methodology. It is clear that the measurement issues need to remain a key item on the future agenda for productivity research. The importance of services industries in accounting for the U.S.–EU gap in aggregate productivity growth underscores the central role that measurement issues are to take in the research agenda.

Second, why was ICT diffusion faster in the U.S.? It is clear that ICT equipment is sold in worldwide markets and that European productivity growth in its manufacture matches that in the U.S. This means the technology is available to potential users about everywhere. Moreover, stronger productivity performance in European ICT–producing services, in particular telecom services, suggests plenty of support for users.

Finally, despite the importance of ICT, it should be noted that ICT is not the only factor explaining differences in productivity growth between Europe and the U.S. A broad literature has addressed a wide range of causes for Europe's slowdown in productivity growth during the 1990s. In turn, these same factors may be behind the slower diffusion of ICT in Europe compared to the U.S.[44] Indeed business organization and the opportunities to exploit technologies depend on the constraints and restrictions that firms face. For example, in McGuckin and van Ark (2001) we argue that in many European industries regulations and structural impediments in product and labor markets limit the opportunities to invest in ICT. Examples of product market restrictions include limits on shop opening hours, and transport regulations that make it difficult for manufacturers and wholesalers to supply customers frequently. Restrictive labor rules and procedures limit flexibility in organizing the workplace and hiring and firing of workers. Furthermore, barriers to entry and restrictions on the free flow of capital are still an issue in many countries. We note that such queries would not just focus on European rigidities. The relatively poor performance of telecom services in the U.S. may be associated with cable and broad-spectrum regulations and the lack of universal standards that limit entry and competition in telecommunications services.

More information on these issues may also help with the related question posed in the paper: How was the U.S. was able to simultaneously expand employment in industries such as retail trade and increase labor productivity? In Europe, it appears that the slower pace of ICT diffusion

[44] A useful summary is in Scarpetta et al. (2000).

meant that employment gains went together with declining productivity. This slower pace involves a risk that Europe may enter a low-productivity growth path, which will make it difficult to raise output and living standards in the long run.

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Table 1: Productivity growth and GDP shares of ICT-producing, ICT-using and non-ICT industries in the EU and the U.S.

	Productivity growth				GDP share	
	1990-1995		1995-2000		2000	
	EU[b]	US	EU[b]	US	EU[b]	US
Total Economy	2.0	1.2	1.3	2.4	100.0	100.0
ICT Producing Industries	6.9	8.0	8.7	9.3	5.8	7.6
ICT Producing Manufacturing	11.6	14.5	14.2	20.3	1.5	2.3
ICT Producing Services	4.5	4.1	6.4	3.7	4.3	5.3
ICT Using Industries[a]	1.3	1.3	1.2	4.4	30.0	34.4
ICT Using Manufacturing	3.5	0.1	2.6	1.9	6.0	4.3
ICT Using Services	0.7	1.6	0.8	4.8	24.1	30.1
Non-ICT Industries	2.0	0.4	0.8	0.3	64.2	58.0
Non-ICT Manufacturing	3.6	3.0	1.3	1.3	12.3	9.1
Non-ICT Services	0.9	-0.3	0.3	0.2	41.6	39.3
Non-ICT Other	3.3	0.7	1.6	0.4	10.3	9.6

a) excluding ICT producing

b) EU includes Austria, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden and the United Kingdom, which represents over 90% of EU GDP.

Notes: Productivity is defined as value added per person employed

Source: Tables 5 and 6

Table 2 – Grouping of ICT producing, ICT using, and less intensive ICT-using Industries

ISIC Rev. 3	**ICT-producing industries**
	ICT-producing manufacturing
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.
	ICT-producing services
64	Post and Telecommunications
72	Computer and Related Services

ISIC Rev. 3	**ICT-using industries**
	ICT-using manufacturing
18	Wearing Apparel, Dressing and Dying of Fur
22	Publishing
29	Machinery and Equipment n.e.c.
31, excl. 313	Electrical Machinery, Apparatus, nec
33, excl. 331	Medical, Precision and Optical Instruments
351	Building and Repairing of Ships and Boats
353	Aircraft and Spacecraft
352+359	Railroad Equipment and Transport Equipment n.e.c.
36-37	Manufacturing n.e.c.; Recycling
	ICT-using services
51	Wholesale Trade
52	Retail Trade
65	Financial Intermediation
66	Insurance and Pension Funding
67	Activities Related to Financial Intermediation
71	Renting of Machinery and Equipment
73	Research and Development
741-743	Professional Business Services

ISIC Rev. 3	**Less-intensive ICT-using industries**
	Other Manufacturing
15-16	Food Products, Beverages and Tobacco
17	Textiles
19	Leather, Leather Products and Footwear
20	Wood and Products of Wood and Cork
21	Pulp, Paper, Paper Products
23	Coke, Refined Petroleum Products and Nuclear Fuel
24	Chemicals and Chemical Products
25	Rubber and Plastic Products
26	Other Non-Metallic Mineral Products
27	Basic Metals
28	Fabricated Metal Products, except Machinery and Equipment
34	Motor Vehicles, Trailers and Semi-Trailers

Table 2 (continued)

	Other Services
50	Repairs
55	Hotels and Restaurants
60-63	Transport and Storage
70	Real Estate Activities
745-749	Other Business Services (non-professional)
75	Public Administration and Defense; Compulsory Social Security
80	Education
85	Health and Social Work
90-93	Other Community, Social and Personal Services
95	Private Households with Employed Persons
99	Extra-Territorial Organizations and Bodies
	Other Industries
01-05	Agriculture, Hunting, Forestry and Fishing
10-14	Mining and Quarrying
40-41	Electricity, Gas and Water Supply
45	Construction

Table 3: Rank correlations between IT investment intensity by industry, mid 1990s

	France	Germany	Netherlands	UK	US
France		0.12	0.45	0.24	0.35
Germany			0.66	0.64	0.67
Netherlands				0.61	0.66
UK					0.85
US					

Note: investment intensity measured as investment in IT equipment (excluding communication equipment) as share of total equipment investment. France, UK, US: 1993-1997; Germany: 1991-1994; Netherlands; 1990-1995
Sources: Appendix Table A.2

Table 4: Rank correlations between the ICT capital intensity, 1995

	France	UK	US
France		0.32	0.44
UK			0.67
US			

Note: capital intensity measured as ICT capital as share of total capital equipment in 1995. France, UK, US: 1995
Sources: France and UK: O'Mahony and de Boer (2002); US: BEA, Fixed Asset Tables, Section 4: Non-Residential Fixed Assets (http://www.bea.gov/bea/dn/faweb/AllFATables.asp#S4)

Table 5: GDP shares of ICT-producing, ICT-using and non-ICT industries, 2000, current prices

	ICT Producing		ICT Using[a]		Non-ICT		
	Manufac-turing	Services	Manufac-turing	Services	Manufac-turing	Services	Other[d]
Austria[b]	1.7%	3.0%	5.6%	22.3%	12.9%	41.2%	13.4%
Denmark	1.1%	3.6%	5.9%	20.6%	10.1%	47.7%	11.0%
Finland	5.6%	4.5%	5.7%	18.4%	13.6%	41.4%	10.8%
France[b]	1.3%	4.0%	5.0%	23.1%	12.2%	44.8%	9.5%
Germany[b]	1.5%	3.9%	7.4%	21.8%	13.4%	43.0%	9.0%
Ireland	7.0%	5.3%	6.2%	25.2%	18.9%	24.8%	12.5%
Italy	1.0%	3.5%	6.6%	26.4%	13.1%	39.0%	10.4%
Netherlands	1.3%	5.1%	4.2%	26.6%	10.7%	39.7%	12.4%
Spain[b]	0.7%	3.6%	4.5%	18.9%	13.1%	44.7%	14.6%
Sweden[c]	2.2%	5.0%	6.0%	18.4%	13.2%	46.2%	9.0%
UK[b]	1.8%	5.2%	5.8%	24.8%	10.5%	41.3%	10.6%
EU	1.5%	4.3%	6.0%	24.1%	12.3%	41.6%	10.3%
Canada[b]	1.9%	5.5%	3.3%	30.7%	14.7%	28.4%	15.6%
Japan[c]	2.9%	3.3%	7.0%	16.2%	11.2%	45.6%	13.8%
Norway	0.6%	2.6%	3.8%	16.2%	5.7%	37.7%	33.5%
Switzerland	2.2%	4.0%	7.2%	32.9%	12.5%	32.0%	9.3%
US	2.3%	5.3%	4.3%	30.1%	9.1%	39.3%	9.6%

a) excluding ICT-producing; b) 1999; c) 1998; d) agriculture, mining, construction and public utilities

Table 6: Labour productivity growth (value added per person engaged) by industry group, 1990-1995 and 1995-2000

	Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden[c]	UK[b]	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
	1990-1995																
Total Economy	2.4	2.0	4.4	1.1	2.3	2.9	1.8	1.1	1.6	2.9	2.5	**2.0**	1.2	0.8	2.9	0.0	**1.2**
ICT Producing Industries	6.7	8.2	8.7	4.5	7.7	10.2	2.5	6.3	4.6	8.7	8.8	**6.9**	3.4	8.3	7.6	2.9	**8.0**
ICT Producing Manufacturing	10.7	9.3	14.1	9.4	8.9	15.5	5.1	12.9	9.8	12.6	15.8	**11.6**	8.8	11.4	10.0	5.1	**14.5**
ICT Producing Services	4.6	7.9	4.8	2.7	6.0	2.2	1.6	2.8	3.1	6.8	5.5	**4.5**	1.2	4.2	7.0	1.5	**4.1**
ICT Using Industries[d]	2.6	1.1	5.4	0.6	1.5	0.7	2.0	0.3	-0.6	3.0	1.6	**1.3**	2.2	0.9	1.4	-1.8	**1.3**
ICT Using Manufacturing	2.9	3.1	5.3	4.2	4.1	6.4	4.1	1.9	2.4	4.4	2.5	**3.5**	1.0	-0.2	1.4	0.4	**0.1**
ICT Using Services	2.0	0.5	5.4	-0.3	0.6	-0.9	1.2	0.0	-1.7	2.5	1.5	**0.7**	2.0	1.5	1.5	-2.4	**1.6**
Non-ICT Industries	2.0	2.0	3.6	1.1	2.2	2.8	1.7	1.1	2.1	2.4	2.4	**2.0**	0.5	0.2	3.2	1.0	**0.4**
Non-ICT Manufacturing	4.6	2.9	6.2	3.3	4.5	7.8	2.7	3.3	3.5	6.2	3.9	**3.6**	2.3	0.4	1.4	4.4	**3.0**
Non-ICT Services	0.2	1.2	2.3	0.1	1.2	-0.1	0.7	0.7	1.3	1.5	1.3	**0.9**	0.0	0.1	1.0	0.2	**-0.3**
Non-ICT Other	4.5	4.1	4.2	2.6	2.7	2.9	3.0	1.5	2.8	2.8	7.2	**3.3**	1.6	0.2	9.9	-0.2	**0.7**
	1995-2000																
Total Economy	1.8	1.6	3.0	1.2	1.4	4.6	0.9	1.1	0.4	2.2	1.5	**1.3**	1.0	0.9	1.4	1.2	**2.4**
ICT Producing Industries	5.5	6.9	18.4	7.4	12.1	16.2	6.6	8.2	5.7	6.3	8.0	**8.7**	4.6	12.6	6.1	-0.3	**9.3**
ICT Producing Manufacturing	16.0	10.0	28.6	10.8	13.1	29.9	8.1	14.1	12.1	10.6	15.1	**14.2**	9.0	20.4	6.7	0.5	**20.3**
ICT Producing Services	-0.4	5.9	7.7	6.1	11.4	-0.2	6.2	5.7	4.1	3.9	5.0	**6.4**	2.9	4.0	6.1	-0.7	**3.7**
ICT Using Industries[d]	1.5	2.1	2.8	0.6	1.4	3.6	0.9	1.6	-0.2	3.3	1.4	**1.2**	0.2	0.7	2.2	1.5	**4.4**
ICT Using Manufacturing	5.1	0.7	2.8	2.4	3.4	10.7	2.0	3.1	2.9	2.1	1.4	**2.6**	1.6	0.8	0.3	4.2	**1.9**
ICT Using Services	0.3	2.5	2.8	0.2	0.8	1.3	0.5	1.3	-1.0	3.6	1.5	**0.8**	-0.1	0.5	2.6	0.9	**4.8**
Non-ICT Industries	1.4	1.0	1.1	1.0	0.6	2.4	0.5	0.2	0.2	1.4	0.8	**0.8**	0.5	0.0	0.9	1.1	**0.3**
Non-ICT Manufacturing	3.8	3.8	2.8	2.7	0.0	10.4	0.8	2.1	-0.4	2.2	0.2	**1.3**	1.4	-0.3	0.5	4.4	**1.3**
Non-ICT Services	-0.4	0.4	0.3	0.4	0.1	-1.5	-0.5	0.0	0.1	1.2	1.6	**0.3**	-0.4	0.4	0.5	0.5	**0.2**
Non-ICT Other	3.7	1.2	2.2	1.2	2.5	0.8	3.1	0.1	0.9	1.1	-1.6	**1.6**	0.9	-1.4	2.4	-1.3	**0.4**

a) 1991-1995 and 1995-1999; b) 1995-99; c) 1995-98; d) excluding ICT-producing industries

Table 7: Impact of Non-ICT and ICT-using Industry Groupings on Productivity Growth

