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"Changing Gear"
Productivity, ICT and Services Industries: Europe and the United States

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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 52 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 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 52 individual industries (ISIC rev 3), of which 20 are in services, for 16 OECD countries. The countries are thirteen European countries (Austria, Denmark, Finland, France,

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[1] See, for example, Jorgenson (2001).

[2] See, for example, Baily and Lawrence (2001), Jorgenson, Ho and Stiroh (2002) and Triplett and Bosworth (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 Finland, van der Wiel (2001) for the Netherlands, Cette, Mairesse and Kocuglu (2001) for France, and De Arcangelis, Jona-Lasinio and Manzocchi (2001) for Italy.

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 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 in particular for ICT-producing manufacturing and ICT-using services. Secondly, in contrast to the U.S., overall productivity growth in the European Union slowed, except for the ICT-producing sector of the economy where it accelerated. In the ICT-using sector in Europe productivity growth did not improve, whereas growth rates declined in non-ICT industries.

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	1.9	1.1	1.4	2.5	100.0	100.0
ICT Producing Industries	6.7	8.1	8.7	10.1	5.9	7.3
ICT Producing Manufacturing	11.1	15.1	13.8	23.7	1.6	2.6
ICT Producing Services	4.4	3.1	6.5	1.8	4.3	4.7
ICT Using Industries[a]	1.7	1.5	1.6	4.7	27.0	30.6
ICT Using Manufacturing	3.1	-0.3	2.1	1.2	5.9	4.3
ICT Using Services	1.1	1.9	1.4	5.4	21.1	26.3
Non-ICT Industries	1.6	0.2	0.7	0.5	67.1	62.1
Non-ICT Manufacturing	3.8	3.0	1.5	1.4	11.9	9.3
Non-ICT Services	0.6	-0.4	0.2	0.4	44.7	43.0
Non-ICT Other	2.7	0.7	1.9	0.6	10.5	9.8

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

The latter 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, technology diffusion is a big part of the story. There is diffusion of ICT in Europe, but at a slower pace than in the United States in particularly during the second half of the 1990s.

Looking beyond the aggregate numbers there are 3 factors that stand out. 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 European countries have shown a significant difference between productivity growth in ICT-using services and non-ICT services although 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 productivity growth differential. 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 patterns across industries that are similar to those 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. 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: 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.[6] In this paper we make use of both approaches to examine the relationship between ICT use and labor productivity growth, but our focus is on a somewhat indirect measure of the impact of ICT on growth, i.e, labour productivity growth by industry related to the intensity of ICT use.

To distinguish between industries that use ICT more or less intensively, we must choose as a practical matter between three possible measures of ICT use by industry. These are 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.[7] 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.[8] 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 countries. Outside the U.S. there is an almost complete lack of data on ICT capital services by industry.

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

[7] 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.

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

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.[9] 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).

ICT-Producing, ICT-Using and Non-ICT Industry 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 Classification).[10] On the one hand, this reduces the industry detail for the U.S. somewhat since our database distinguishes 52 industries instead of a maximum for the U.S. of 57 industries.[11] 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 included all transport and storage in the group of non-ICT industries.

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

[10] 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, ICT-using groups and non-ICT groups we distinguish further between manufacturing industries and service industries. Section 3 and Appendix B describe our data sources in more detail.

[11] For none of the countries, data was available on extra-territorial organizations (ISIC 99), so we do not report on this industry.

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
321	Semiconductors and other electronic components
322	Communication and broadcasting equipment
323	Radio and TV receivers
331	Medical and measuring equipment and industrial process control
	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	Printing and publishing
29	Machinery and equipment
31, excl. 313	Electrical machinery and apparatus, excluding insulated wire
33, excl. 331	Precision and optical instruments, excluding ICT instruments
351	Building and repairing of ships and boats
353	Aircraft and spacecraft
352+359	Railroad equipment and transport equipment
36-37	Miscellaneous manufacturing and 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 and paper products
23	Coke, refined petroleum products and nuclear fuel
24	Chemicals and chemical products
25	Rubber and plastic products
26	Non-metallic mineral products
27	Basic metals
28	Fabricated metal products
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

On the other hand, in some cases we use a more refined classification than Stiroh did on the basis of the U.S. 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 for the sake of analysis are distinguished from the group of intensive ICT using industries) is derived from a classification by the OECD (2002), that includes industries producing ICT-hardware, software and ICT services.[12] We therefore broke out office and computer equipment (U.S. SIC 357) from industrial machinery and equipment (U.S. SIC 35), and radio and TV equipment (U.S. SIC 365-367) from electronic and electric equipment (U.S. SIC 36). We also distinguish computer services and telecommunication services as ICT-producing service industries. In ICT-using services, 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).

[12] 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 still include postal services.

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, they 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 industries. Our preference to exclude these industries from ICT-intensive using industries has some implications for our econometric results, but do not affect the main conclusions outlined above.[13]

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 IT investment (i.e., excluding investment in communication equipment) in total investment for France, Germany, the Netherlands, the U.K. and the U.S over the 1993-97 period. We also obtained information on the share of ICT capital in the total capital stock for France and the UK from a recent study by O'Mahony and de Boer (2002), and compared it to information on the U.S. ICT capital share obtained from the BEA. While the data are spotty, they show wide variation across industries in ICT or 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 IT investment and ICT capital intensities respectively.[14] All rank correlations for IT intensity in Table 3 are positive and most are above 0.50.[15] France is the only country where the correlations with other countries appear 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.

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[13] 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 include industrial machinery with the ICT-using industries. It is not possible to make this decision solely based on the U.S. intensity measures since industrial machinery under the SIC classification also includes computers. However, in the other countries for which we have intensity measures, the machinery industry (without computers) also shows up as an intensive ICT user.

[14] 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.

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

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

	France	Germany	Netherlands	UK	U.S.
France		0.12	0.45	0.24	0.35
Germany			0.66	0.64	0.67
Netherlands				0.61	0.66
UK					0.85
U.S.					

Note: investment intensity measured as investment in IT equipment (excluding communication equipment) as share of total equipment investment. France, UK, U.S.: 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	U.S.
France		0.32	0.44
UK			0.67
U.S.			

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

Overall, the rankings suggest that the intensive ICT using industries are similar across countries. This suggests that using the U.S. experience with ICT diffusion as a measure of the opportunity set is reasonable. This conclusion is also supported by results from O'Mahony and de Boer (2002) that show that ICT capital shares in French and British service industries are –just as in the U.S.– higher than in manufacturing. Industries like transport and communication and financial and business services are all in the upper part of the intensity distribution –a finding which also emerges from a similar study on the Netherlands (CPB, 2001).[16] 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 all 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), Colecchia and Schreyer (2001), and van Ark *et al.* (2002).

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

3. Does ICT make a Difference for Productivity?

In the remainder of this paper we use the grouping of industries according to ICT use 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 in productivity growth rates across countries within the industry groupings. We begin with a brief overview of our productivity data and related measurement issues.

Data and Adjustments for Deflation of ICT goods[17]

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.[18] STAN includes 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 persons. As hours per employee at industry level were only available for a limited number of countries, our computations relate only to output per person employed.[19]

For some ICT-producing industries, like insulated wire (ISIC 313) and instruments (ISIC 331), the STAN database does not report the detail separating them from the broader industry to which they belong. For the U.S. we also had to break out office and computer equipment (ISIC 30) and radio, TV and communication equipment (ISIC 321-323) 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.[20]

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

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17 A detailed description of the data and adjustments is given in Appendix B.

18 See http://www.oecd.org/EN/document/0,,EN-document-0-nodirectorate-no-1-3245-0,00.html.

Data for Netherlands, Norway and Switzerland are directly obtained from the countries' national accounts. For France and Spain data presently only run up to 1999, and for Japan 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.

19 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.

20 In the case of the United States, we also heavily relied on detailed series from the Bureau of Economic Analysis on value of shipments at the 4-digit level for manufacturing industries and gross output at the 3-digit level for non-manufacturing industries (http://www.bea.gov/bea/dn2/gpo.htm). In addition we used Input/Output tables from the Bureau of Labor Statistics (http://www.bls.gov/emp) to obtain shares of intermediate inputs in gross output which are needed for the double deflation (i.e., separate deflation of series on gross output and intermediate inputs) at value added level (see below and Appendix B).

chain-weighted Törnqvist 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 a limited number of countries, including the United States, Australia, Canada and France, use hedonic output price indexes in their national accounts 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 U.S. dollar 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 for 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 series for ICT-producing manufacturing industries are not separately reported in the U.S. National Income and Product Accounts, the hedonic price indices for these industries were constructed with procedures and data similar to those used by BEA.[21] For most countries this procedure leads to considerably higher growth in ICT-producing manufacturing industries compared to the estimates reported in the national statistics (see Table 6 below).

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.[22]

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.[23] Various efforts to improve output measurement in services have been undertaken at statistical agencies across

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

[22] 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.

the OECD. But much remains to be done. Unfortunately the actual steps taken to implement new methodologies in the national accounts are often not well documented, particularly outside the United States. Thus the evidence to claim that the national accounts in 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 actual 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 eleven EU member states in our sample (covering more than 90 per cent of EU GDP). The 1995-based value added in each industry was converted to the euros using the exchange rate between each national currency and the value of the euro as fixed on January 1, 1999.[24] This procedure follows the actual practice of the OECD concerning data for years before 1999 (see OECD 2001b). This method assumes, somewhat 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 by Industry Group

Table 5 shows the relative importance of seven industry groups in the year 2000 for each country in our sample and for the European Union average. 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).

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 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.

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[23] 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%.

[24] For Sweden and the UK, which do not participate in the euro, we used their average exchange rate to the euro for 1999. For European countries for which we had missing years (e.g., 1990 for Germany and 2000 for France and Spain) we filled gaps by extrapolating with growth rates for the years for which we had data.

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

	ICT Producing		ICT Using[a]		Non-ICT		
	Manufac-turing	Services	Manufac-turing	Services	Manufac-turing	Services	Othe
Austria	1.7	2.8	5.7	22.7	13.5	40.7	12.7
Denmark	1.1	3.6	5.9	20.6	10.1	47.7	11.0
Finland	5.9	4.7	6.1	15.3	13.9	43.1	11.1
France[b]	1.4	4.1	5.0	20.3	11.8	47.8	9.7
Germany	1.6	4.0	7.4	21.1	13.1	44.3	8.4
Ireland	7.0	5.3	6.2	25.2	18.9	24.8	12.5
Italy	1.0	3.7	6.8	22.8	12.8	42.8	10.3
Netherlands	1.4	4.4	4.7	24.1	10.3	42.7	12.5
Spain[b]	0.7	3.6	4.5	18.9	13.1	44.7	14.6
Sweden	2.1	5.7	5.6	18.1	12.2	48.2	8.1
UK	1.8	5.3	5.8	21.5	9.8	44.7	11.1
EU	1.6	4.3	5.9	21.1	11.9	44.7	10.5
Canada[b]	1.2	5.2	4.7	26.4	15.4	30.5	16.7
Japan[c]	2.9	3.3	7.0	20.4	11.2	41.3	13.8
Norway	0.6	2.9	3.6	17.2	6.0	36.4	33.2
Switzerland	2.2	4.0	7.2	30.0	12.5	34.9	9.3
US	2.6	4.7	4.3	26.3	9.3	43.0	9.8

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

In ICT-using manufacturing, almost every European country has higher GDP shares than the U.S., with Germany and Switzerland having notably larger shares.[25] This partly reflects the lower proportion of the manufacturing sector in the U.S. economy, 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.

[25] 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.

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

	Austria	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden	UK	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
1990-1995																	
Total Economy	2.3	1.6	3.3	1.0	2.1	3.0	1.8	0.7	1.6	2.8	2.8	**1.9**	1.1	0.8	3.3	-0.1	**1.1**
ICT Producing Industries	5.8	7.6	6.9	4.7	7.1	11.2	2.5	3.8	4.3	4.8	8.8	**6.7**	2.6	8.8	3.2	1.5	**8.1**
ICT Producing Manufacturing	7.6	6.5	8.9	10.0	6.8	17.1	4.6	5.7	8.3	-0.7	15.8	**11.1**	11.8	12.4	8.4	1.4	**15.1**
ICT Producing Services	4.8	7.9	4.8	2.6	5.9	2.2	1.6	2.3	3.1	6.8	5.6	**4.4**	0.4	4.2	2.1	1.5	**3.1**
ICT Using Industries[d]	2.2	1.1	1.9	1.1	1.6	1.4	2.2	0.6	-0.2	3.4	2.3	**1.7**	1.8	0.7	4.3	-1.5	**1.5**
ICT Using Manufacturing	1.9	2.7	4.7	3.3	2.6	6.1	3.4	1.8	1.7	5.6	2.1	**3.1**	2.1	-1.1	1.3	0.0	**-0.3**
ICT Using Services	2.1	0.6	0.7	0.5	1.1	0.2	1.6	0.4	-0.7	2.5	2.5	**1.1**	1.9	1.4	5.2	-2.0	**1.9**
Non-ICT Industries	2.1	1.4	3.4	0.7	2.0	2.6	1.5	0.5	2.0	2.4	2.5	**1.6**	0.5	0.1	3.0	0.7	**0.2**
Non-ICT Manufacturing	4.6	2.9	6.2	3.4	4.4	7.8	2.7	3.7	3.5	6.3	4.0	**3.8**	2.1	0.4	2.2	4.4	**3.0**
Non-ICT Services	0.1	0.5	2.0	-0.3	0.9	-0.9	0.6	-0.2	0.9	1.5	1.5	**0.6**	-0.2	-0.2	0.7	-0.2	**-0.4**
Non-ICT Other	4.5	4.1	4.2	1.6	2.7	2.9	3.0	0.9	2.9	2.8	6.1	**2.7**	1.4	0.2	9.3	-0.2	**0.7**
Pro memoria: with national deflators																	
Total Economy	2.2	1.6	3.3	1.1	2.1	2.4	1.8	0.6	1.5	2.8	2.7	**1.9**	1.0	0.7	3.2	0.0	**1.1**
ICT Producing Manufacturing	3.8	6.7	12.4	9.5	4.3	4.0	3.5	4.3	0.5	-0.1	9.8	**7.8**	6.8	6.8	2.3	4.8	**15.1**
1995-2000																	
Total Economy	2.3	1.9	2.5	1.2	1.3	5.3	0.8	0.9	0.4	2.1	1.8	**1.4**	1.4	0.9	1.7	1.1	**2.5**
ICT Producing Industries	3.4	5.9	10.9	8.7	12.7	23.5	6.3	3.2	5.9	2.7	8.3	**8.7**	5.3	12.1	8.4	-1.9	**10.1**
ICT Producing Manufacturing	9.6	5.7	13.2	15.0	13.7	42.3	6.0	-1.9	13.1	1.1	16.1	**13.8**	16.9	19.5	4.9	-4.3	**23.7**
ICT Producing Services	-0.4	5.9	8.1	6.2	11.9	-0.2	6.2	4.5	4.1	3.3	5.2	**6.5**	2.8	4.0	9.2	-0.7	**1.8**
ICT Using Industries[d]	3.0	2.0	2.5	1.0	1.3	2.9	1.0	2.0	0.1	2.9	2.3	**1.6**	2.5	0.1	3.7	1.3	**4.7**
ICT Using Manufacturing	6.0	0.1	1.5	1.9	2.4	8.7	1.5	2.7	1.1	1.7	1.7	**2.1**	1.1	0.5	-1.3	3.3	**1.2**
ICT Using Services	2.1	2.5	3.0	0.7	0.9	1.4	0.6	1.9	-0.1	3.3	2.6	**1.4**	2.8	0.0	4.8	0.8	**5.4**
Non-ICT Industries	1.8	1.5	1.4	0.7	0.5	2.7	0.4	0.2	0.1	1.6	0.8	**0.7**	0.5	0.1	0.7	1.1	**0.5**
Non-ICT Manufacturing	4.6	3.8	3.0	2.7	0.5	10.4	0.6	2.0	-0.3	3.3	0.5	**1.5**	1.3	-0.3	1.7	4.4	**1.4**
Non-ICT Services	-0.4	1.2	0.6	0.1	-0.1	-1.2	-0.4	0.1	-0.1	1.4	0.9	**0.2**	-0.4	0.6	0.4	0.8	**0.4**
Non-ICT Other	4.0	1.2	2.3	1.1	2.3	1.2	2.5	0.0	1.3	0.5	1.5	**1.9**	1.1	-1.5	1.4	-1.3	**0.6**
Pro memoria: with national deflators																	
Total Economy	2.2	1.8	2.9	1.2	1.3	3.3	0.8	1.0	0.3	2.5	1.6	**1.4**	1.3	0.7	1.7	1.2	**2.5**
ICT Producing Manufacturing	4.6	3.9	19.9	13.9	6.8	8.6	1.4	3.3	1.6	21.1	5.5	**10.1**	6.6	9.3	3.2	0.7	**23.7**

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

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 are 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. Hence once comparable price indexes reflecting the rapid technological change in ICT-producing manufacturing are adopted for all countries – and not just for the U.S. – ICT-producing industries exhibit rapid productivity growth in this (small) part of the economy nearly everywhere.[26]

The clearest and most systematic differences between Europe and the U.S., however, arise in services, particularly in ICT-producing and ICT-using services. In ICT-producing services productivity growth in many European countries is faster than in the United States.[27] As we will see in Section 4 this is mainly due to the faster productivity growth in telecommunication services in Europe. In contrast, in ICT-using services (excluding the ICT-producing services), U.S. performance was substantially better than in other countries since 1995. For example, productivity in ICT-using services grew at 5.4% in the U.S. compared to 1.4% for Europe in the 1995-2000 period. This difference is mainly due to better U.S. productivity performance in the securities and trade sectors.