	Productivity Growth (1990-1995)		Difference over non-ICT	Productivity Growth (1995-2000)		Difference over non-ICT
	Non-ICT	ICT-Using	ICT-Using	Non-ICT	ICT-Using	ICT-Using
Austria[b]	2.218	2.199	-0.019	1.079	2.012	0.932
	(1.205)*	(0.718)***	(1.403)	(0.764)	(0.682)***	(1.081)
Canada[b]	0.076	1.976	1.901	0.405	1.627	1.222
	(0.408)	(0.473)***	(0.618)***	(0.412)	(0.424)***	(0.643)*
Denmark	2.058	2.405	0.347	0.915	2.326	1.411
	(0.478)***	(0.734)***	(0.875)	(0.437)**	(0.797)***	(0.861)
Finland	2.427	5.466	3.039	1.195	4.400	3.205
	(0.732)***	(1.538)***	(1.702)*	(0.439)***	(0.973)***	(1.092)***
France[b]	0.765	1.723	0.958	0.732	1.603	0.871
	(0.453)*	(0.592)***	(0.746)	(0.348)**	(0.626)**	(0.693)
Germany[ab]	1.649	2.217	0.567	0.101	2.215	2.114
	(0.781)**	(0.846)***	(1.162)	(0.354)	(0.759)***	(0.838)**
Ireland	0.825	1.591	0.766	0.201	4.190	3.989
	(0.870)	(1.469)	(1.715)	(1.298)	(1.921)**	(2.155)*
Italy	1.528	2.147	0.619	0.570	1.375	0.805
	(0.702)**	(0.717)***	(1.004)	(0.349)	(0.482)***	(0.657)
Japan[c]	-0.518	1.951	2.469	-1.149	2.824	3.973
	(0.424)	(1.030)*	(1.118)**	(0.898)	(1.390)**	(1.685)**
Netherlands	0.959	1.022	0.063	0.737	2.130	1.393
	(0.408)**	(0.546)*	(0.682)	(0.291)**	(0.574)***	(0.645)**
Norway	1.768	3.026	1.258	0.679	2.661	1.982
	(0.667)***	(0.861)***	(1.090)	(0.310)**	(0.446)***	(0.535)***
Spain[b]	1.532	1.123	-0.409	0.270	1.129	0.859
	(0.477)***	(0.494)**	(0.677)	(0.411)	(0.353)***	(0.624)
Sweden[c]	1.836	4.104	2.268	1.375	3.542	2.167
	(0.577)***	(0.756)***	(0.956)**	(0.295)***	(0.674)***	(0.723)***
Switzerland	-1.316	-0.677	0.639	-0.059	0.479	0.538
	(0.899)	(1.316)	(1.595)	(0.495)	(0.523)	(0.551)
UK[b]	2.222	2.929	0.707	1.005	2.163	1.158
	(0.515)***	(0.583)***	(0.772)	(0.439)**	(0.466)***	(0.611)*
EU	1.685	2.278	0.594	0.621	2.047	1.427
	(0.442)***	(0.544)***	(0.701)	(0.213)***	(0.397)***	(0.468)***
US	0.134	2.423	2.290	0.245	5.176	4.930
	(0.376)	(0.555)***	(0.671)***	(0.311)	(0.520)***	(0.715)***

a) 1991-95; b) 1995-99; c) 1995-98

Notes: The dependent variable is yearly productivity growth.

Standard errors, consistent for heteroscedasticity and autocorrelation, are in brackets.

All estimations are done using weighted least squares, where employment is used as weights

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 8: Impact of Non-ICT, ICT-producing and ICT-using Industry Groupings on Productivity Growth

	Productivity Growth (1990-95)			Difference over non-ICT		Productivity Growth (1995-2000)			Difference over non-ICT	
	Non-ICT	ICT-Producing	ICT-Using[d]	ICT-Producing	ICT-Using[d]	Non-ICT	ICT-Producing	ICT-Using[d]	ICT-Producing	ICT-Using[d]
Austria[b]	2.218	6.907	1.599	4.689	-0.619	1.079	4.943	1.632	3.864	0.552
	(1.208)*	(2.266)***	(0.568)***	(2.568)*	(1.337)	(0.766)	(2.896)*	(0.660)**	(3.079)	(1.033)
Canada[b]	0.076	3.612	1.740	3.537	1.665	0.405	4.494	1.165	4.088	0.759
	(0.409)	(1.467)**	(0.482)***	(1.523)**	(0.628)***	(0.413)	(1.437)***	(0.388)***	(1.545)***	(0.588)
Denmark	2.058	7.783	1.593	5.725	-0.465	0.915	7.297	1.596	6.382	0.681
	(0.479)***	(1.866)***	(0.731)**	(1.926)***	(0.873)	(0.438)**	(1.395)***	(0.865)*	(1.507)***	(0.918)
Finland	2.427	7.607	5.068	5.180	2.641	1.195	13.004	2.308	11.809	1.112
	(0.733)***	(2.741)***	(1.800)***	(2.838)*	(1.942)	(0.440)***	(2.285)***	(0.591)***	(2.379)***	(0.712)
France[b]	0.765	4.058	1.383	3.293	0.618	0.732	6.629	0.863	5.897	0.132
	(0.454)*	(1.776)**	(0.607)**	(1.833)*	(0.759)	(0.349)**	(1.026)***	(0.576)	(1.117)***	(0.635)
Germany[ab]	1.649	6.645	1.566	4.996	-0.083	0.101	10.535	1.151	10.434	1.051
	(0.783)**	(2.235)***	(0.789)**	(2.368)**	(1.123)	(0.355)	(1.433)***	(0.637)*	(1.501)***	(0.711)
Ireland	0.825	7.589	0.630	6.764	-0.194	0.201	11.095	2.566	10.894	2.365
	(0.872)	(5.762)	(1.215)	(5.828)	(1.504)	(1.301)	(5.908)*	(1.843)	(6.096)*	(2.006)
Italy	1.528	1.829	2.182	0.301	0.654	0.570	6.408	0.792	5.838	0.222
	(0.703)**	(1.877)	(0.774)***	(2.004)	(1.046)	(0.350)	(1.024)***	(0.440)*	(1.112)***	(0.622)
Japan[c]	-0.518	8.651	0.730	9.169	1.248	-1.149	14.063	0.741	15.211	1.890
	(0.426)	(2.520)***	(0.898)	(2.555)***	(0.998)	(0.901)	(2.933)***	(0.867)	(3.131)***	(1.218)
Netherlands	0.959	6.386	0.354	5.428	-0.604	0.737	8.262	1.289	7.526	0.553
	(0.408)**	(2.441)***	(0.339)	(2.475)**	(0.531)	(0.292)**	(1.555)***	(0.461)***	(1.586)***	(0.553)
Norway	1.768	7.804	2.076	6.035	0.307	0.679	6.063	1.959	5.384	1.280
	(0.668)***	(2.303)***	(0.588)***	(2.398)**	(0.891)	(0.310)**	(1.236)***	(0.494)***	(1.294)***	(0.557)**
Spain[b]	1.532	4.367	0.843	2.835	-0.689	0.270	5.460	0.738	5.190	0.468
	(0.478)***	(1.432)***	(0.527)	(1.510)*	(0.700)	(0.412)	(1.410)***	(0.316)**	(1.480)***	(0.607)
Sweden[c]	1.836	8.288	3.238	6.452	1.402	1.375	6.156	2.974	4.781	1.599
	(0.579)***	(1.823)***	(0.728)***	(1.913)***	(0.936)	(0.297)***	(1.806)***	(0.733)***	(1.830)**	(0.769)**
Switzerland	-1.316	3.087	-1.174	4.403	0.142	-0.059	0.334	0.501	0.393	0.560
	(0.901)	(1.861)*	(1.470)	(2.068)**	(1.725)	(0.496)	(1.065)	(0.608)	(1.226)	(0.591)
UK[b]	2.222	8.051	2.182	5.829	-0.040	1.005	5.954	1.544	4.949	0.539
	(0.516)***	(2.358)***	(0.438)***	(2.413)**	(0.672)	(0.440)**	(1.243)***	(0.432)***	(1.276)***	(0.610)
EU	1.685	6.491	1.695	4.806	0.011	0.621	7.908	1.246	7.287	0.625
	(0.442)***	(1.973)***	(0.433)***	(2.022)**	(0.619)	(0.214)***	(1.049)***	(0.230)***	(1.111)***	(0.314)**
US	0.134	7.137	1.788	7.003	1.654	0.245	7.513	4.825	7.268	4.580
	(0.377)	(2.491)***	(0.521)***	(2.519)***	(0.644)**	(0.311)	(1.554)***	(0.558)***	(1.626)***	(0.742)***

a) 1991-95; b) 1995-99; c) 1995-98; d) excluding ICT-producing

Notes: The dependent variable is yearly productivity growth. Standard errors, consistent for heteroscedasticity and autocorrelation, are in brackets.
All estimations are done using weighted least squares, where employment is used as weights

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 9: Impact of Non-ICT Services, ICT-using Manufacturing, ICT-using Services and other non-ICT on Productivity Growth

	Productivity Growth (1990-1995)				Difference over non-ICT Services			Productivity Growth (1995-2000)				Difference over non-ICT Services		
	Non-ICT Services	ICT-using Manufct.	ICT-using Services	Other non-ICT	ICT-using Manufct.	ICT-using Services	Other non-ICT	Non-ICT Services	ICT-using Manufct.	ICT-using Services	Other non-ICT	ICT-using Manufct.	ICT-using Services	Other non-ICT
Austria[b]	-0.055	3.519	1.700	4.537	3.574	1.755	4.592	-0.633	6.228	0.646	3.059	6.861	1.279	3.692
	(0.549)	(1.605)**	(0.676)**	(1.739)***	(1.696)**	(0.871)**	(1.824)**	(0.861)	(1.520)***	(0.729)	(0.870)***	(1.808)***	(1.056)	(1.238)***
Canada[b]	-0.327	3.980	1.731	0.825	4.306	2.058	1.151	-0.178	2.616	1.512	1.475	2.794	1.691	1.654
	(0.486)	(1.795)**	(0.463)***	(0.731)	(1.860)**	(0.665)***	(0.878)	(0.395)	(1.809)	(0.396)***	(0.713)**	(1.910)	(0.537)***	(0.817)**
Denmark	1.658	3.568	1.975	2.983	1.910	0.317	1.325	0.495	1.637	2.561	1.972	1.142	2.066	1.477
	(0.310)***	(1.591)**	(0.842)**	(1.329)**	(1.621)	(0.898)	(1.364)	(0.399)	(1.643)	(0.914)***	(1.082)*	(1.695)	(0.981)**	(1.146)
Finland	1.272	5.498	5.452	4.311	4.226	4.180	3.039	0.386	6.667	3.304	2.683	6.281	2.918	2.297
	(0.647)**	(2.075)***	(2.039)***	(1.050)***	(2.174)*	(2.136)*	(1.236)**	(0.307)	(2.147)***	(0.724)***	(0.938)***	(2.203)***	(0.807)***	(1.033)**
France[b]	-0.221	4.316	0.951	2.647	4.538	1.172	2.868	0.329	3.484	1.102	1.624	3.155	0.773	1.295
	(0.554)	(1.185)***	(0.617)	(0.653)***	(1.308)***	(0.829)	(0.854)***	(0.292)	(1.147)***	(0.650)*	(0.912)*	(1.168)***	(0.676)	(0.984)
Germany[ab]	0.348	4.344	1.239	3.567	3.996	0.891	3.219	-0.545	4.144	1.485	1.200	4.688	2.030	1.745
	(0.850)	(1.156)***	(0.884)	(1.646)**	(1.434)***	(1.223)	(1.838)*	(0.309)*	(1.534)***	(0.713)**	(0.721)*	(1.554)***	(0.751)***	(0.776)**
Ireland	-1.038	6.092	-0.063	2.777	7.130	0.975	3.815	-0.666	11.488	1.693	1.294	12.154	2.359	1.959
	(0.789)	(3.534)*	(1.101)	(1.099)**	(3.620)**	(1.355)	(1.353)***	(1.795)	(4.535)**	(1.870)	(1.702)	(4.747)**	(2.175)	(2.448)
Italy	0.547	4.292	1.207	2.931	3.745	0.660	2.384	-0.245	2.286	1.011	1.868	2.532	1.256	2.113
	(0.702)	(1.172)***	(0.698)*	(1.222)**	(1.366)***	(0.991)	(1.409)*	(0.294)	(0.854)***	(0.506)**	(0.602)***	(0.916)***	(0.595)**	(0.682)***
Japan[c]	-0.461	1.748	2.113	-0.599	2.209	2.574	-0.138	-0.595	5.457	0.947	-1.986	6.052	1.542	-1.391
	(0.587)	(2.160)	(0.698)***	(0.634)	(2.238)	(0.912)***	(0.865)	(1.040)	(2.463)**	(1.109)	(1.162)*	(2.815)**	(1.533)	(1.283)
Netherlands	0.629	3.930	0.291	1.718	3.301	-0.337	1.090	0.447	5.160	1.496	1.494	4.713	1.049	1.047
	(0.369)*	(1.722)**	(0.362)	(1.054)	(1.761)*	(0.515)	(1.117)	(0.257)*	(1.316)***	(0.547)***	(0.737)**	(1.335)***	(0.593)*	(0.800)
Norway	0.932	2.094	3.421	4.192	1.163	2.490	3.260	0.739	0.772	3.459	0.491	0.033	2.720	-0.248
	(0.597)	(0.995)**	(1.096)***	(1.065)***	(1.160)	(1.249)**	(1.224)***	(0.357)**	(0.997)	(0.543)***	(0.741)	(1.057)	(0.612)***	(0.844)
Spain[b]	0.774	2.661	0.699	2.516	1.887	-0.076	1.742	0.050	2.217	0.828	0.573	2.167	0.778	0.523
	(0.471)	(1.079)**	(0.601)	(0.806)***	(1.178)	(0.765)	(0.933)*	(0.194)	(0.569)***	(0.394)**	(0.911)	(0.611)***	(0.494)	(0.915)
Sweden[c]	1.020	6.112	3.285	4.000	5.092	2.265	2.980	1.346	4.035	3.345	1.456	2.689	1.999	0.110
	(0.298)***	(1.724)***	(0.791)***	(0.829)***	(1.750)***	(0.848)***	(0.883)***	(0.318)***	(1.900)**	(0.607)***	(0.799)*	(1.935)	(0.736)***	(0.898)
Switzerland	-2.567	1.095	-1.262	0.528	3.662	1.305	3.095	-0.142	3.646	-0.456	0.079	3.789	-0.314	0.222
	(1.213)**	(1.208)	(1.713)	(1.276)	(1.712)**	(2.100)	(1.762)*	(0.608)	(1.164)***	(0.540)	(0.917)	(1.316)***	(0.699)	(1.133)
UK[b]	1.536	4.182	2.563	4.076	2.646	1.027	2.540	1.658	2.387	2.102	-0.905	0.730	0.444	-2.562
	(0.632)**	(1.658)**	(0.548)***	(0.711)***	(1.775)	(0.827)	(0.946)***	(0.434)***	(0.988)**	(0.532)***	(0.998)	(1.101)	(0.702)	(1.148)**
EU	0.659	4.327	1.492	3.317	3.668	0.833	2.658	0.153	3.722	1.504	1.481	3.569	1.351	1.328
	(0.396)*	(1.097)***	(0.492)***	(0.800)***	(1.166)***	(0.631)	(0.892)***	(0.161)	(0.873)***	(0.321)***	(0.430)***	(0.892)***	(0.361)***	(0.464)***
US	-0.335	3.091	2.259	1.536	3.426	2.595	1.871	-0.163	4.857	5.246	1.511	5.020	5.409	1.674
	(0.385)	(1.940)	(0.511)***	(0.730)**	(1.978)*	(0.641)***	(0.825)**	(0.385)	(1.559)***	(0.571)***	(0.528)***	(1.621)***	(0.785)***	(0.710)**

a) 1991-95; b) 1995-99; c) 1995-98

Notes: The dependent variable is yearly productivity growth. Standard errors, consistent for heteroscedasticity and autocorrelation, are in brackets.