Industry Group Contributions to Aggregate Productivity Growth

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 ($L_i/L=S_i$):[28]

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

In a time perspective the change in productivity between year *t* (P_t) and year *t-1* (P_{t-1}) can be written as follows:

[26] In Ireland productivity growth in ICT-producing manufacturing is faster than in the U.S. because of the large impact of the computer and semiconductor industries. The bottom line of Table 6 shows the estimates for all countries based on the original price indexes for ICT-producing manufactuirng. This shows that the procedure adopted here makes substantial differences at the level of ICT-producing manufacturing. However, at the aggregate level the differences between the original and adjusted estimates are much smaller.

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

[28] Based on Fabricant (1942).

$$\frac{P_t - P_{t-1}}{P_t} = \frac{\Delta P}{P_t} = \frac{\sum_{i=1}^{n}\left(\Delta P_i \cdot \overline{S}_i\right)}{P_t} + \frac{\sum_{i=1}^{n}\left(\overline{P}_i \cdot \Delta S_i\right)}{P_t} \qquad (2)$$

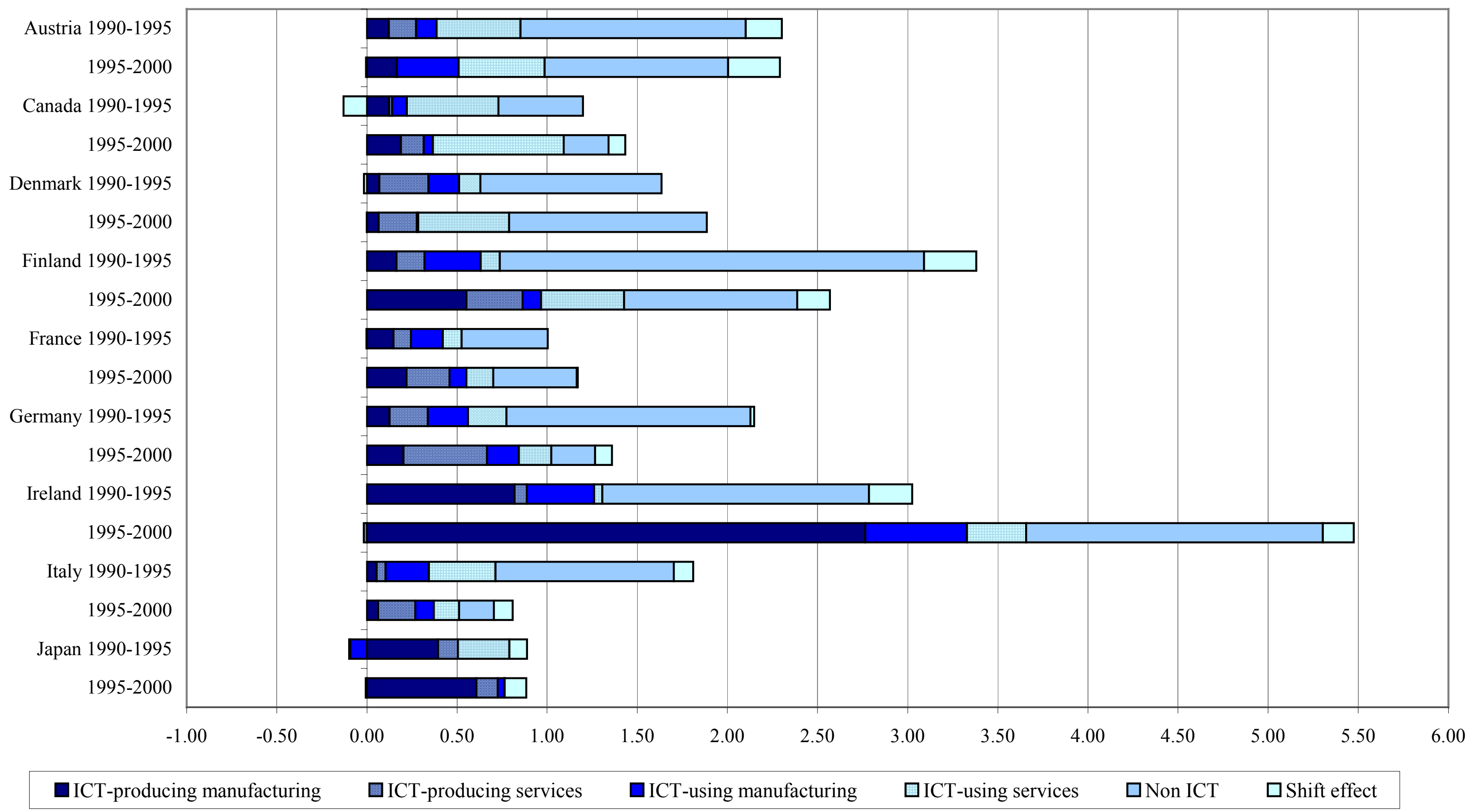
where $\overline{S}_i$ and $\overline{P}_i$ are the average employment share and the average productivity level in year t and t-1 respectively. Thus aggregate productivity growth is decomposed into intra-group productivity growth (the first term on the right-hand side, called "intra-effect") and the effects of the reallocation of labor (the second term, called the "shift-effect").[29]

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.[30] The combined shift effect is shown separately (it is generally positive but small), so that the contributions of each individual 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, the contribution of ICT-producing manufacturing is substantially bigger in the U.S. than in Europe. For some European countries (in particular Germany, the Netherlands and Norway) the contribution of ICT-producing services even exceeded that of ICT-producing manufacturing.

[29] See van Ark (2001), who 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.

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

Figure 1: Contribution of industry groups to labor productivity growth



Source: Appendix C

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 the 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).

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 52 industries, this leads to a maximum of 520 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.[31] The left-hand side of Table 7 focuses on the first half of the 1990s. It shows that in nearly all countries (except Austria and Spain) productivity growth was faster in ICT-using industries than in non-ICT industries. But during the early 1990s the difference between ICT-using and non-ICT industries was statistically significant for only four of the 16 countries (the U.S. at the one-percent level, Japan and Norway at the five-percent level and Canada at the ten-percent 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 more than half of the countries, namely Canada, Finland, France, Germany, Ireland, the Netherlands, Norway, the UK, the

[31] All 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 square root of employment).

U.S. and the EU as a whole. 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.

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	2.238	1.878	-0.360	1.491	2.821	1.330
	(1.074)**	(0.442)***	(1.161)	(0.700)**	(0.546)***	(0.888)
Canada[b]	0.036	1.962	1.926	0.401	2.881	2.481
	(0.420)	(0.954)**	(1.042)*	(0.365)	(0.402)***	(0.543)***
Denmark	1.264	2.209	0.945	1.710	2.051	0.341
	(0.981)	(0.844)***	(1.294)	(1.002)*	(0.850)**	(1.314)
Finland	2.249	2.673	0.424	1.138	3.340	2.202
	(0.641)***	(1.380)*	(1.522)	(0.386)***	(0.725)***	(0.821)***
France[b]	0.631	1.714	1.082	0.538	1.953	1.415
	(0.442)	(0.609)***	(0.753)	(0.431)	(0.646)***	(0.777)*
Germany[a]	1.629	1.946	0.317	0.144	1.743	1.599
	(0.602)***	(0.686)***	(0.913)	(0.329)	(0.684)**	(0.759)**
Ireland	0.799	1.690	0.891	0.358	4.842	4.485
	(0.542)	(1.303)	(1.411)	(1.042)	(1.749)***	(2.036)**
Italy	1.528	1.985	0.457	0.506	1.221	0.714
	(0.464)***	(0.583)***	(0.745)	(0.311)	(0.446)***	(0.544)
Japan[c]	-0.600	1.218	1.819	-0.910	0.920	1.830
	(0.523)	(0.679)*	(0.857)**	(0.714)	(1.257)	(1.445)
Netherlands	0.585	0.921	0.336	0.640	1.741	1.101
	(0.343)*	(0.418)**	(0.541)	(0.356)*	(0.510)***	(0.622)*
Norway	2.308	4.191	1.883	0.832	4.125	3.293
	(0.495)***	(0.731)***	(0.883)**	(0.371)**	(0.759)***	(0.845)***
Spain[b]	1.523	1.044	-0.479	0.097	0.841	0.744
	(0.341)***	(0.441)**	(0.558)	(0.235)	(0.441)*	(0.500)
Sweden	1.863	3.377	1.514	1.913	2.567	0.654
	(0.347)***	(0.939)***	(1.001)	(0.584)***	(0.498)***	(0.768)
Switzerland	-1.287	-0.933	0.354	-0.093	0.100	0.194
	(0.691)*	(0.886)	(1.124)	(0.461)	(0.570)	(0.733)
UK	2.382	3.258	0.876	1.015	2.923	1.908
	(0.536)***	(0.462)***	(0.708)	(0.443)**	(0.662)***	(0.797)**
EU	1.462	2.184	0.722	0.703	2.160	1.456
	(0.286)***	(0.347)***	(0.450)	(0.183)***	(0.351)***	(0.396)***
U.S.	0.041	2.361	2.320	0.529	5.105	4.576
	(0.324)	(0.527)***	(0.619)***	(0.242)**	(0.622)***	(0.667)***