All estimations are done using weighted least squares, where employment is used as weights

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 10: Impact of Non-ICT Services, ICT-using Manufacturing, ICT-using Services and other non-ICT Productivity Acceleration

	Productivity Acceleration (1995-2000 over 1990-1995)				Difference over Productivity Acceleration in non-ICT Services		
	Non-ICT Services	ICT-using Manufct.	ICT-using Services	Other non-ICT	ICT-using Manufct.	ICT-using Services	Other non-ICT
Austria[b]	-0.578	2.708	-1.054	-1.479	3.287	-0.475	-0.901
	(1.136)	(2.074)	(1.149)	(1.563)	(2.364)	(1.594)	(1.931)
Canada[b]	0.148	-1.364	-0.219	0.651	-1.512	-0.367	0.502
	(0.499)	(3.910)	(0.620)	(0.903)	(3.942)	(0.771)	(1.032)
Denmark	-1.163	-1.932	0.585	-1.011	-0.769	1.749	0.152
	(0.510)**	(2.349)	(1.329)	(1.544)	(2.403)	(1.417)	(1.631)
Finland	-0.886	1.169	-2.148	-1.628	2.055	-1.261	-0.742
	(0.647)	(4.584)	(2.481)	(1.232)	(4.629)	(2.593)	(1.287)
France[b]	0.550	-0.833	0.151	-1.023	-1.383	-0.400	-1.573
	(0.539)	(2.132)	(0.933)	(1.181)	(2.199)	(1.084)	(1.318)
Germany[a]	-0.893	-0.201	0.246	-2.367	0.692	1.139	-1.473
	(0.855)	(2.361)	(1.248)	(1.681)	(2.511)	(1.566)	(1.870)
Ireland	0.372	5.398	1.755	-1.483	5.026	1.383	-1.855
	(1.097)	(6.448)	(1.960)	(1.801)	(6.541)	(2.194)	(2.120)
Italy	-0.792	-2.006	-0.196	-1.063	-1.213	0.596	-0.271
	(0.831)	(1.773)	(1.003)	(1.309)	(1.958)	(1.304)	(1.536)
Japan[c]	-0.134	3.708	-1.167	-1.387	3.842	-1.032	-1.253
	(0.808)	(3.045)	(0.747)	(0.951)	(3.150)	(1.100)	(1.239)
Netherlands	-0.181	1.231	1.205	-0.224	1.412	1.386	-0.043
	(0.552)	(2.422)	(0.725)*	(1.066)	(2.484)	(0.913)	(1.203)
Norway	-0.192	-1.323	0.038	-3.701	-1.131	0.230	-3.509
	(0.514)	(1.658)	(1.390)	(1.145)***	(1.735)	(1.491)	(1.181)***
Spain[b]	-0.724	-0.445	0.129	-1.943	0.280	0.854	-1.218
	(0.528)	(1.153)	(0.679)	(1.484)	(1.268)	(0.850)	(1.585)
Sweden[c]	0.326	-2.077	0.060	-2.544	-2.403	-0.265	-2.869
	(0.478)	(2.244)	(0.804)	(1.061)**	(2.294)	(0.937)	(1.154)**
Switzerland	2.425	2.551	0.806	-0.448	0.126	-1.619	-2.873
	(1.217)**	(2.251)	(1.800)	(1.476)	(2.559)	(2.174)	(1.905)
UK[b]	0.122	-1.795	-0.462	-4.981	-1.916	-0.584	-5.103
	(0.932)	(2.292)	(0.863)	(1.142)***	(2.474)	(1.277)	(1.519)***
EU	-0.506	-0.606	0.011	-1.837	-0.099	0.518	-1.330
	(0.405)	(1.898)	(0.686)	(0.737)**	(1.941)	(0.813)	(0.849)
US	0.172	1.766	2.986	-0.025	1.593	2.814	-0.197
	(0.449)	(2.678)	(0.956)***	(1.349)	(2.716)	(1.055)***	(1.418)

a) 1991-95; b) 1995-99; c) 1995-98

Notes: The dependent variable is yearly productivity growth.

Standard errors, consistent for heteroscedasticity and autocorrelation, are in brackets.

All estimations are done using weighted least squares, where employment is used as weights

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 11: Labor Productivity Growth and Productivity Differential for EU and US, 1990-1995 and 1995-2000

ISIC		1990-1995			1995-2000			Acceleration		
Rev3		EU[a]	U.S.	U.S.-EU	EU[a]	U.S.	U.S.-EU	EU[a]	U.S.	U.S.-EU
	Total Economy	**2.0**	**1.2**	**-0.9**	**1.3**	**2.4**	**1.1**	**-0.7**	**1.3**	**1.9**
	ICT Producing Industries	**6.9**	**8.0**	**1.1**	**8.7**	**9.3**	**0.6**	**1.8**	**1.3**	**-0.5**
	Manufacturing	**11.6**	**14.5**	**2.9**	**14.2**	**20.3**	**6.1**	**2.6**	**5.8**	**3.2**
30	Office and Comp. Eq.	29.6	27.0	-2.6	40.9	47.5	6.6	11.3	20.5	9.2
32	Radio, TV and Comm. Eq.	15.7	18.4	2.7	24.3	23.4	-0.9	8.6	5.0	-3.6
313	Fiber optics	6.0	5.6	-0.4	2.9	5.1	2.2	-3.1	-0.5	2.6
331	Instruments	-1.3	-2.1	-0.7	-9.5	-7.8	1.7	-8.2	-5.7	2.5
	Services	**4.5**	**4.1**	**-0.4**	**6.4**	**3.7**	**-2.7**	**1.9**	**-0.5**	**-2.3**
64	Telecommunications	5.8	4.5	-1.2	9.4	8.0	-1.3	3.6	3.5	-0.1
72	Computer services	1.7	3.4	1.7	2.2	-2.2	-4.4	0.4	-5.6	-6.1
	ICT Using Industries[a]	**1.3**	**1.3**	**-0.1**	**1.2**	**4.4**	**3.2**	**-0.2**	**3.1**	**3.3**
	Manufacturing	**3.5**	**0.1**	**-3.4**	**2.6**	**1.9**	**-0.8**	**-0.9**	**1.7**	**2.6**
33-33.1	Watches & instruments	4.2	0.6	-3.5	-0.1	5.0	5.1	-4.3	4.4	8.7
351	Ships	4.7	-3.6	-8.3	4.9	-1.5	-6.4	0.1	2.1	1.9
31-31.3	Electrical machinery	7.1	6.1	-1.0	7.4	9.9	2.5	0.3	3.8	3.6
18	Apparel	4.4	3.4	-0.9	0.9	3.8	2.9	-3.5	0.3	3.8
353	Aircraft	1.1	0.0	-1.2	4.1	2.3	-1.8	3.0	2.3	-0.7
36-37	Misc. manufacturing	0.6	1.3	0.7	2.0	2.4	0.4	1.4	1.0	-0.3
29	Machinery	3.6	1.0	-2.7	0.6	0.3	-0.2	-3.1	-0.6	2.4
22	Printing & Publishing	2.0	-2.6	-4.6	2.6	-0.2	-2.8	0.6	2.4	1.9
352+359	Railroad and other	2.5	-1.8	-4.3	4.2	-0.2	-4.4	1.7	1.6	-0.2
	Services	**0.7**	**1.6**	**0.9**	**0.8**	**4.8**	**3.9**	**0.2**	**3.2**	**3.1**
67	Securities trade	0.8	3.2	2.4	0.7	15.3	14.6	-0.1	12.1	12.2
51	Wholesale trade	2.9	3.4	0.5	0.8	6.1	5.3	-2.1	2.7	4.7
52	Retail trade	1.1	2.5	1.4	0.9	6.7	5.8	-0.1	4.2	4.4
73	R&D	-0.1	-0.4	-0.4	-1.0	3.8	4.8	-0.9	4.2	5.2
71	Renting of machinery	2.9	0.8	-2.1	0.9	3.4	2.5	-2.0	2.6	4.6
65	Banks	0.5	1.3	0.8	3.8	2.8	-0.9	3.3	1.5	-1.7
741-743	Professional services	-0.5	-0.5	0.0	-0.1	1.7	1.8	0.4	2.2	1.7
66	Insurance	0.1	3.0	2.9	-0.8	-1.0	-0.1	-0.9	-4.0	-3.0
	Non-ICT Industries	**2.0**	**0.4**	**-1.6**	**0.8**	**0.3**	**-0.4**	**-1.2**	**0.0**	**1.2**
	Manufacturing	**3.6**	**3.0**	**-0.6**	**1.3**	**1.3**	**0.0**	**-2.3**	**-1.7**	**0.6**
24	Chemicals	6.7	3.4	-3.3	4.0	4.4	0.4	-2.7	1.0	3.8
25	Rubber & plastics	3.0	4.6	1.6	1.6	4.1	2.5	-1.3	-0.5	0.8
17	Textiles	2.6	3.0	0.4	0.8	3.3	2.5	-1.8	0.3	2.1
27	Basic metals	6.9	3.9	-3.0	2.2	3.1	0.9	-4.7	-0.8	3.9
26	Stone, clay & glass	3.0	2.8	-0.3	1.1	2.6	1.5	-1.9	-0.2	1.8
23	Petroleum & coal	6.7	5.0	-1.7	0.9	1.5	0.6	-5.8	-3.5	2.3
34	Motor vehicles	2.5	4.9	2.4	0.8	1.4	0.6	-1.7	-3.5	-1.8
19	Leather	3.3	4.9	1.7	-0.1	1.3	1.4	-3.3	-3.6	-0.3
28	Fabricated metals	2.1	3.2	1.1	0.1	0.6	0.5	-2.0	-2.6	-0.6
20	Wood	3.0	-2.8	-5.7	2.4	0.3	-2.2	-0.5	3.1	3.6
21	Paper	3.4	0.0	-3.4	2.2	0.2	-2.0	-1.2	0.2	1.4
15-16	Food & beverages	2.8	3.5	0.7	0.2	-4.5	-4.7	-2.6	-8.0	-5.4
	Services	**0.9**	**-0.3**	**-1.2**	**0.3**	**0.2**	**-0.1**	**-0.6**	**0.5**	**1.1**
70	Real estate	0.0	1.6	1.6	-0.8	1.7	2.5	-0.8	0.1	0.9
60-63	Transportation	3.4	2.1	-1.3	1.8	1.6	-0.2	-1.5	-0.4	1.1
95	Private households		2.2			0.7			-1.5	
74.9	Other business services	-1.1	-1.7	-0.6	-1.1	0.2	1.2	0.0	1.9	1.8
75	Government	1.3	0.0	-1.4	0.9	0.2	-0.6	-0.5	0.3	0.8
85	Health	1.1	-2.2	-3.3	0.5	-0.3	-0.8	-0.6	1.9	2.5
55	Hotels & restaurants	-1.8	-0.2	1.6	-1.0	-0.6	0.4	0.8	-0.4	-1.2
50	Repairs	0.3	0.8	0.5	0.1	-1.2	-1.3	-0.2	-2.0	-1.8
80	Education	0.8	-0.2	-1.0	0.0	-1.2	-1.2	-0.8	-1.0	-0.2
90-93	Personal & social serv.	-0.4	0.5	0.9	-0.6	-2.3	-1.7	-0.2	-2.8	-2.6
	Other non-ICT industries	**3.3**	**0.7**	**-2.6**	**1.6**	**0.4**	**-1.2**	**-1.7**	**-0.3**	**1.4**
01-05	Agriculture	5.5	-1.0	-6.5	4.1	6.3	2.1	-1.4	7.3	8.7
40-41	Utilities	4.0	2.5	-1.5	0.2	2.3	2.0	-3.8	-0.2	3.5
45	Construction	0.2	0.5	0.3	0.4	0.2	-0.2	0.2	-0.3	-0.5
10-14	Mining	14.1	5.4	-8.8	4.9	-1.8	-6.7	-9.2	-7.2	2.0

Note: EU includes Austria, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden and the United Kingdom. See Appendix B for notes on data and methods

Table 12: Correlation between EU and US Productivity Growth by Industry

	Spearman Rank Correlations (1)	Pearson Correlations on Productivity Growth (2)	Pearson Correlations on Industry Contributions to Aggregate Productivity Growth (3)
All industries			
EU and US (1995-2000)	0.425**	0.903**	0.582**
EU and US Acceleration 1995-2000/1990-95	0.453**	0.647**	0.179
EU (1995-2000) and US (1990-95)	0.298**	0.853**	0.391**
All industries (except 30 & 32)			
EU and US (1995-2000)	0.346**	0.481**	0.497**
EU and US Acceleration 1995-2000/1990-95	0.379**	0.443**	0.111
EU (1995-2000) over US (1990-95)	0.203	0.260*	0.388**
Service industries			
EU and US (1995-2000)	0.363	0.395	0.374
EU and US Acceleration 1995-2000/1990-95	-0.012	0.075	0.191
EU (1995-2000) over US (1990-95)	0.600**	0.556**	0.181