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

Using a slight modification of equation (3) we allow for differential effects between ICT-producing and ICT-using industries (excluding ICT-producing):

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

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, most countries (except France, Ireland, Italy, Norway, Spain and Sweden) showed significantly higher growth rates in ICT-producing compared to the non-ICT industries. On the other hand, only Norway and the United States showed significantly faster growth in other ICT-using (excluding ICT-producing) industries. For the second half of the 1990s the difference between productivity growth in ICT-producing and non-ICT is still strong and significant at the 1%-significance level for most countries (including the EU as a whole). Moreover, the coefficient on the differences is higher than for the period 1990-1995 in eight countries as well as for the EU as a whole. Still, apart from the United States, only Canada, Norway, the UK and the EU as a whole showed significantly higher growth for ICT-using industries as well.[32]

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[32] 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 individual EU member countries.

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	2.238	5.098	1.467	2.860	-0.771	1.491	3.440	2.740	1.948	1.248
	(1.076)**	(1.018)***	(0.451)***	(1.481)*	(1.167)	(0.701)**	(2.498)	(0.523)***	(2.594)	(0.875)
Canada[b]	0.036	3.850	1.737	3.814	1.701	0.401	6.775	2.366	6.374	1.965
	(0.421)	(1.078)***	(1.059)	(1.157)***	(1.140)	(0.366)	(1.840)***	(0.402)***	(1.876)***	(0.544)***
Denmark	1.264	7.013	1.485	5.748	0.221	1.710	6.136	1.451	4.427	-0.258
	(0.983)	(1.738)***	(0.930)	(1.997)***	(1.353)	(1.004)*	(1.760)***	(0.918)	(2.027)**	(1.360)
Finland	2.249	5.870	2.079	3.620	-0.171	1.138	8.847	2.001	7.709	0.863
	(0.642)***	(1.684)***	(1.602)	(1.802)**	(1.726)	(0.387)***	(2.253)***	(0.564)***	(2.286)***	(0.684)
France[b]	0.631	4.332	1.326	3.701	0.694	0.538	7.629	1.099	7.091	0.562
	(0.443)	(2.587)*	(0.584)**	(2.624)	(0.734)	(0.432)	(2.273)***	(0.613)*	(2.313)***	(0.750)
Germany[a]	1.629	6.860	1.224	5.231	-0.405	0.144	11.712	0.459	11.569	0.315
	(0.604)***	(1.963)***	(0.697)*	(2.054)**	(0.922)	(0.329)	(2.760)***	(0.548)	(2.779)***	(0.640)
Ireland	0.799	8.945	0.528	8.147	-0.271	0.358	14.922	2.472	14.564	2.114
	(0.543)	(5.252)*	(1.178)	(5.280)	(1.297)	(1.044)	(5.946)**	(1.623)	(6.037)**	(1.930)
Italy	1.528	2.110	1.970	0.582	0.442	0.506	5.965	0.653	5.459	0.147
	(0.465)***	(1.892)	(0.614)***	(1.948)	(0.770)	(0.312)	(1.686)***	(0.422)	(1.714)***	(0.524)
Japan[c]	-0.600	8.328	0.341	8.928	0.941	-0.910	12.257	-0.499	13.168	0.411
	(0.525)	(2.796)***	(0.647)	(2.845)***	(0.833)	(0.717)	(6.254)*	(1.019)	(6.295)**	(1.246)
Netherlands	0.585	3.636	0.571	3.051	-0.014	0.640	2.533	1.627	1.893	0.987
	(0.344)*	(1.326)***	(0.423)	(1.370)**	(0.545)	(0.357)*	(2.272)	(0.483)***	(2.300)	(0.600)
Norway	2.308	3.247	4.344	0.939	2.036	0.832	8.338	3.436	7.506	2.604
	(0.496)***	(3.314)	(0.651)***	(3.351)	(0.819)**	(0.371)**	(2.385)***	(0.773)***	(2.414)***	(0.858)***
Spain[b]	1.523	3.605	0.543	2.082	-0.980	0.097	2.015	0.582	1.918	0.485
	(0.342)***	(1.226)***	(0.459)	(1.272)	(0.572)*	(0.236)	(1.908)	(0.325)*	(1.923)	(0.402)
Sweden	1.863	3.343	3.383	1.480	1.520	1.913	2.549	2.572	0.636	0.658
	(0.348)***	(2.731)	(0.990)***	(2.753)	(1.050)	(0.585)***	(1.415)*	(0.522)***	(1.531)	(0.784)
Switzerland	-1.287	1.726	-1.284	3.014	0.003	-0.093	-1.443	0.330	-1.350	0.423
	(0.693)*	(1.453)	(0.988)	(1.610)*	(1.206)	(0.462)	(1.437)	(0.627)	(1.509)	(0.779)
UK	2.382	7.778	2.610	5.396	0.228	1.015	6.019	2.410	5.004	1.395
	(0.537)***	(1.493)***	(0.470)***	(1.587)***	(0.714)	(0.444)**	(1.920)***	(0.708)***	(1.971)**	(0.836)*
EU	1.462	6.187	1.632	4.725	0.170	0.703	7.482	1.413	6.779	0.710
	(0.287)***	(1.310)***	(0.317)***	(1.341)***	(0.427)	(0.184)***	(1.836)***	(0.225)***	(1.845)***	(0.291)**
U.S.	0.041	6.382	1.784	6.341	1.743	0.529	6.655	4.858	6.126	4.329
	(0.324)	(1.976)***	(0.542)***	(2.002)***	(0.631)***	(0.242)**	(2.538)***	(0.626)***	(2.549)**	(0.671)***

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 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 further support for the hypothesis that ICT use, in particular in services, is driving productivity growth. Between 1990 and 1995, six 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 already significant between 1990-1995 but became significant at the 1% level for the period 1995-2000. 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 a substantial increase in both the spread between ICT and non-ICT services and in the productivity growth of industries within the ICT-using services group itself.

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	-0.025	2.280	1.726	4.537	2.305	1.751	4.562	-0.361	6.209	1.725	3.676	6.570	2.086	4.036
	(0.379)	(0.707)***	(0.542)***	(1.987)**	(0.802)***	(0.662)***	(2.023)**	(0.818)	(1.212)***	(0.591)***	(1.030)***	(1.463)***	(1.009)**	(1.315)***
Canada[b]	-0.327	3.850	1.693	0.731	4.176	2.019	1.057	-0.178	3.866	2.750	1.490	4.044	2.928	1.669
	(0.542)	(1.066)***	(1.081)	(0.654)	(1.196)***	(1.209)*	(0.849)	(0.390)	(1.731)**	(0.399)***	(0.671)**	(1.775)**	(0.558)***	(0.776)**
Denmark	0.515	2.855	1.971	2.982	2.340	1.456	2.467	1.604	0.551	2.561	1.972	-1.053	0.956	0.368
	(1.323)	(1.794)	(0.957)**	(1.150)**	(2.229)	(1.633)	(1.753)	(1.345)	(1.661)	(1.006)**	(1.039)*	(2.137)	(1.680)	(1.699)
Finland	0.980	4.201	1.981	4.311	3.222	1.001	3.331	0.326	3.482	3.271	2.619	3.156	2.945	2.293
	(0.373)***	(2.195)*	(1.755)	(1.462)***	(2.227)	(1.794)	(1.509)**	(0.282)	(1.253)***	(0.892)***	(0.898)***	(1.284)**	(0.935)***	(0.942)**
France[b]	-0.230	3.872	1.060	2.284	4.102	1.290	2.514	0.111	3.652	1.489	1.495	3.541	1.378	1.383
	(0.467)	(1.247)***	(0.695)	(0.905)**	(1.331)***	(0.837)	(1.019)**	(0.461)	(1.566)**	(0.700)**	(0.996)	(1.632)**	(0.838)	(1.097)
Germany[a]	0.363	3.499	1.232	3.547	3.136	0.869	3.183	-0.452	3.708	1.012	1.207	4.160	1.464	1.660
	(0.594)	(1.380)**	(0.728)*	(1.302)***	(1.502)**	(0.940)	(1.431)**	(0.355)	(1.294)***	(0.766)	(0.644)*	(1.342)***	(0.845)*	(0.736)**
Ireland	-1.029	6.459	-0.063	2.769	7.488	0.966	3.797	-0.373	14.056	1.692	1.295	14.429	2.065	1.668
	(0.601)*	(3.319)*	(1.175)	(0.712)***	(3.373)**	(1.320)	(0.932)***	(1.412)	(4.688)***	(1.651)	(1.550)	(4.896)***	(2.172)	(2.097)
Italy	0.547	3.707	1.229	2.932	3.161	0.682	2.385	-0.172	1.797	0.991	1.585	1.969	1.163	1.757
	(0.508)	(1.050)***	(0.657)*	(0.795)***	(1.167)***	(0.831)	(0.943)**	(0.277)	(0.794)**	(0.531)*	(0.622)**	(0.841)**	(0.599)*	(0.681)**
Japan[c]	-0.601	1.211	1.222	-0.599	1.812	1.823	0.002	0.007	4.377	-0.535	-1.986	4.370	-0.542	-1.993
	(0.478)	(1.606)	(0.665)*	(0.965)	(1.676)	(0.819)**	(1.077)	(0.907)	(2.729)	(1.229)	(1.144)*	(2.875)	(1.528)	(1.460)
Netherlands	0.070	2.508	0.507	1.782	2.438	0.438	1.712	0.356	1.250	1.847	1.395	0.894	1.491	1.039
	(0.395)	(0.965)**	(0.447)	(0.672)***	(1.043)**	(0.596)	(0.779)**	(0.386)	(1.640)	(0.513)***	(0.789)*	(1.685)	(0.642)**	(0.878)
Norway	1.416	1.973	4.908	4.714	0.557	3.492	3.298	0.935	-0.388	5.586	0.538	-1.323	4.651	-0.397
	(0.437)***	(0.924)**	(0.888)***	(1.052)***	(1.022)	(0.990)***	(1.139)***	(0.385)**	(1.167)	(0.801)***	(0.929)	(1.229)	(0.889)***	(1.005)
Spain[b]	1.006	1.608	0.814	2.837	0.602	-0.192	1.831	0.023	0.650	0.917	0.289	0.626	0.894	0.266
	(0.303)***	(1.122)	(0.428)*	(0.898)***	(1.162)	(0.524)	(0.948)*	(0.208)	(0.988)	(0.479)*	(0.665)	(1.009)	(0.522)*	(0.697)
Sweden	1.056	3.580	3.294	4.004	2.525	2.238	2.949	1.904	1.816	2.858	1.939	-0.087	0.954	0.035
	(0.306)***	(2.354)	(0.917)***	(0.892)***	(2.374)	(0.966)**	(0.943)***	(0.774)**	(1.000)*	(0.567)***	(0.554)***	(1.265)	(0.959)	(0.952)
Switzerland	-2.489	0.063	-1.262	0.526	2.552	1.228	3.016	-0.194	1.984	-0.456	0.079	2.178	-0.261	0.274
	(1.019)**	(0.982)	(1.141)	(0.813)	(1.415)*	(1.529)	(1.303)**	(0.501)	(1.154)*	(0.633)	(0.922)	(1.258)*	(0.807)	(1.049)
UK	1.822	3.756	3.122	3.664	1.934	1.301	1.843	1.131	2.394	3.058	0.713	1.262	1.927	-0.418
	(0.720)**	(1.180)***	(0.496)***	(0.630)***	(1.382)	(0.874)	(0.957)*	(0.574)*	(1.389)*	(0.751)***	(0.576)	(1.503)	(0.946)**	(0.813)
EU	0.515	4.081	1.490	3.057	3.566	0.975	2.542	0.230	3.211	1.826	1.615	2.981	1.596	1.385
	(0.287)*	(0.804)***	(0.334)***	(0.559)***	(0.854)***	(0.440)**	(0.628)***	(0.176)	(0.913)***	(0.351)***	(0.392)***	(0.930)***	(0.393)***	(0.430)***
U.S.	-0.452	2.944	2.214	1.535	3.396	2.666	1.987	0.216	4.891	5.153	1.510	4.675	4.937	1.294
	(0.292)	(1.301)**	(0.578)***	(0.917)*	(1.334)**	(0.648)***	(0.962)**	(0.243)	(1.791)***	(0.645)***	(0.621)**	(1.807)**	(0.689)***	(0.667)*

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

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 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 the United States showed an acceleration of productivity in ICT-using services that was significantly different from that in non-ICT services. In fact in Denmark, Japan, Sweden and Switzerland, ICT-using services showed deceleration relative to non-ICT services, even though none of these differences are statistically significant.

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 is the only country that also shows a significantly faster acceleration in ICT-using services compared to non-ICT services since 1995. 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.

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	-0.336	3.929	-0.001	-0.861	4.265	0.335	-0.526
	(0.902)	(1.403)***	(0.802)	(2.238)	(1.668)**	(1.207)	(2.413)
Canada[b]	0.148	0.015	1.057	0.759	-0.133	0.909	0.611
	(0.668)	(2.031)	(1.152)	(0.936)	(2.138)	(1.331)	(1.150)
Denmark	1.089	-2.303	0.589	-1.009	-3.392	-0.500	-2.098
	(1.887)	(2.445)	(1.389)	(1.550)	(3.088)	(2.343)	(2.442)
Finland	-0.654	-0.719	1.291	-1.692	-0.065	1.944	-1.038
	(0.467)	(2.528)	(1.969)	(1.716)	(2.571)	(2.023)	(1.779)
France[b]	0.341	-0.220	0.430	-0.790	-0.561	0.088	-1.131
	(0.656)	(2.000)	(0.986)	(1.345)	(2.105)	(1.184)	(1.496)
Germany[a]	-0.815	0.209	-0.220	-2.339	1.024	0.595	-1.524
	(0.692)	(1.892)	(1.058)	(1.453)	(2.015)	(1.264)	(1.609)
Ireland	0.656	7.586	1.754	-1.483	6.930	1.099	-2.138
	(1.535)	(5.744)	(2.026)	(1.705)	(5.945)	(2.542)	(2.294)
Italy	-0.719	-1.911	-0.238	-1.347	-1.191	0.482	-0.628
	(0.578)	(1.317)	(0.845)	(1.009)	(1.438)	(1.024)	(1.163)
Japan[c]	0.608	3.166	-1.757	-1.387	2.558	-2.366	-1.995
	(1.022)	(3.158)	(1.394)	(1.493)	(3.319)	(1.728)	(1.810)
Netherlands	0.286	-1.259	1.340	-0.387	-1.545	1.054	-0.673
	(0.552)	(1.903)	(0.680)*	(1.036)	(1.982)	(0.876)	(1.174)
Norway	-0.481	-2.360	0.678	-4.176	-1.879	1.158	-3.695
	(0.582)	(1.489)	(1.196)	(1.403)***	(1.598)	(1.330)	(1.519)**
Spain[b]	-0.983	-0.958	0.103	-2.549	0.024	1.086	-1.566
	(0.368)***	(1.493)	(0.642)	(1.116)**	(1.538)	(0.740)	(1.175)
Sweden	0.848	-1.767	-0.435	-2.064	-2.615	-1.283	-2.912
	(0.832)	(2.558)	(1.078)	(1.050)*	(2.690)	(1.362)	(1.340)**
Switzerland	2.295	1.927	0.806	-0.448	-0.369	-1.489	-2.743
	(1.135)**	(1.515)	(1.305)	(1.229)	(1.893)	(1.729)	(1.673)
UK	-0.691	-1.363	-0.065	-2.952	-0.673	0.626	-2.261
	(0.921)	(1.822)	(0.900)	(0.854)***	(2.041)	(1.287)	(1.256)*
EU	-0.285	-0.870	0.336	-1.442	-0.585	0.621	-1.157
	(0.337)	(1.216)	(0.484)	(0.683)**	(1.262)	(0.590)	(0.761)
U.S.	0.669	1.947	2.939	-0.024	1.279	2.271	-0.693
	(0.380)*	(2.214)	(0.866)***	(1.107)	(2.246)	(0.946)**	(1.171)

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

4. Is Diffusion is Europe Slower than in the U.S?

Even though the grouping of 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 51 of the 52 industries in our database.[33] Since we now deal with 16 countries and 51 industries for two sub-periods (1990-1995 and 1995-2000), most of our discussion below centers on comparisons of industry averages for the eleven EU member countries and the U.S. In addition, the discussion concentrates on services industries, which are among the largest users of ICT and which, because of their sheer size, are major contributors to aggregate productivity growth.[34]

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.