Notes: Stars denote significance: * 10%, ** 5%

Figure 1: Contribution of industry groups to labor productivity growth

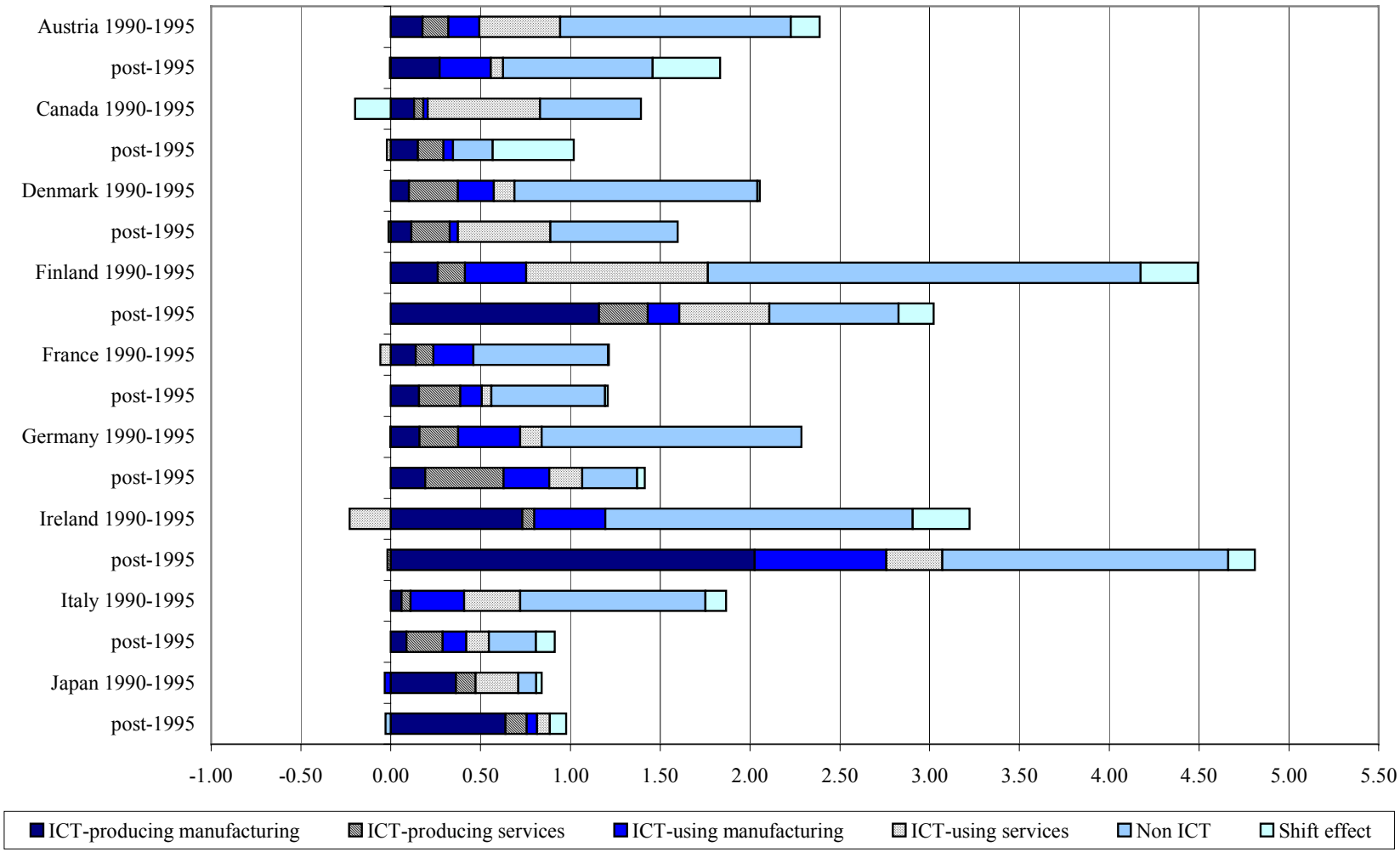


Figure 1: Contribution of industry groups to labor productivity growth

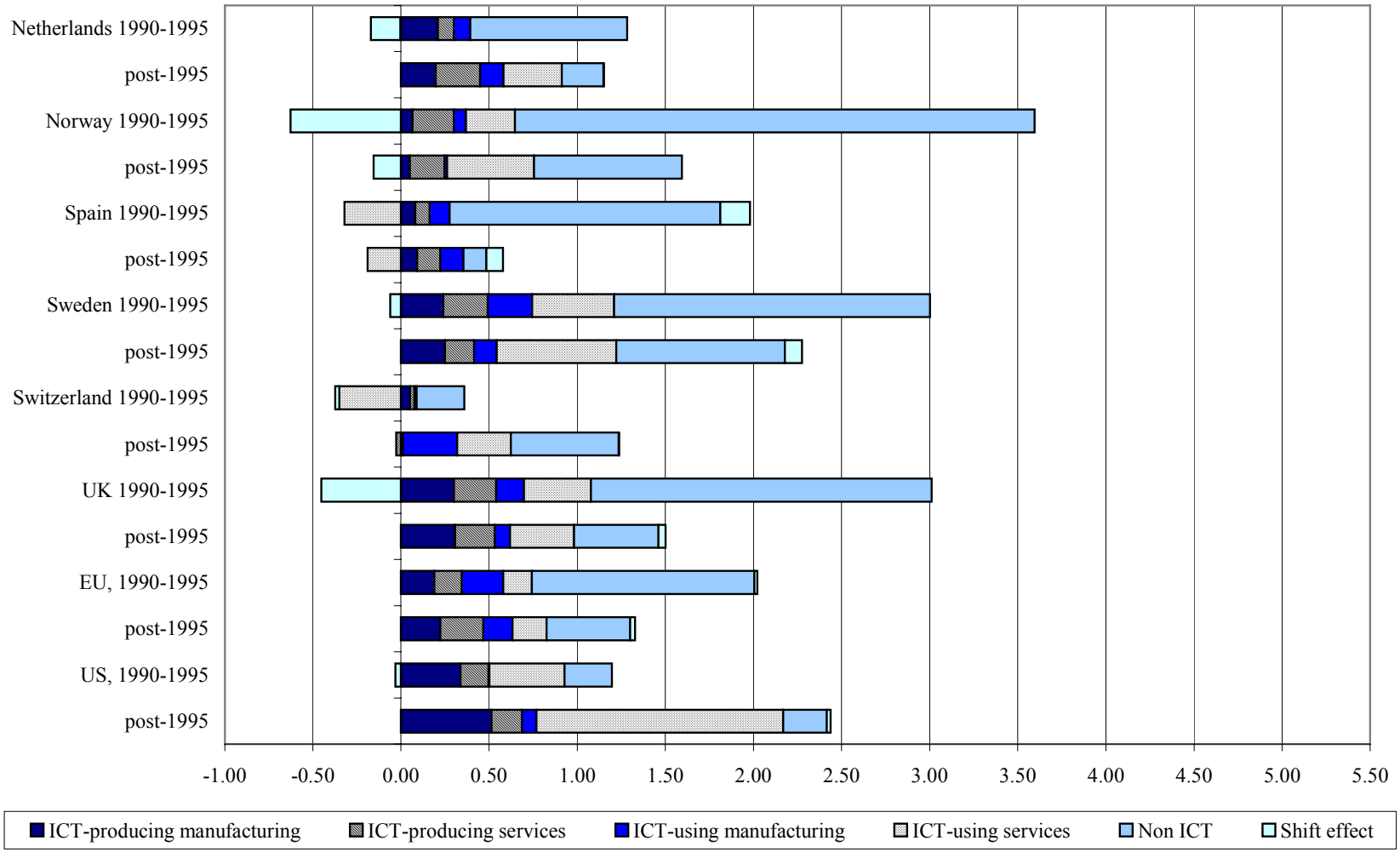
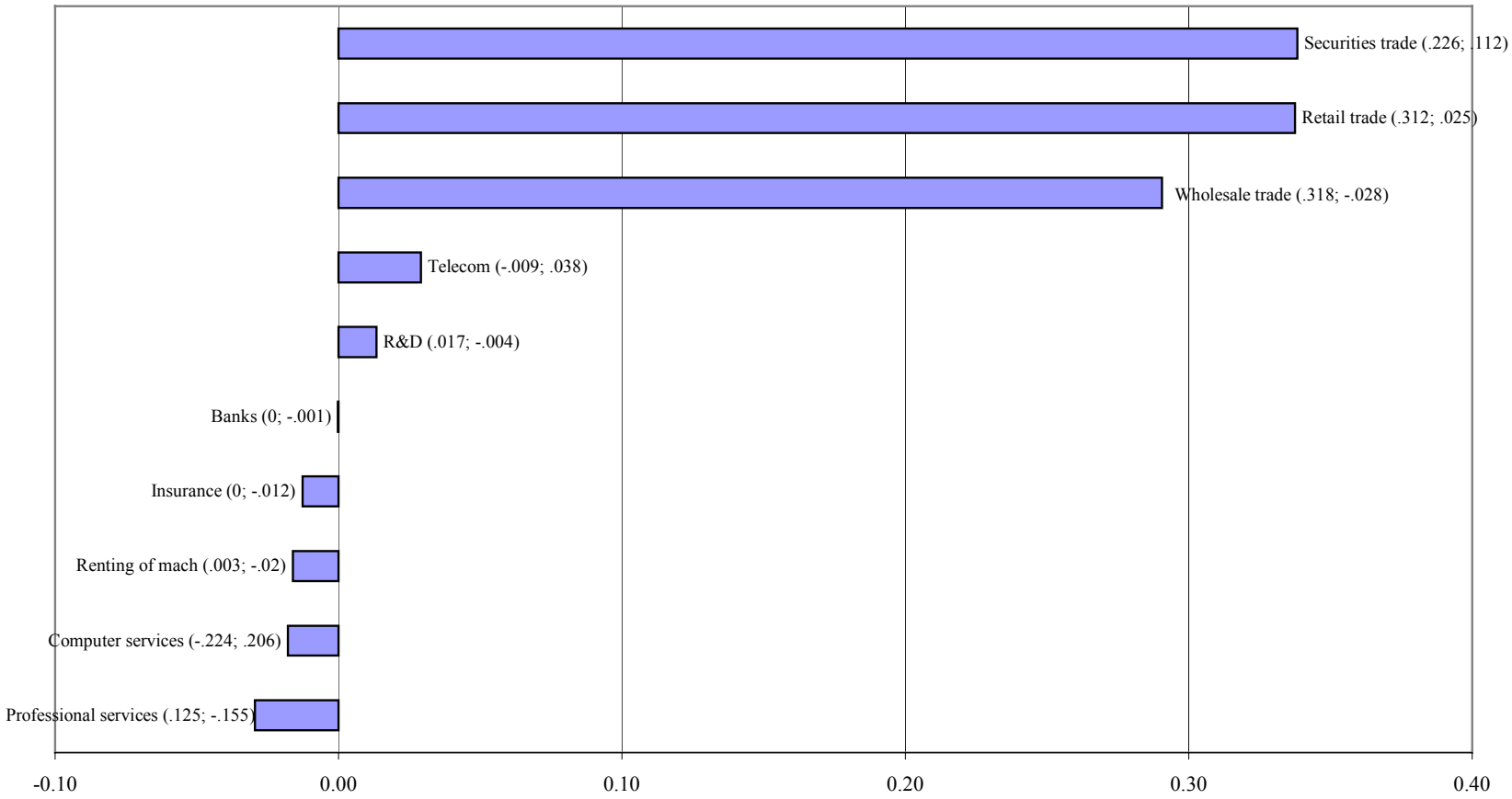
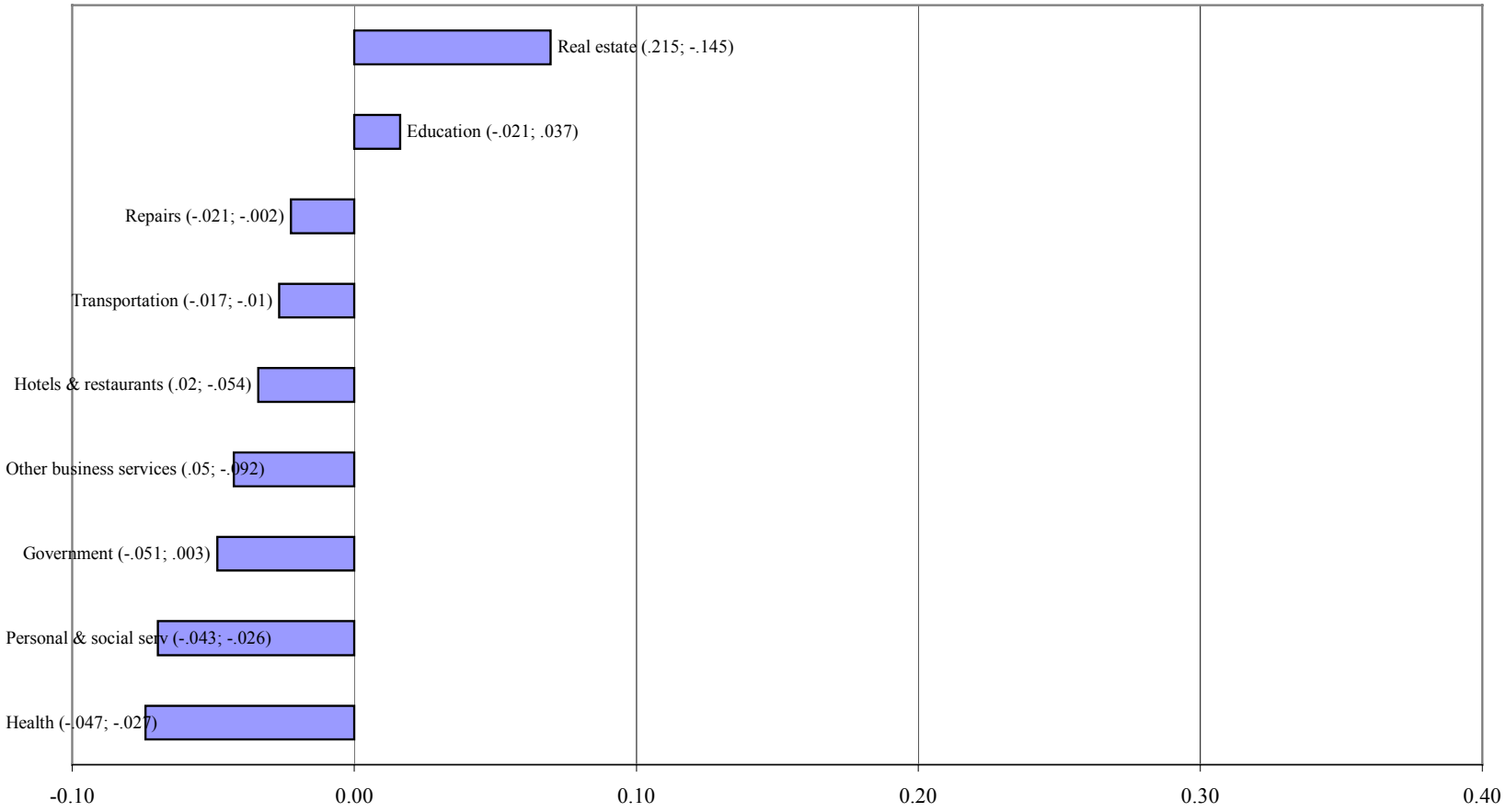