<u>ICT-Producing Industries</u>

In the ICT producing sector, both the U.S. and the EU show very strong productivity growth. Turning first to the ICT producing manufacturing industries, our attention is drawn to the very rapid productivity growth in office and computer equipment and semiconductors. 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 the ICT-producing manufacturing sector as a whole in the second half of the decade has been faster in the U.S.. Also noteworthy is the negative productivity growth in some of the ICT producing manufacturing industries, like radio and TV equipment. The reason for the decline in productivity is that these industries make intensive use of semiconductors and other electronic components. While the prices of these inputs have spectacularly decreased, the output of these industries is valued at roughly unchanged prices. As a result, the (implicit) price of value added is rising rapidly and productivity is declining.

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[33] We excluded Private households (ISIC 95) because of missing data for many countries.

[34] See Appendix D for numbers for individual countries including the numbers for manufacturing industries.

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

ISIC Rev3		1990-1995			1995-2000			Acceleration		
		EU[a]	U.S.	U.S.-EU	EU[a]	U.S.	U.S.-EU	EU[a]	U.S.	U.S.-EU
	Total Economy	**1.9**	**1.1**	**-0.8**	**1.4**	**2.5**	**1.1**	**-0.5**	**1.4**	**1.9**
	ICT Producing Industries	**6.7**	**8.1**	**1.4**	**8.7**	**10.1**	**1.4**	**2.0**	**2.0**	**0.0**
	Manufacturing	**11.1**	**15.1**	**4.0**	**13.8**	**23.7**	**10.0**	**2.6**	**8.6**	**6.0**
30	Computers	33.2	28.6	-4.6	49.3	52.3	3.0	16.1	23.7	7.6
321	Semiconductors	37.7	36.8	-1.0	56.4	52.1	-4.3	18.7	15.3	-3.4
322	Communication eq.	5.0	6.6	1.7	3.5	-0.4	-3.9	-1.5	-7.0	-5.6
313	Fiber optics	6.9	5.6	-1.3	2.9	5.7	2.8	-4.0	0.1	4.1
331	Instruments	-2.6	-4.5	-1.9	-7.2	-5.9	1.3	-4.7	-1.4	3.3
323	Radio and TV eq.	-2.6	-4.6	-2.1	-13.9	-12.5	1.4	-11.3	-7.9	3.4
	Services	**4.4**	**3.1**	**-1.3**	**6.5**	**1.8**	**-4.7**	**2.1**	**-1.4**	**-3.4**
64	Telecommunications	5.7	3.3	-2.5	9.9	6.5	-3.4	4.2	3.2	-0.9
72	Computer services	1.5	2.7	1.2	1.5	-4.5	-6.0	0.0	-7.2	-7.2
	ICT Using Industries[a]	**1.7**	**1.5**	**-0.2**	**1.6**	**4.7**	**3.2**	**-0.1**	**3.3**	**3.4**
	Manufacturing	**3.1**	**-0.3**	**-3.4**	**2.1**	**1.2**	**-1.0**	**-1.0**	**1.4**	**2.4**
31-31.3	Electrical machinery	2.2	0.5	-1.6	2.3	-0.7	-3.0	0.1	-1.3	-1.3
33-33.1	Watches & instruments	7.5	2.1	-5.3	5.1	14.2	9.1	-2.3	12.1	14.4
18	Apparel	5.2	3.4	-1.8	2.9	3.8	0.9	-2.4	0.3	2.7
36-37	Misc. manufacturing	1.1	1.3	0.3	1.5	2.4	0.9	0.4	1.0	0.6
353	Aircraft	0.5	-1.0	-1.5	6.4	1.1	-5.3	5.9	2.1	-3.8
29	Machinery	4.2	0.9	-3.3	1.0	0.3	-0.7	-3.3	-0.7	2.6
352+359	Railroad and other	5.9	-2.0	-7.9	3.1	-0.1	-3.1	-2.8	1.9	4.8
22	Printing & Publishing	1.9	-2.6	-4.6	2.5	-0.2	-2.7	0.5	2.4	1.9
351	Ships	4.1	-3.8	-7.9	0.4	-0.2	-0.6	-3.8	3.6	7.4
	Services	**1.1**	**1.9**	**0.8**	**1.4**	**5.4**	**4.0**	**0.3**	**3.5**	**3.2**
67	Securities trade	1.1	3.2	2.1	2.0	15.3	13.4	0.9	12.1	11.3
52	Retail trade	1.1	2.3	1.2	1.4	6.9	5.5	0.3	4.7	4.4
51	Wholesale trade	2.9	3.4	0.5	1.2	6.1	4.9	-1.7	2.7	4.4
65	Banks	0.4	1.3	0.9	3.0	2.8	-0.2	2.6	1.5	-1.0
73	R&D	-0.2	1.0	1.2	-0.5	3.1	3.6	-0.3	2.1	2.4
741-743	Professional services	-0.4	-0.7	-0.3	0.4	1.0	0.6	0.8	1.8	0.9
71	Renting of machinery	2.4	6.7	4.2	0.5	5.7	5.2	-2.0	-1.0	1.0
66	Insurance	0.2	3.0	2.8	0.2	-1.0	-1.1	-0.1	-4.0	-3.9
	Non-ICT Industries	**1.6**	**0.2**	**-1.4**	**0.7**	**0.5**	**-0.2**	**-0.9**	**0.2**	**1.1**
	Manufacturing	**3.8**	**3.0**	**-0.8**	**1.5**	**1.4**	**-0.1**	**-2.4**	**-1.6**	**0.7**
24	Chemicals	6.8	3.4	-3.4	4.7	4.4	-0.4	-2.0	1.0	3.0
25	Rubber & plastics	3.2	4.6	1.4	1.6	4.1	2.5	-1.6	-0.5	1.1
17	Textiles	3.5	3.0	-0.4	1.4	3.3	2.0	-2.1	0.3	2.4
27	Basic metals	6.9	3.9	-3.0	0.9	3.1	2.2	-6.0	-0.8	5.2
26	Stone, clay & glass	2.5	2.8	0.3	1.4	2.6	1.3	-1.1	-0.2	1.0
23	Petroleum & coal	9.6	5.0	-4.5	0.2	1.5	1.3	-9.3	-3.5	5.8
34	Motor vehicles	3.2	4.9	1.7	0.9	1.4	0.5	-2.3	-3.5	-1.2
19	Leather	3.3	4.9	1.6	0.7	1.3	0.5	-2.5	-3.6	-1.1
28	Fabricated metals	2.2	3.2	1.0	0.9	0.6	-0.3	-1.3	-2.6	-1.3
20	Wood	2.5	-2.8	-5.3	2.7	0.3	-2.4	0.1	3.1	2.9
21	Paper	3.5	0.0	-3.5	2.3	0.2	-2.1	-1.2	0.2	1.4
15-16	Food & beverages	2.9	3.5	0.6	0.0	-4.5	-4.5	-2.9	-8.0	-5.1
	Services	**0.6**	**-0.4**	**-0.9**	**0.2**	**0.4**	**0.2**	**-0.4**	**0.8**	**1.2**
70	Real estate	-0.7	1.6	2.3	-0.8	1.7	2.5	-0.1	0.1	0.2
60-63	Transportation	3.2	2.1	-1.1	1.7	1.6	0.0	-1.5	-0.4	1.0
55	Hotels & restaurants	-1.8	-1.1	0.7	-1.2	0.4	1.6	0.6	1.5	0.9
95	Private households		2.2			0.7			-1.5	
75	Government	1.4	0.0	-1.4	1.1	0.2	-0.8	-0.3	0.3	0.6
74.9	Other business services	-1.1	-1.0	0.1	-0.3	1.4	1.7	0.8	2.4	1.6
85	Health	0.8	-2.2	-2.9	0.4	-0.3	-0.7	-0.3	1.9	2.3
80	Education	0.9	-0.2	-1.1	-0.1	-1.2	-1.1	-0.9	-1.0	0.0
50	Repairs	-0.1	-1.4	-1.2	1.0	-2.5	-3.4	1.1	-1.1	-2.2
90-93	Personal & social serv.	-0.4	0.3	0.7	-0.5	-0.9	-0.5	-0.1	-1.3	-1.2
	Other non-ICT industries	**2.7**	**0.7**	**-2.0**	**1.9**	**0.6**	**-1.3**	**-0.8**	**-0.1**	**0.7**
01-05	Agriculture	5.2	-1.0	-6.3	4.0	6.3	2.3	-1.3	7.3	8.5
40-41	Utilities	4.5	2.5	-2.0	4.9	2.3	-2.7	0.5	-0.2	-0.7
45	Construction	0.4	0.5	0.1	0.2	0.2	0.0	-0.2	-0.3	-0.1
10-14	Mining	7.5	5.4	-2.1	3.5	-1.8	-5.4	-3.9	-7.2	-3.3

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

While the ICT-producing services industries showed notably slower productivity growth than the ICT producing manufacturing industries, ICT-producing services 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 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. From 1995-2000 Europe showed positive productivity growth rates in computer services, whereas negative growth rates were reported for the U.S.[35]

ICT-Using Industries

The ICT-using ector (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 "other electrical machinery" industry and the aircraft industry. However, these widespread gains in the U.S. come against the backdrop of generally lower productivity growth compared to the EU.. Even from 1995-2000 U.S. productivity growth in mostICT-using manufacturing industries was still lower than in Europe.