Figure 2a: Contribution of ICT services to US-EU Productivity Differential, 1995-2000



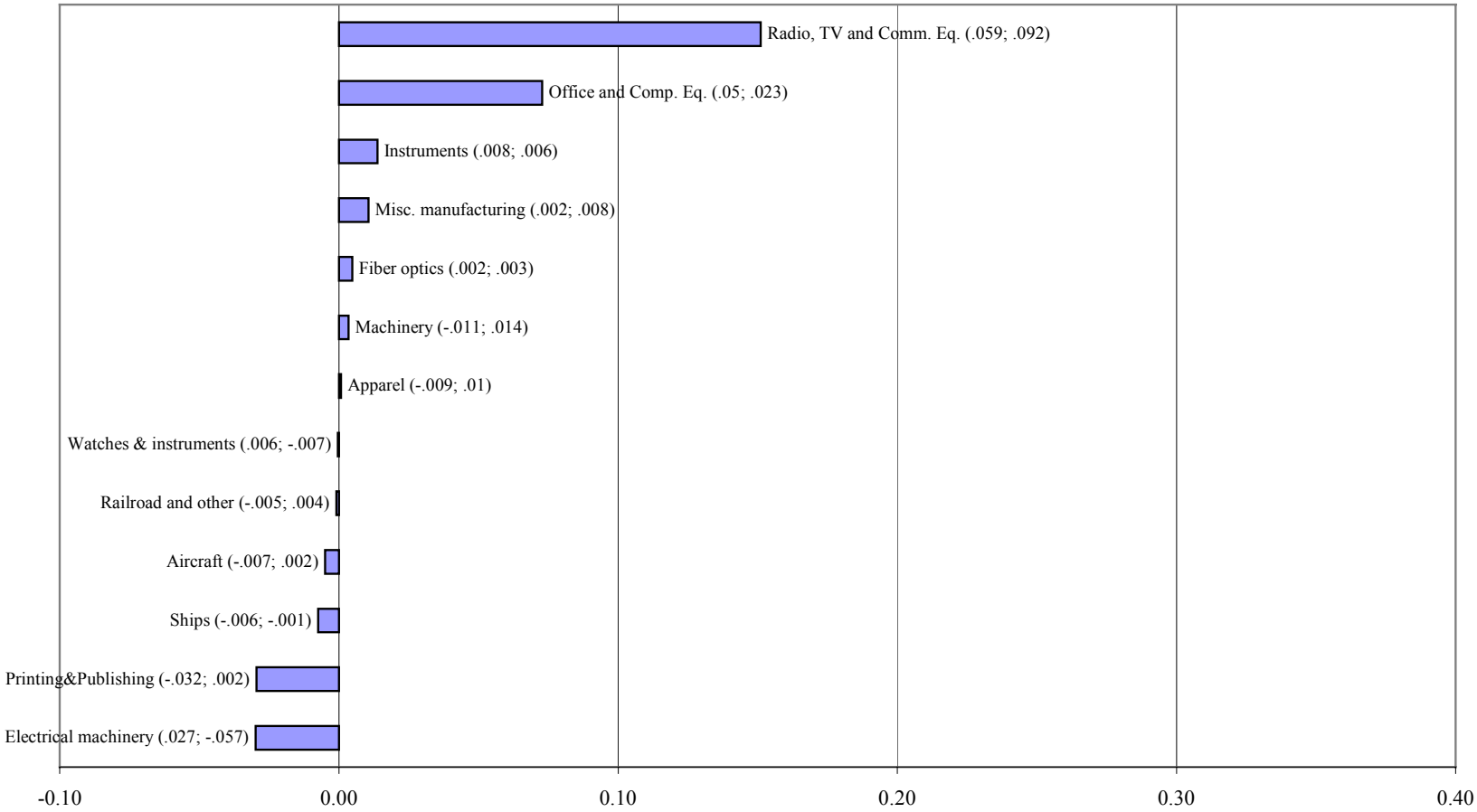
Note: first figure between brackets is differential due to slower (-) or faster (+) productivity growth in US than in EU; second figure better (+) or worse (-) structural developments in US than in EU

Figure 2b: Contribution of non-ICT services to US-EU Productivity Differential, 1995-2000



Note: first figure between brackets is differential due to slower (-) or faster (+) productivity growth in US than in EU; second figure better (+) or worse (-) structural developments in US than in EU

Figure 2c: Contribution of ICT-using manufacturing to US-EU Productivity Differential, 1995-2000



Note: first figure between brackets is differential due to slower (-) or faster (+) productivity growth in US than in EU; second figure better (+) or worse (-) structural developments in US than in EU

Appendix Table A1: ICT Industry Grouping on basis of ISIC Rev. 3
(1=ICT-producing or ICT-using ; 0=non-ICT)

ISIC	Industry	Stiroh (2001)	Our
01-05	AGRICULTURE, HUNTING, FORESTRY AND FISHING	0	0
10-14	MINING AND QUARRYING	0	0
15-16	FOOD PRODUCTS, BEVERAGES AND TOBACCO	0/1	0
17	TEXTILES	0	0
18	WEARING APPAREL, DRESSING AND DYING OF FUR	1	1
19	LEATHER, LEATHER PRODUCTS AND FOOTWEAR	0	0
20	WOOD AND PRODUCTS OF WOOD AND CORK	0	0
21	PULP, PAPER, PAPER PRODUCTS	0	0
22	PRINTING & PUBLISHING	1	1
23	COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	0	0
24	CHEMICALS AND CHEMICAL PRODUCTS	0	0
25	RUBBER AND PLASTICS PRODUCTS	0	0
26	OTHER NON-METALLIC MINERAL PRODUCTS	0	0
27	BASIC METALS	0	0
28	FABRICATED METAL PRODUCTS, except machinery and equipment	0	0
29	MACHINERY AND EQUIPMENT, NEC	1	1
30	OFFICE, ACCOUNTING AND COMPUTING MACHINERY	1	1
31	ELECTRICAL MACHINERY AND APPARATUS, NEC	1	1
313	Fiber optics	1	1
31-313	Electrical machinery and apparatus, excl. fiber optics	1	1
32	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	1	1
33	MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	1	1
331	Medical, measuring and industrial control instruments	1	1
33-331	Medical, precision and optical instruments excl. other instruments	1	1
34	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	0	0
35	OTHER TRANSPORT EQUIPMENT	1	1
351	Building and repairing of ships and boats	1	1
353	Aircraft and spacecraft	1	1
352+359	Railroad equipment and other transport equipment, nec	1	1
36-37	MANUFACTURING NEC; RECYCLING	1	1
40-41	ELECTRICITY, GAS AND WATER SUPPLY	0	0
45	CONSTRUCTION	0	0
50	REPAIRS	0/1	0
51	WHOLESALE TRADE	1	1
52	RETAIL TRADE	1	1
55	HOTELS AND RESTAURANTS	0	0
60-63	TRANSPORT AND STORAGE	0/1	0
64	POST AND TELECOMMUNICATIONS	1	1
65	FINANCIAL INTERMEDIATION except insurance and pension funding	1	1
66	INSURANCE AND PENSION FUNDING, except compulsory social security	1	1
67	ACTIVITIES RELATED TO FINANCIAL INTERMEDIATION	1	1
70	REAL ESTATE ACTIVITIES	0	0
71	RENTING OF MACHINERY AND EQUIPMENT	1	1
72	COMPUTER AND RELATED ACTIVITIES	1	1
73	RESEARCH AND DEVELOPMENT	1	1
74	OTHER BUSINESS ACTIVITIES	1	0/1
741-743	Professional Service	1	1
749	Other business activities, excl. professional	1	0
75	PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY	na	0
80	EDUCATION	1	0
85	HEALTH AND SOCIAL WORK	1	0
90-93	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	na/0/1	0
95	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	0	0
99	EXTRA-TERRITORIAL ORGANIZATIONS AND BODIES	0	0

Notes: "na" means that Stiroh (2001) did not classify this industry due to a lack of investment data by type. "0/1" means that part of this ISIC industry was classified by Stiroh (2001) as non-ICT, but another part as ICT intensive in Stiroh (2001). "na/0/1" is analogous and also includes not classified industries.

Appendix Table A.2: IT investment as a % of total investment by industry

		IT investment as a % of total investment				
		US	France	Germany	Netherlands	UK
	ISIC rev.3	1993-1997	1993-1997	1991-1994	1990-1995	1993-1997
AGRICULTURE, HUNTING, FORESTRY AND FISHING	01-05	0.5%	0.2%	0.2%	0.6%	0.4%
MINING AND QUARRYING	10-14	1.4%		1.6%		0.1%
FOOD PRODUCTS, BEVERAGES AND TOBACCO	15-16	3.1%	1.6%	3.0%	3.1%	5.2%
TEXTILES, APPAREL AND LEATHER	17-19	6.1%		6.7%	5.2%	11.0%
TEXTILES AND APPAREL	17-18	6.1%	9.9%	6.6%		9.6%
TEXTILES	17	4.7%		6.3%		
WEARING APPAREL, DRESSING AND DYING OF FUR	18	14.5%		7.8%		
LEATHER, LEATHER PRODUCTS AND FOOTWEAR	19	6.5%		8.1%		25.6%
WOOD AND PRODUCTS OF WOOD AND CORK	20	3.0%	6.4%	2.8%	3.3%	6.1%
PAPER, PRINTING & PUBLISHING	21-22	7.3%		4.9%	6.8%	11.7%
PULP, PAPER AND PAPER PRODUCTS	21	2.1%		6.7%	3.9%	
PRINTING AND PUBLISHING	22	13.3%		4.1%	8.1%	
CHEMICAL, RUBBER, PLASTICS AND FUEL PRODUCTS	23-25	3.3%	1.7%	3.0%	4.9%	5.6%
COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FU	23	1.2%		1.7%	10.5%	0.5%
CHEMICALS AND CHEMICAL PRODUCTS	24	3.8%		2.5%	4.5%	8.3%
RUBBER AND PLASTICS PRODUCTS	25	3.0%		5.0%	2.7%	7.1%
OTHER NON-METALLIC MINERAL PRODUCTS	26	3.0%		2.0%		6.2%
BASIC METALS AND FABRICATED METAL PRODUCTS	27-28	3.8%	2.5%	6.3%	6.4%	6.1%
BASIC METALS	27	2.4%		3.8%	10.8%	
FABRICATED METAL PRODUCTS, except machinery and equipme	28	5.1%		8.3%	4.6%	
MACHINERY AND EQUIPMENT AND OFFICE AND COMP EQ	29	15.8% [a]		7.1%	9.8%	16.2%
ELECTRICAL AND OPTICAL EQUIPMENT	30-33	9.6%	2.0%	10.2%	6.9%	15.4%
ELECTRICAL MACHINERY AND RADIO, TV AND COMM EQ	31-32	7.0%				
MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	33	12.2%				
TRANSPORT EQUIPMENT	34-35	3.9%	2.1%	6.3%	4.0%	5.8%
MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	34	2.0%		6.4%		
OTHER TRANSPORT EQUIPMENT	35	9.1%		5.8%		
BUILDING AND REPAIRING OF SHIPS AND BOATS	351			2.0%		
AIRCRAFT AND SPACECRAFT	353			9.7%		
RAILROAD EQUIPMENT AND TRANSPORT EQUIPMENT	352+359			5.5%		
MANUFACTURING NEC; RECYCLING	36-37	5.8%		7.4%		6.8%
ELECTRICITY, GAS AND WATER SUPPLY	40-41	1.9%	5.1%	0.4%	1.6%	4.2%
CONSTRUCTION	45	3.4%	1.7%	2.1%	5.8%	5.1%
WHOLESALE AND RETAIL TRADE; REPAIRS	50-52	9.8%	1.8%	10.8%	6.0%	10.0%
REPAIRS	50	1.3%			4.0%	
WHOLESESALE TRADE	51	15.6%			11.0%	
RETAIL TRADE	52	5.3%			4.0%	
HOTELS AND RESTAURANTS	55	1.9%	1.9%	1.4%	2.3%	0.5%
TRANSPORT AND TELECOMMUNICATIONS	60-64	2.6%	2.3%	0.8%	2.4%	11.6%
TRANSPORT AND STORAGE	60-63	2.0%		0.9%		
POST AND TELECOMMUNICATIONS	64	2.7%		0.6%		
FINANCIAL INTERMEDIATION	65-67	13.6%	21.5%	13.1%	20.2%	20.3%
FINANCIAL INTERMEDIATION except insurance and pension fund	65	14.5%		15.0%	26.7%	
INSURANCE AND PENSION FUNDING, except compulsory social	66	12.4%		7.9%	12.5%	
ACTIVITIES RELATED TO FINANCIAL INTERMEDIATION	67	3.2%		14.0%	10.9%	
REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	70-74	8.6%	0.6%	2.1%	10.4%	16.7%
REAL ESTATE ACTIVITIES	70	4.0%	0.0% [b]	0.0%	0.2%	0.0% [b]
RENTING OF M&EQ AND OTHER BUSINESS ACTIVITIES	71-74	16.1%	2.9%	8.4%	13.4%	38.7%
RENTING OF MACHINERY AND EQUIPMENT	71				1.3%	
COMPUTER AND RELATED ACTIVITIES	72				68.7%	
RESEARCH AND DEVELOPMENT	73				24.5%	
PROFESSIONAL SERVICES	74.1-74.3				18.7%	
OTHER BUSINESS ACTIVITIES (non-professional)	74.9				5.1%	
PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECUR	75	NA	2.6%	NA		
EDUCATION	80	6.7%		3.2%		
HEALTH AND SOCIAL WORK	85	6.1%		1.9%	3.3%	
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	90-93	3.5%			6.3%	
PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	95	NA				
EXTRA-TERRITORIAL ORGANIZATIONS AND BODIES	99	NA				

Notes: a: includes office and computing machinery (ISIC 30) as well; b: assumed to be equal to 0

Source: US: BEA, Germany: Ifo Investorenrechnung. France, Netherlands, UK: Data from national statistical offices

Appendix B: Data description

General

Our main data on value added in current and constant prices and employment by industry for this study are largely obtained from the OECD Structural Analysis (STAN) database.[45] This database, which is largely based on national accounts of individual OECD member states, provides a comprehensive tool for analyzing industrial performance at a relatively detailed level of activity across countries using the ISIC Rev. 3 industry classification.[46] Even though STAN mostly goes back to 1970, our data so far only cover the period 1990-2000. For a number of countries, however, we only have data up to 1998 or 1999 (see below).

The STAN database does not show separate entries for two ICT producing industries (insulated wire, 313 and instruments, 331), repairs, wholesale and retail trade (50, 51 and 52) and "other" business services (professional services 741-9). For some countries, there were also missing disaggregations for other industries, for example basic metals and fabricated metals (27 and 28). We generally break these industries out by using the share in value added and employment which we then apply to the aggregate from STAN. Although the data sources differ between countries, for breaking out the manufacturing industries, we commonly rely on value added at current prices and employment from the *OECD Structural Statistics for Industry and Services* (I&S, 2000). For services, we mostly used the *OECD Services Statistics on Value Added and Employment* (SerNA, 2001), which also provides value added in constant prices. The I&S data cover at most 1991-1998, while SerNA covers 1990-1999. For years outside this range, or in cases for which no data are available for particular years, we extrapolate by the change in value added and employment shares. Only when data are available for less than 4 years of data, the share itself is assumed constant over time.

In cases where the more detailed data sources did not provide value added estimates in constant prices, we used the deflator for the aggregate industry groups. This procedure would obviously be inadequate for ICT-producing industries (30, 313, 31ex313, 32, 331 and 33ex331) for which price changes are very different from those for the aggregate industry groups to which they belong. The large quality improvements of ICT equipment have led to very rapid declines. Unlike traditional matched models, the quality changes are better picked up by hedonic price indexes, which are estimates of price changes based on changes in the quality characteristics of ICT equipment. Whereas the U.S. National Income and Product Accounts (NIPA) make extensive use of hedonic price indexes, most other countries do not use independent hedonic price indices, which implies that their deflators for computers, electrical machinery, telecom equipment and instruments for many countries did not decline or declined much less than in the United States. Since this would understate productivity growth in other countries relative to the US, we applied the U.S. deflators for ICT-producing industries (30, 313, 31ex313, 32, 331 and 33ex331) to these industries in all countries. In order to correct for differences in overall inflation between each country and the U.S., we adjusted these hedonic deflators for the ratio of the GDP price indexes of each country and the US.[47]. Since the ICT-producing industries are not separately distinguished in the US NIPA, we had to construct these deflators ourselves, taking account of price changes in output and intermediate inputs of ICT goods. We did this in a fashion that

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[45] http://www.oecd.org/EN/document/0,,EN-document-0-nodirectorate-no-1-3245-0,00.html

[46] In the remainder, any number within brackets that do not refer to years, are ISIC rev3 codes for the industry in question.

[47] This procedure is based on Schreyer (2000), although he uses each country's deflator for non-ICT investment relative to that of the USA as a correction factor. As we do not have non-ICT investment deflators for each country, we use the ratio of the overall GDP (excluding ICT producing industries) deflators

approximates the BEA's procedures and results as closely as possible. We describe the details below in the overall description of the US data.

Finally, in (re)calculating aggregates for industry groups and for the aggregate economy we used chain-weighted Fisher quantity indices for value added in constant prices. This implies that the sum of individual industries does not exactly sum to the original total of a group or sector.

United States[48]

Since the United States does not use the ISIC rev 3 classification, a large number of adaptations had to be made, mainly in the ICT producing manufacturing industries. While the STAN database contained data on value added in current prices for the industries 29 up to 33, no separate price deflators were available for industries 29 to 32.[49] We therefore developed our own deflators for these and a number of other industries.

From the BEA data sets on "Gross Output by Detailed Industry" and "Shipments of Manufacturing Industries" we have gross output deflators, as well as gross output for non-manufacturing industries and value of shipments for manufacturing industries. If there is a one-to-one correspondence between a (3-digit or 4-digit) US industry and an ISIC industry, we use the gross output deflator. If there is a many-to-one correspondence, we calculate a Fisher chain-weighted deflator. Overall we obtained 39 deflators distributed over 9 ISIC industries.

We then use the Input/Output (I/O) tables for 1987, 1992 and 1996-1998 to calculate an intermediate input deflator for each ISIC industry. For the years between 1987 and 1992 and 1992 and 1996, we linearly interpolate; for 1999 and 2000, we assume the input structure remained constant.[50] For each of the input categories we apply the relevant gross output deflators.[51] We then Fisher-aggregate these series to obtain an intermediate input deflator for each industry. We calculate value added in constant prices by subtracting intermediate inputs in constant prices from gross output in constant prices.[52] Dividing value added in current prices by the newly obtained index of value added in constant prices, we then get the implicit value added deflator. While this procedure does not exactly replicate the BEA deflators, it serves as a good approximation when comparing aggregates based on our new value added deflators with the value added deflator from the NIPA.

Before we could apply this procedure, however, we needed to estimate value added in current prices for a number of industries which are not included in STAN. For 313, insulated wire and cable and 331, medical and measurement instruments and industrial process control, no data were available at all. For these industries, value added shares were taken from the U.S. Census Bureau's *Annual Survey of Manufacturers* (ASM) and used as weights to calculate value added in current prices.[53] For some 4-digit industries, no ASM data for 1990 and 1991 was available, so

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[48] Source descriptions for individual countries (except the U.S.) are not included in this version of the paper, but can be obtained from the authors upon request.

[49] If no specific classification is mentioned, the industry code refers to the ISIC rev 3 industry code.

[50] This is completely in line with the BEA's own practice.

[51] If there is a many-to-one correspondence, we aggregate to a chain-weighted deflator.

[52] Formally, we use the Laspeyres (Paasche) gross output and intermediate input deflators to come up with Laspeyres (Paasche) value added in constant prices. We then take the geometric average of the Laspeyres and Paasche these to come up with value added in constant prices based on a Fisher quantity index. See, Yuskavage (1996).

[53] Here, the BEA data could not be used, since these only contain value of shipments figures apart from the price data. Because the concordance between NAICS and SIC is not perfect, the shares showed a shift between 1997 and 1998. For the deflators this is less of a problem than for the value added and employment data. Therefore, for 1996-97, I extrapolated 31 and 313 as well as 33 and 331 with the growth rate of 31 and 33 respectively. For the years 1997-2000, I applied the growth rates from the NAICS based data.

we extrapolated these series. For a number of other (2-digit) industries, data for 2000 were lacking in STAN (these include, amongst others 31, electrical machinery and 32, radio, television and communication equipment). The 1999 figures were extrapolated using 2000 ASM. The procedure to obtain a complete set of employment figures is comparable to that used for value added in current prices. Extrapolations to 2000 (where needed) are also based on the 2000 ASM.

A number of other adjustments also had to be made. First, wholesale trade, retail trade and repairs had to be separated. While these are separate industries in the BEA's "GDP by Industry" data set, they are combined in STAN. In ISIC, retail trade (52) does not include eating and drinking places, but in the U.S. SIC this industry (SIC 58) is included in retail trade (SIC 52-59). We used the BEA "Gross Output by Detailed Industry" data to relocate eating and drinking places to ISIC 55, Hotels and restaurants. Since gross output from this source is not consistent with the GDP by Industry figures, we first adjust for that and calculate a 'new' gross output series for retail trade and for hotels and restaurants.[54] We next used value added from the I/O tables to calculate value added in current prices. Here, too, we had to make an adjustment so that value added in current prices for these industries combined would sum to the total from the national accounts. In a similar procedure as for industries 30-33, we calculate value added deflators and apply these. Employment figures come from the BLS, which are figures for employees instead of for persons employed figures, and not completely consistent with the figures the BEA reports in the GDP by Industry data. We use employee shares to calculate the number of persons employed. Despite the complexity, these adjustments do matter. It diminishes value added (in current prices) in retail trade by around 25%, while quadrupling value added in hotels and restaurants.

The calculation of value added (in current and constant prices) and employment for business services follows a similar procedure. In STAN, business services (ISIC 71-74) is equal to the industries business services (SIC 73), legal services (SIC 81) and other services (SIC 84, 87, 89). While this is roughly correct, there are some important exceptions, like automobile renting (part of ISIC 71 but included in automobile repair in the U.S.) ISIC 71-74 in STAN also includes Museums, botanical, zoological gardens (SIC 84), which we relocated to ISIC 90-93 (Personal, Social and Community Services). For each of the new industries we calculated value added, for which we relied on gross output shares from the BEA "Gross Output by Detailed Industry", employment and double-deflated value added deflators.[55]

[54] The Gross Output by Detailed Industry data are based on the benchmark I/O tables (last one for 1992) and are extrapolated for other years.

[55] The Census also does not include any data on value added.

Appendix Table C: Contribution of industry groups to labor productivity growth, 1990-1995 and 1995-2000

1990-1995	Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden[c]	UK[b]	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy	2.39	2.05	4.49	1.16	2.28	2.99	1.87	1.11	1.66	2.94	2.56	**2.02**	1.19	0.81	2.97	-0.01	**1.16**
ICT Producers	0.32	0.37	0.41	0.24	0.37	0.80	0.11	0.30	0.16	0.49	0.54	**0.34**	0.18	0.47	0.30	0.08	**0.50**
ICT-producing manufacturing	0.18	0.10	0.26	0.14	0.16	0.73	0.06	0.21	0.08	0.24	0.30	**0.19**	0.13	0.36	0.06	0.05	**0.34**
ICT-producing services	0.14	0.27	0.15	0.10	0.21	0.07	0.05	0.09	0.08	0.25	0.24	**0.16**	0.05	0.11	0.24	0.03	**0.16**
ICT Users	0.62	0.31	1.35	0.16	0.47	0.17	0.61	0.09	-0.21	0.72	0.54	**0.40**	0.65	0.20	0.35	-0.34	**0.43**
ICT-using manufacturing	0.17	0.20	0.34	0.22	0.35	0.39	0.30	0.09	0.11	0.25	0.16	**0.24**	0.03	-0.03	0.07	0.01	**0.00**
ICT-using services	0.45	0.12	1.01	-0.06	0.12	-0.23	0.31	-0.01	-0.32	0.47	0.38	**0.16**	0.63	0.24	0.28	-0.35	**0.43**
Non ICT	1.28	1.35	2.41	0.75	1.45	1.71	1.03	0.89	1.54	1.79	1.93	**1.26**	0.56	0.10	2.95	0.27	**0.27**
Non-ICT manufacturing	0.60	0.28	0.82	0.41	0.66	1.30	0.38	0.40	0.47	0.76	0.51	**0.49**	0.29	0.04	0.10	0.24	**0.30**
Non-ICT services	0.06	0.59	1.02	0.03	0.49	-0.04	0.29	0.28	0.56	0.71	0.52	**0.38**	0.01	0.03	0.43	0.03	**-0.11**
Non-ICT other industries	0.63	0.48	0.56	0.31	0.29	0.45	0.36	0.22	0.50	0.33	0.90	**0.40**	0.27	0.03	2.41	-0.01	**0.08**
Shift effect	0.16	0.01	0.32	0.01	0.00	0.32	0.11	-0.17	0.17	-0.06	-0.45	**0.02**	-0.20	0.03	-0.63	-0.02	**-0.03**

1995-2000	Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden[c]	UK[b]	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy	1.83	1.58	3.02	1.21	1.41	4.79	0.91	1.15	0.39	2.28	1.50	**1.33**	1.00	0.95	1.44	1.21	**2.44**
ICT Producers	0.27	0.33	1.43	0.39	0.63	2.01	0.29	0.45	0.22	0.42	0.53	**0.47**	0.29	0.76	0.25	-0.02	**0.69**
ICT-producing manufacturing	0.27	0.12	1.16	0.16	0.19	2.03	0.09	0.20	0.09	0.25	0.31	**0.22**	0.15	0.64	0.05	0.01	**0.51**
ICT-producing services	-0.01	0.21	0.27	0.23	0.44	-0.02	0.20	0.25	0.13	0.17	0.23	**0.25**	0.14	0.12	0.20	-0.03	**0.17**
ICT Users	0.35	0.56	0.68	0.17	0.44	1.04	0.26	0.46	-0.06	0.81	0.45	**0.41**	0.03	0.13	0.51	0.61	**1.48**
ICT-using manufacturing	0.29	0.05	0.18	0.12	0.25	0.73	0.13	0.13	0.13	0.13	0.09	**0.16**	0.05	0.06	0.02	0.31	**0.08**
ICT-using services	0.07	0.51	0.50	0.05	0.18	0.31	0.13	0.33	-0.19	0.68	0.36	**0.25**	-0.02	0.07	0.49	0.30	**1.40**
Non ICT	0.83	0.71	0.72	0.63	0.31	1.59	0.26	0.24	0.13	0.96	0.48	**0.43**	0.22	-0.03	0.84	0.61	**0.25**
Non-ICT manufacturing	0.50	0.37	0.36	0.33	0.01	1.85	0.11	0.23	-0.05	0.29	0.02	**0.16**	0.20	-0.03	0.04	0.57	**0.12**
Non-ICT services	-0.18	0.19	0.11	0.18	0.04	-0.41	-0.18	0.00	0.04	0.56	0.64	**0.09**	-0.12	0.18	0.21	0.17	**0.09**
Non-ICT other industries	0.51	0.15	0.25	0.12	0.26	0.15	0.34	0.01	0.14	0.11	-0.18	**0.18**	0.14	-0.18	0.60	-0.13	**0.04**
Shift effect	0.38	-0.01	0.20	0.02	0.04	0.15	0.10	0.00	0.09	0.10	0.04	**0.02**	0.45	0.09	-0.16	0.00	**0.02**

Notes: contributions of industry groups refer to the "intra-effect" only, that is the weighted average productivity growth of the group (see text). The "shift-effect", which refers to the effect of reallocations between groups on aggregate productivity growth, is reported separately.