The story is much different for ICT-using services (other than ICT-producing) where the EU experienced a negligible improvement in productivity growth of 0.3 %-point compared to an increase of 3.5 %-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 two (renting of machinery and insurance) show acceleration in labor productivity growth in the United States, whereas in the European Union most of these industries experienced a decelerating growth performance.

The strong acceleration of productivity in trade is recognized in the U.S. literature.[36] 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, Ireland and the Netherlands

[35] But recently concerns have surfaced concerning the still too fragmented market structure of the European telecom market. See, for example, Isern and Rios (2002).

[36] See, for example, McKinsey Global Institute (2001)

(see Appendix 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 these problems 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.[37] 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.

Table 11 shows that the average productivity growth for a considerable part of 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

[37] 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, 2001).

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.[38] 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. (1.2% in the EU versus 5.0% in the U.S.) Moreover, U.S. productivity accelerated in both sectors, though by substantially more in ICT-using (3.5 % in ICT-services versus 0.8% 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 0.6% to 0.2%).

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 return to our decomposition analysis – introduced by equations (1) and (2) in Section 3. Using this decomposition, aggregate productivity growth in both countries was allocated to the 50 industries used in the industry-by-industry analysis.

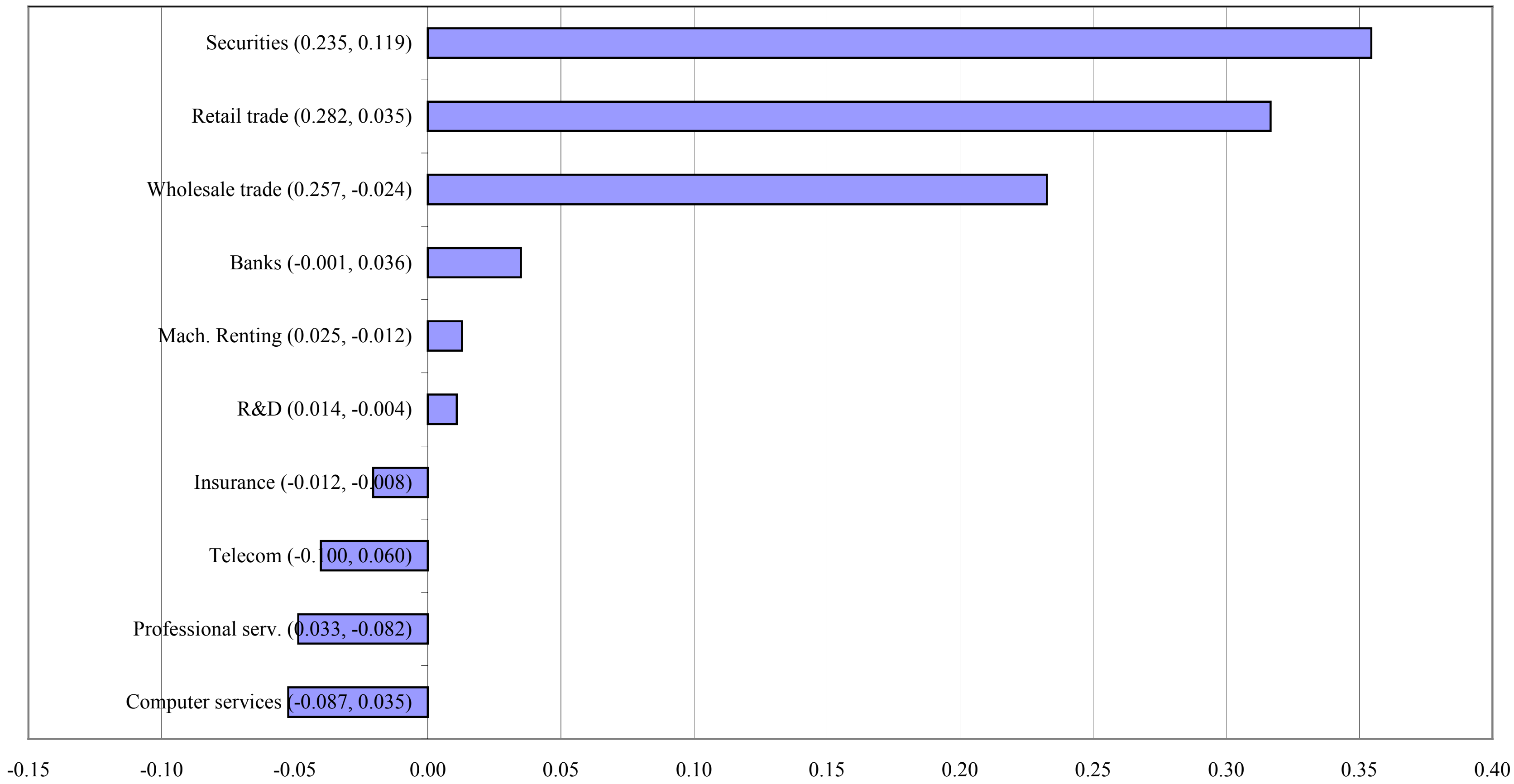
By taking the difference between the EU and the U.S. in terms of industry contributions to aggregate productivity growth, we can allocate the aggregate difference in productivity growth between the U.S. and the EU (which was of 1.1 percentage points from 1995-2000) to the individual industries. The results of this exercise are displayed in Figures 2a to 2c. 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 0.90 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 from 1995-2000. Figure 2b shows that most non-ICT services in Europe

[38] 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.

show faster productivity growth than in the U.S., offsetting part of the slower growth in Europe's ICT-using services. Figure 2c shows that office and computer machinery and semiconductors add substantially to the U.S.-EU productivity differential, but the contributions of other manufacturing industries to the differences in productivity growth between the EU and the U.S. are small.

Figure 2a, Contribution of ICT-using services to U.S.-EU Productivity Differential, 1995-2000



Source: See Appendix Table E.5

Figure 2b, Contribution of Non-ICT services to U.S.-EU Productivity Differential, 1995-2000