a) 1991-1995 and 1995-1999; b) 1995-99; c) 1995-98; d) excluding ICT-producing industries

Appendix Table D1: Labor productivity growth (value added per person engaged) by individual industry, 1990-1995

1990-1995		Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden[c]	UK[b]	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy		**2.4**	**2.0**	**4.4**	**1.1**	**2.3**	**2.9**	**1.8**	**1.1**	**1.6**	**2.9**	**2.5**	**2.0**	**1.2**	**0.8**	**2.9**	**0.0**	**1.2**
Total ICT-producing manufacturing		**10.7**	**9.3**	**14.1**	**9.4**	**8.9**	**15.5**	**5.1**	**12.9**	**9.8**	**12.6**	**15.8**	**11.6**	**8.8**	**11.4**	**10.0**	**5.1**	**14.5**
Office and Comp. Eq.	30	20.5	23.4	10.1	24.8	25.0	26.6	27.8	28.5	27.0	32.9	32.1	29.6	15.2	25.3	29.9	26.5	27.0
Fiber optics	31.3	5.6	13.3	10.8	6.1	7.0	13.6	6.9	7.0	12.2	11.1	-1.3	6.0	6.0	14.2	8.0	3.8	5.6
Radio, TV and Comm. Eq.	32	14.6	13.1	19.5	13.7	15.4	8.9	5.1	14.8	7.1	15.3	21.2	15.7	15.8	9.4	18.9	15.3	18.4
Instruments	33.1	-1.8	3.2	1.6	-2.6	-1.3	-10.5	-3.7	-0.7	-2.3	2.1	0.3	-1.3	0.6	-5.3	-1.7	-0.8	-2.1
Total ICT-producing services		**4.6**	**7.9**	**4.8**	**2.7**	**6.0**	**2.2**	**1.6**	**2.8**	**3.1**	**6.8**	**5.5**	**4.5**	**1.2**	**4.2**	**7.0**	**1.5**	**4.1**
Telecommunications	64	5.6	5.1	6.6	2.5	7.7	4.8	4.4	3.7	4.0	8.0	6.2	5.8	2.1	4.7	9.3	3.2	4.5
Computer services	72	1.3	12.3	0.0	2.9	0.5	-3.5	-3.4	1.0	0.9	3.3	5.2	1.7	1.3	3.7	-0.8	-3.3	3.4
Total ICT-using manufacturing		**2.9**	**3.1**	**5.3**	**4.2**	**4.1**	**6.4**	**4.1**	**1.9**	**2.4**	**4.4**	**2.5**	**3.5**	**1.0**	**-0.2**	**1.4**	**0.4**	**0.1**
Apparel	18	2.8	3.2	2.0	3.2	3.6	-6.6	8.0	-1.2	4.1	5.8	3.4	4.4		-5.9	-0.2	-10.5	3.4
Printing & Publishing	22	-0.7	-0.7	3.7	2.7	2.7	6.4	0.2	2.1	-1.1	8.2	0.2	2.0	-0.8	-2.5	0.6	-3.1	-2.6
Machinery	29	1.9	2.6	4.4	5.3	4.7	7.5	3.2	2.2	2.9	3.1	2.4	3.6	2.7	-1.8	1.2	1.6	1.0
Electrical machinery	31-31.3	9.4	13.3	10.8	6.7	7.1	9.9	7.2	7.6	5.3	10.2	7.1	7.1	5.9	7.8	11.5	3.8	6.1
Watches & instruments	33-33.1	3.1	8.0	6.4	4.2	4.0	-1.0	1.3	4.1	2.5	7.2	7.8	4.2	5.4	-1.4	-8.0	-0.7	0.6
Ships	351	7.9	10.6	8.9	0.6	-0.1	-5.5	8.2		3.1	-4.2	11.5	4.7	5.8	14.6	1.2	-13.5	-3.6
Aircraft	353			4.0	6.5	-6.5		-3.1		-3.0	-2.5	2.1	1.1	-0.1	4.7	0.9		0.0
Railroad and other	352+359	7.9	0.6	-7.4	8.0	-2.7	-6.8	1.0		7.9	-2.2	3.5	2.5	10.1	5.8	-1.6		-1.8
Misc. manufacturing	36-37	-0.3	0.8	3.1	0.7	-0.7	6.0	3.9	0.3	0.1	5.6	-1.0	0.6		-2.6	-2.3	4.1	1.3
Total ICT-using services		**2.0**	**0.5**	**5.4**	**-0.3**	**0.6**	**-0.9**	**1.2**	**0.0**	**-1.7**	**2.5**	**1.5**	**0.7**	**2.0**	**1.5**	**1.5**	**-2.4**	**1.6**
Wholesale trade	51	0.7	2.6	4.0	2.9	3.2	-0.6	4.1	0.3	0.7	3.8	4.1	2.9	3.7	2.0 [g)]	3.6	-6.0	3.4
Retail trade	52	0.7	2.6	10.2	1.3	0.2	-0.6	0.7	0.1	1.6	3.8	1.8	1.1	1.1		3.6	2.9	2.5
Banks	65	5.4	-1.1	-0.3	-2.1	1.3	4.8	0.6	1.7	-4.0	3.1 [e)]	2.0	0.5	2.1	0.0 [e)]	-0.3	-0.9	1.3
Insurance	66	-0.4	-6.5	-3.5	0.4	2.9	4.8	3.3	-7.9	-4.7		1.3	0.1	2.2		2.2	4.1	3.0
Securities trade	67	-3.1	1.9	7.1	3.6	-2.2	4.8	1.5	0.2	0.2		0.8	0.8			2.8	-10.2	3.2
Renting of machinery	71	5.9		0.5	-0.3	0.8	-3.5	1.2	2.1	1.1	-6.3	5.4	2.9		3.7	6.9	-5.0	0.8
R&D	73	13.0	-2.5	0.1	-0.1	0.3	-3.5	-3.4	1.7	-1.7	-0.6	2.1	-0.1	1.3	3.7	1.2	-4.8	-0.4
Professional services	74.1-74.3	1.4	-2.0	3.7	-1.5	-2.2	-3.5	-0.5	-0.2	0.5	-0.6	1.5	-0.5	0.4	3.7	1.2	-5.4	-0.5
Total Non-ICT manufacturing		**4.6**	**2.9**	**6.2**	**3.3**	**4.5**	**7.8**	**2.7**	**3.3**	**3.5**	**6.2**	**3.9**	**3.6**	**2.3**	**0.4**	**1.4**	**4.4**	**3.0**
Food & beverages	15-16	3.7	3.1	5.9	2.2	3.7	3.9	2.1	4.5	1.2	6.5	2.9	2.8	1.4	-1.7	1.8	4.1	3.5
Textiles	17	0.5	2.8	8.6	3.2	4.3	2.1	1.3	-1.2	4.1	4.8	3.4	2.6	3.6	0.6	-0.5	5.8	3.0
Leather	19	1.4	1.7	3.4	1.5	8.2	-4.5	3.8	-1.8	2.1	4.7	2.8	3.3		-2.7	-2.1	-0.2	4.9
Wood	20	1.2	4.5	5.5	2.9	5.7	0.5	3.0	-1.6	2.2	1.1	0.6	3.0	-2.0	-2.7	-1.9	1.1	-2.8
Paper	21	8.3	5.8	7.6	2.8	0.6	1.5	3.5	3.4	3.1	3.8	3.6	3.4	-0.8	-2.6	5.1	1.1	0.0
Petroleum & coal	23	51.5	-18.9	5.8	9.7	-1.6	17.1	5.7	3.0	5.2	11.9	8.5	6.7	4.0	-3.0	-16.3	-22.3	5.0
Chemicals	24	3.4	5.2	4.4	5.9	8.4	10.5	3.5	7.1	3.9	6.7	7.4	6.7	3.6	2.4	2.1	11.5	3.4
Rubber & plastics	25	4.9	-3.7	3.2	4.3	3.3	5.9	2.2	1.8	3.1	6.3	2.3	3.0	3.6	0.8	1.9	-0.6	4.6
Stone, clay & glass	26	-0.7	1.7	3.9	1.6	6.7	6.9	1.4	-1.4	2.8	2.0	4.1	3.0	0.0	0.1	2.7	-1.1	2.8
Basic metals	27	3.9	4.9	7.9	3.9	10.7	-5.0	4.3	5.3	7.5	9.1	4.4	6.9	3.8	1.7	2.9	3.5	3.9
Fabricated metals	28	4.4	3.4	4.9	1.3	1.8	0.5	4.3	2.1	2.1	6.1	0.8	2.1	2.0	2.2	1.9	-0.6	3.2
Motor vehicles	34	7.9	-3.3	0.7	2.8	2.4	-3.6	0.1	1.6 [d)]	8.1	8.8	3.0	2.5	5.0	-1.3	3.6	-10.1	4.9

Appendix Table D1 (cont.)

1990-1995		Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden[c]	UK[b]	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Non-ICT services		**0.2**	**1.2**	**2.3**	**0.1**	**1.2**	**-0.1**	**0.7**	**0.7**	**1.3**	**1.5**	**1.3**	**0.9**	**0.0**	**0.1**	**1.0**	**0.2**	**-0.3**
Repairs	50	0.7	2.0	9.9	-1.6	-3.1	-0.6	5.4	-0.2	-0.4	3.8	0.5	0.3		0.0	3.6	-1.4	0.8
Hotels & restaurants	55	-1.3	2.1	3.1	-4.6	-5.1	-1.5	-1.4	-0.4	0.6	1.5	-1.4	-1.8	0.1	0.0	-2.3	-5.8	-0.2
Transport	60-63	0.4	2.3	4.0	0.8	4.9	4.8	5.5	3.2	3.2	-0.3	3.6	3.4	1.4	-2.1	4.3	-3.3	2.1
Real estate	70	-0.3	1.6	6.9	1.4	-3.2	-3.5	0.0	-0.2	5.1	6.3	-5.1	0.0		1.1	-0.2	6.2	1.6
Other business services	74.9	1.4	1.5	-0.2	-1.9	-2.2	0.0	-2.2	-1.3		-0.6	2.1	-1.1		10.1	1.2		-1.7
Government	75	1.2	1.8	-0.2	1.2	2.3	0.7	2.5	1.8	1.2	0.9 [f)]	-0.2	1.3	1.3	0.4	0.4	2.7	0.0
Education	80	-2.5	1.7	0.4	0.4	0.4	-3.7	0.0	0.8	0.7		2.4	0.8	-1.4	1.2	-0.5	-7.5	-0.2
Health	85	1.8	1.4	0.0	0.5	1.7	-1.3	-1.4	0.2	1.6		2.7	1.1	-0.6	1.4	0.0	-1.0	-2.2
Personal & social serv.	90-93	-0.2	1.3	0.0	-2.3	-1.5	-2.4	-0.7	0.6	-1.3		3.3	-0.4	-1.5	-1.6	1.4	-0.6	0.5
Private households	95	1.3	-0.7	0.5				-1.4	1.0							-1.6		
Extra-terr. org.	99																	
Total Non-ICT other industries		**4.5**	**4.1**	**4.2**	**2.6**	**2.7**	**2.9**	**3.0**	**1.5**	**2.8**	**2.8**	**7.2**	**3.3**	**1.6**	**0.2**	**9.9**	**-0.2**	**0.7**
Agriculture	01-05	6.8	7.2	5.1	4.4	10.1	3.9	7.1	4.0	1.8	2.0	2.8	5.5	0.6	0.4	7.8	-0.8	-1.0
Mining	10-14	-1.2	8.1	5.5		10.4	8.4	5.8	4.4	9.3	4.4	24.0	14.1	3.8	-0.9	9.4	-2.1	5.4
Utilities	40-41	1.7	5.5	7.2	2.2	4.0	5.6	2.8	3.2	1.6	2.5	10.0	4.0	1.1	0.7	2.4	6.1	2.5
Construction	45	2.0	-0.4	0.8	0.9	-1.1	-1.6	-0.6	-1.5	1.9	2.6	4.0	0.2	-1.4	-1.9	3.4	-2.3	0.5

a) 1991-1995 and 1995-1999; b) 1995-99; c) 1995-98

d) Refers to total transport equipment (34-35); e) Refers to total finance (65-67); f) Refers to total non-market services (75-99) g) Refers to Trade (50-52) as a whole

Appendix Table D2: Labor productivity growth (value added per person engaged) by individual industry, 1995-2000

1995-2000		Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden[c]	UK[b]	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy		**1.8**	**1.6**	**3.0**	**1.2**	**1.4**	**4.6**	**0.9**	**1.1**	**0.4**	**2.2**	**1.5**	**1.3**	**1.0**	**0.9**	**1.4**	**1.2**	**2.4**
Total ICT-producing manufacturing		**16.0**	**10.0**	**28.6**	**10.8**	**13.1**	**29.9**	**8.1**	**14.1**	**12.1**	**10.6**	**15.1**	**14.2**	**9.0**	**20.4**	**6.7**	**0.5**	**20.3**
Computers	30	77.6	48.4	-8.4	33.1	46.6	40.8	35.1	41.9	28.5	49.6	41.3	40.9	30.9	34.6	43.8	51.8	47.5
Fiber optics	31.3	8.1	5.5	3.7	3.0	9.5	-3.4	-3.7	5.7	-1.2	8.7	-6.0	2.9	14.5	4.7	-5.3	13.0	5.1
Telecom eq	32	20.9	25.1	34.5	22.8	28.6	39.5	19.6	20.0	13.3	17.7	23.4	24.3	25.7	21.3	24.4	18.0	23.4
Instruments	33.1	-5.2	-8.0	-9.5	-11.8	-8.8	-5.9	-10.2	-12.0	-7.6	-6.3	-14.8	-9.5	-7.8	-10.0	-12.2	-11.2	-7.8
Total ICT-producing services		**-0.4**	**5.9**	**7.7**	**6.1**	**11.4**	**-0.2**	**6.2**	**5.7**	**4.1**	**3.9**	**5.0**	**6.4**	**2.9**	**4.0**	**6.1**	**-0.7**	**3.7**
Telecommunications	64	4.4	6.6	12.4	9.4	14.7	-0.6	8.1	10.0	5.0	6.5	8.2	9.4	6.9	6.8	9.0	1.1	8.0
Computer services	72	-12.6	5.4	-1.1	0.4	5.6	-2.1	4.3	0.5	0.2	-0.9	0.9	2.2	-0.4	0.7	-1.8	-3.6	-2.2
Total ICT-using manufacturing		**5.1**	**0.7**	**2.8**	**2.4**	**3.4**	**10.7**	**2.0**	**3.1**	**2.9**	**2.1**	**1.4**	**2.6**	**1.6**	**0.8**	**0.3**	**4.2**	**1.9**
Apparel	18	1.3	11.2	-0.1	3.0	4.3	2.2	0.1	2.7	0.6	-12.0	1.3	0.9		-0.8	-1.1	6.6	3.8
Printing&Publishing	22	6.1	-1.3	2.7	2.3	3.7	8.0	1.5	4.5	0.7	4.9	1.2	2.6	-1.4	1.6	-3.7	3.6	-0.2
Machinery	29	3.8	1.2	1.1	2.6	0.2	-3.1	-0.2	2.2	1.1	0.1	-1.3	0.6	-5.4	-1.2	0.5	2.3	0.3
Electrical machinery	31-31.3	12.8	8.8	7.6	5.5	8.5	20.4	7.8	5.8	4.4	6.4	5.3	7.4	16.2	3.1	5.1	16.3	9.9
Watches & instruments	33-33.1	6.2	3.3	-1.2	-0.7	0.6	9.4	4.0	-0.6	0.4	1.5	-12.2	-0.1	2.1	3.8	2.7	4.6	5.0
Ships	351	4.8	-15.7	-1.7	12.4	10.2	2.4	2.7		-0.8	-2.1	6.7	4.9	7.7	0.1	2.9	-12.3	-1.5
Aircraft	353			0.2	-12.3	16.7		1.8		4.9	-6.4	8.8	4.1	6.3	-2.3	2.6		2.3
Railroad and other	352+359	4.8	0.5	6.0	0.2	12.9	14.7	1.2		5.9	5.1	-11.4	4.2	-13.4	-11.0	-6.1		-0.2
Misc. manufacturing	36-37	3.3	0.2	2.1	3.4	0.0	-1.3	2.7	1.0	0.7	4.8	-0.3	2.0		2.9	0.1	2.5	2.4
Total ICT-using services		**0.3**	**2.5**	**2.8**	**0.2**	**0.8**	**1.3**	**0.5**	**1.3**	**-1.0**	**3.6**	**1.5**	**0.8**	**-0.1**	**0.5**	**2.6**	**0.9**	**4.8**
Wholesale trade	51	1.5	0.3	2.1	1.5	0.3	6.2	0.0	3.3	0.2	4.6	-1.2	0.8	2.0	0.2 [g)]	2.9	-2.3	6.1
Retail trade	52	2.1	0.8	1.6	0.7	-0.1	6.2	0.8	0.4	1.1	3.5	2.0	0.9	2.0		3.1	0.0	6.7
Banks	65	1.0	5.2	12.1	-1.3	9.0	-1.9	4.6	0.0	0.1	5.6 [e)]	3.4	3.8	1.0	1.7 [e)]	6.0	5.0	2.8
Insurance	66	5.8	8.9	4.4	-1.9	-2.5	-1.9	-3.2	-1.4	-8.8		-0.6	-0.8	2.0		3.8	0.8	-1.0
Securities trade	67	-6.1	-13.3	16.6	-0.6	2.9	-1.9	-2.2	2.0	4.1		1.1	0.7			7.1	4.3	15.3
Renting of machinery	71	-2.7		2.4	-0.3	2.0	-2.1	0.2	3.8	0.4	-2.2	2.3	0.9		0.7	5.2	0.2	3.4
R&D	73	-1.0	4.1	-0.6	-0.8	2.5	-2.1	-0.1	-2.1	-2.4	-0.2	-7.0	-1.0	-0.4	0.7	-1.6	-7.1	3.8
Professional services	74.1-74.3	-4.8	5.8	-0.2	0.9	-3.0	-2.1	-1.6	0.0	-0.2	-0.2	4.6	-0.1	-1.4	0.7	0.8	-2.3	1.7
Total Non-ICT manufacturing		**3.8**	**3.8**	**2.8**	**2.7**	**0.0**	**10.4**	**0.8**	**2.1**	**-0.4**	**2.2**	**0.2**	**1.3**	**1.4**	**-0.3**	**0.5**	**4.4**	**1.3**
Food & beverages	15-16	1.8	0.8	3.1	-1.2	-1.0	2.4	1.5	1.7	-0.2	2.1	-1.1	0.2	-0.4	0.4	-2.6	0.0	-4.5
Textiles	17	3.9	7.0	2.1	2.7	0.2	-3.9	0.1	4.5	-0.5	5.1	1.3	0.8	0.9	-4.7	-0.1	2.5	3.3
Leather	19	0.0	11.4	1.4	4.0	3.9	-2.3	-1.4	3.6	0.4	4.9	1.6	-0.1		-1.0	-0.1	1.1	1.3
Wood	20	6.1	0.0	5.2	0.9	2.9	6.5	4.7	2.3	0.8	8.4	-2.7	2.4	-0.5	-6.7	1.8	1.7	0.3
Paper	21	3.2	3.0	4.1	3.1	6.5	1.1	2.0	2.4	-2.5	2.9	-3.9	2.2	-1.4	1.4	3.4	2.3	0.2
Petroleum & coal	23	21.1	19.0	5.2	5.3	-11.2	25.7	-5.5	-2.6	0.1	4.9	-3.0	0.9	4.4	4.0	19.9	16.6	1.5
Chemicals	24	5.0	11.2	4.3	4.3	1.9	10.5	1.1	4.1	0.5	3.7	2.4	4.0	1.8	2.4	0.1	11.5	3.4
Rubber & plastics	25	7.8	8.8	-0.3	3.5	1.8	5.9	0.4	2.9	0.7	3.6	-0.9	1.6	3.3	0.8	0.3	-0.6	4.6
Stone, clay & glass	26	4.3	-0.2	2.6	3.0	1.1	6.9	1.2	2.0	0.6	-1.6	0.3	1.1	6.1	0.1	-0.8	-1.1	2.8
Basic metals	27	8.3	1.6	4.0	2.1	4.6	-5.0	-2.3	3.6	-2.7	1.8	1.2	2.2	1.4	1.7	5.0	3.5	3.9
Fabricated metals	28	0.3	0.6	0.0	1.0	0.1	0.5	0.6	0.6	-0.7	-2.2	-0.6	0.1	0.8	2.2	0.1	-0.6	3.2
Motor vehicles	34	-1.4	5.4	5.0	11.5	-4.8	6.2	4.1	4.7 [d)]	0.3	1.7	2.0	0.8	3.7	-4.4	-1.7	0.9	1.4

Appendix Table D2 (cont.)

1995-2000		Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden[c]	UK[b]	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Non-ICT services		**-0.4**	**0.4**	**0.3**	**0.4**	**0.1**	**-1.5**	**-0.5**	**0.0**	**0.1**	**1.2**	**1.6**	**0.3**	**-0.4**	**0.4**	**0.5**	**0.5**	**0.2**
Repairs	50	1.4	-1.5	1.4	-1.1	-0.2	6.2	0.7	1.2	-0.9	2.1	2.6	0.1		-2.7	2.0	1.4	-1.2
Hotels & restaurants	55	0.1	-1.3	-0.2	-0.6	-5.1	4.2	-0.5	1.7	-0.5	3.4	-0.1	-1.0	0.6	0.0	0.5	0.9	-0.6
Transport	60-63	2.8	3.3	2.1	3.0	3.5	-0.6	-1.9	2.0	0.7	3.1	1.8	1.8	1.5	-0.7	2.4	2.5	1.6
Real estate	70	-2.9	0.1	0.5	-0.2	-3.5	-2.1	-0.8	-0.3	-5.1	5.3	2.2	-0.8		1.7	0.6	1.5	1.7
Other business services	74.9	-5.1	2.7	-2.0	-2.4	-3.0	0.0	-1.7	-1.0		-0.2	5.8	-1.1		13.8	2.5		0.2
Government	75	0.0	0.0	1.2	1.3	1.2	-0.8	1.2	1.2	0.9	0.9 [f)]	0.3	0.9	1.3	1.8	0.6	0.3	0.2
Education	80	0.4	-0.1	-0.3	0.6	-0.3	-5.8	-0.8	0.6	0.3		-0.2	0.0	-1.6	1.9	-0.6	-3.7	-1.2
Health	85	-4.4	0.2	-0.1	0.5	-0.4	-1.8	0.8	-1.4	-0.1		3.0	0.5	-0.8	0.2	0.3	0.0	-0.3
Personal & social serv.	90-93	-1.4	0.8	0.6	-1.3	-1.1	-1.1	0.1	1.1	-0.2		0.0	-0.6	-0.6	-1.1	0.3	-1.3	-2.3
Private households	95	-3.6	1.3	0.1				-0.5	4.0							-2.4		
Extra-terr. org.	99																	
Total Non-ICT other industries		**3.7**	**1.2**	**2.2**	**1.2**	**2.5**	**0.8**	**3.1**	**0.1**	**0.9**	**1.1**	**-1.6**	**1.6**	**0.9**	**-1.4**	**2.4**	**-1.3**	**0.4**
Agriculture	01-05	3.4	5.0	5.1	4.6	6.4	2.9	5.2	1.9	2.7	2.9	-3.1	4.1	4.1	0.1	2.6	-4.0	6.3
Mining	10-14	2.1	8.8	-1.9		0.0	-0.7	0.3	0.6	0.3	0.7	0.1	4.9	-0.5	5.0	3.4	4.0	-1.8
Utilities	40-41	4.4	-0.5	4.0	4.4	4.7	7.4	5.8	4.1	4.8	-0.2	6.4	0.2	1.6	4.1	5.6	1.0	2.3
Construction	45	1.9	-1.4	0.0	-2.5	1.1	-1.4	0.8	-0.2	-0.9	-0.2	-2.8	0.4	0.9	-4.2	-2.0	-0.7	0.2

a) 1991-1995 and 1995-1999; b) 1995-99; c) 1995-98
d) Refers to total transport equipment (34-35); e) Refers to total finance (65-67); f) Refers to total non-market services (75-99) g) Refers to Trade (50-52) as a whole

Appendix Table E: Contribution to aggregate productivity growth by industry in 1995-2000 for the U.S. and EU with the difference decomposed into a productivity and structure effect

		EU	U.S.	Difference (U.S.-EU)	*due to* Productivity	Structure
Total Economy		**1.328**	**2.408**	**1.080**	**1.139**	**-0.059**
Total ICT-producing manufacturing						
30	Office and Comp. Eq.	0.109	0.195	0.086	0.059	0.027
313	Fiber optics	0.000	0.005	0.005	0.002	0.003
32	Radio, TV and Comm. Eq.	0.162	0.334	0.173	0.067	0.106
331	Instruments	-0.045	-0.033	0.012	0.007	0.005
Total ICT-producing services						
64	Telecommunications	0.187	0.230	0.046	-0.014	0.060
72	Computer services	0.148	0.139	-0.008	-0.095	0.087
Total ICT-using manufacturing						
18	Apparel	-0.016	-0.016	-0.001	0.006	-0.006
22	Printing & Publishing	0.004	-0.028	-0.032	-0.034	0.003
29	Machinery	-0.019	-0.017	0.000	-0.055	0.055
31-313	Electrical machinery	0.049	0.021	-0.028	0.026	-0.054
33-33.	Watches & instruments	-0.002	-0.002	0.000	0.008	-0.009
351	Ships	0.005	-0.003	-0.008	-0.006	-0.001
353	Aircraft	0.005	0.000	-0.005	-0.007	0.002
352+359	Railroad and other	0.002	0.002	-0.001	-0.004	0.003
36-37	Misc. manufacturing	-0.004	0.007	0.011	0.002	0.009
Total ICT-using services						
51	Wholesale trade	0.064	0.378	0.314	0.343	-0.029
52	Retail trade	0.048	0.411	0.363	0.335	0.028
65	Banks	0.094	0.100	0.004	-0.020	0.024
66	Insurance	-0.014	-0.029	-0.014	0.000	-0.014
67	Securities trade	0.013	0.374	0.362	0.242	0.119
71	Renting of machinery	0.040	0.025	-0.014	0.002	-0.016
73	R&D	0.000	0.014	0.014	0.019	-0.004
741-743	Professional services	0.156	0.135	-0.020	0.080	-0.100
Total Non-ICT manufacturing						
15-16	Food products	-0.020	-0.101	-0.082	-0.105	0.023
17	Textiles	-0.010	-0.013	-0.004	0.009	-0.012
19	Leather	-0.007	-0.005	0.002	0.001	0.001
20	Wood products	0.002	-0.005	-0.007	-0.010	0.003
21	Paper products	0.003	-0.014	-0.017	-0.007	-0.010
23	Petroleum & coke	-0.014	-0.002	0.013	0.013	0.001
24	Chemicals	0.034	0.043	0.009	0.037	-0.027
25	Rubber and plastics	0.014	0.017	0.003	0.014	-0.011
26	Stone, clay & glass	-0.003	0.007	0.010	0.010	0.000
27	Basic metals	-0.010	0.006	0.014	0.006	0.008
28	Fabricated metal products	-0.007	-0.002	0.005	0.009	-0.003
34	Motor vehicles	0.027	0.005	-0.021	0.014	-0.035
Total Non-ICT services						
50	Repairs	0.013	-0.011	-0.023	-0.022	-0.001
55	Hotels & restaurants	0.013	-0.023	-0.036	0.020	-0.056
60-63	Transportation	0.098	0.076	-0.021	-0.013	-0.008
70	Real estate	0.083	0.163	0.082	0.246	-0.163
749	Other business services	0.122	0.085	-0.036	0.041	-0.077
75	Government	-0.040	-0.094	-0.054	-0.058	0.004
80	Education	-0.016	0.000	0.015	-0.020	0.036
85	Health	0.064	-0.011	-0.079	-0.048	-0.031
90-93	Personal & social services	0.030	-0.042	-0.072	-0.045	-0.027
Total Non-ICT other industries						
01-05	Agriculture	0.017	0.057	0.040	0.045	-0.005
10-14	Mining	-0.013	-0.056	-0.043	-0.058	0.016
40-41	Utilities	0.024	-0.028	-0.052	0.108	-0.160
45	Construction	-0.059	0.111	0.169	-0.013	0.182