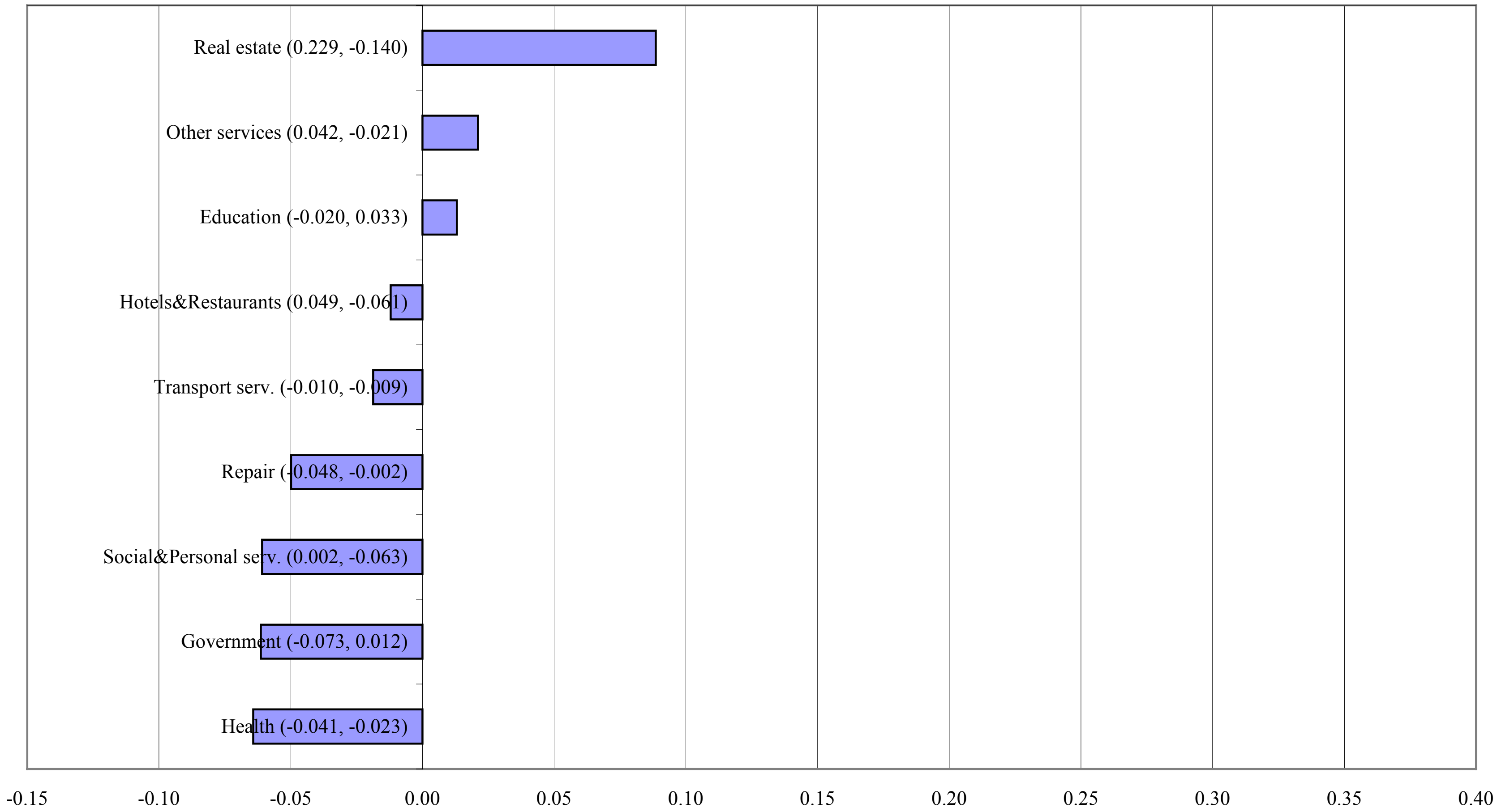
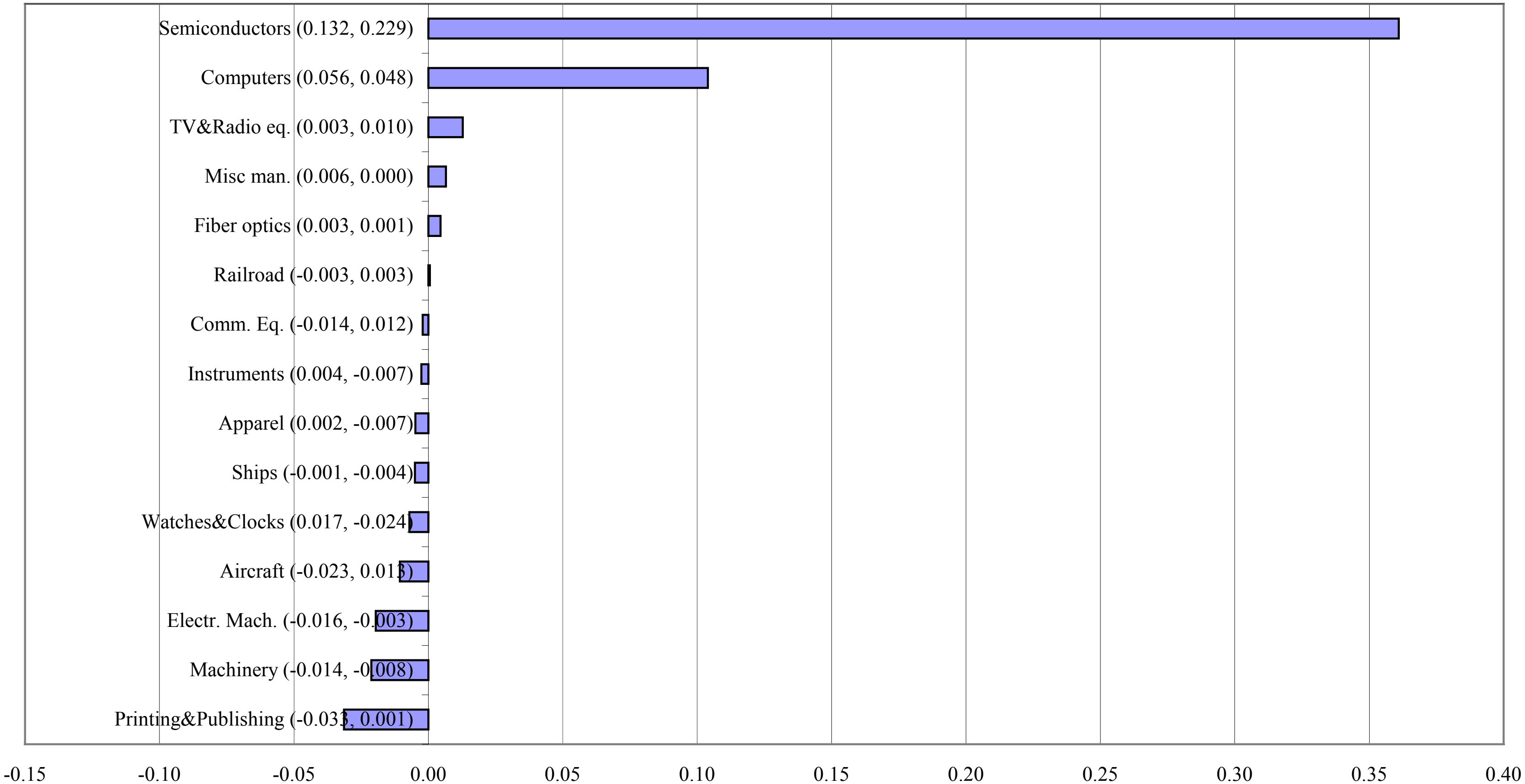


Figure 2c, Contribution of ICT-using manufacturing to U.S.-EU Productivity Differential, 1995-2000



Apart from calculating the differences in the industry contributions to the aggregate growth differential, we can also provide insight into what is driving these differences. In Appendix E we describe a methodology for decomposing the difference in industry contribution to the growth differential between two countries into four effects. From equation (2) it follows that an industry can have a bigger contribution to aggregate growth because 1) its productivity growth is higher, 2) its share in total employment is higher, 3) its productivity level is higher or 4) because the industry has expanded its employment share. We can therefore attribute differences in an industry's contribution to cross-country differences to each of these four factors.

We distinguish between these four effects by running counterfactual shift-share analyses. The employment shares of the U.S. are imposed on the EU and vice-versa. By comparing the "intra-effect" using the same employment shares, we isolate the effect of differences in productivity growth. The remaining difference in the intra-effect is then due to differences in the employment share. By comparing the "shift-effect" with identical employment shares, the productivity level effect is identified. Likewise, the remaining difference in the shift-effect is due to changing employment shares. In the end, we take the average of each of the effects under U.S. and EU employment shares.[39]

In Figure 2a, we not only show the total difference in contribution, but also (between brackets) the part that is due to higher or lower productivity growth. The second figure in brackets is the sum of the remaining three effects.[40] As Figure 2a shows, the majority of the difference in contribution can be explained by differences in productivity growth. This is especially true in the two trade industries and to a lesser extent for the other industries.

Figure 2b shows that in non-ICT services the contributions of individual industries generally have a small effect on the aggregate U.S.-EU productivity differential. The largest positive impact on the U.S.-EU gap is real estate contributing 0.09 percentage points to the productivity growth differential. In this case a much lower productivity growth rate in the EU (-0.8% versus 1.7% in the U.S.) has a reduced impact because of the smaller size of the industry in the EU. The majority of industries in non-ICT services 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 U.S. between 1995-2000.

Figure 2c shows that ICT-using manufacturing industries (including ICT-producing) also account for part of the aggregate productivity differential. Here the role of the semiconductor industry is especially noteworthy. Its contribution to the U.S.-EU growth differential is actually the largest of all industries. This is mostly because the U.S. industry has a much

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[39] See Appendix E for a detailed explanation.

[40] See Appendix Table E5 for the separate effects by industry.

larger employment share than in the EU (0.4 versus 0.2 percent of employment).[41] The computer industry also makes a considerable contribution to the difference between the U.S. and EU, but the remainder of the industries makes only limited contributions. This is because differences in productivity growth rates between the U.S. and the EU are not as large as those found in ICT-using services. In addition, the size differences between the EU and the U.S. in ICT manufacturing are much smaller than those in ICT services.

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 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 semiconductors) omitted, and for service industries only. The first column shows Spearman rank correlation coefficients for productivity growth rates and the second and third columns 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 U.S. 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 U.S. growth pattern during the first period.

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[41] Productivity growth in the semiconductor industry also contributes positively to the U.S.-EU differential. While Table 11 shows higher productivity growth in the EU, the shift-share analysis decomposes the absolute change in productivity (value added per person in currency units) in each industry. Despite the higher European growth rates, the U.S. semiconductor industry has shown a larger absolute increase in productivity.

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

	Spearman Rank Correlations	Pearson correlations	
		On productivity growth	On contributions to aggregate productivity growth
	(1)	(2)	(3)
All industries			
EU and US (1995-2000)	0.47**	0.95**	0.61**
EU and US Acceleration 1995-2000/1990-95	0.47**	0.70**	0.24*
EU (1995-2000) and US (1990-95)	0.31**	0.92**	0.58**
All industries (except 30 and 32.1)			
EU and US (1995-2000)	0.40**	0.60**	0.51**
EU and US Acceleration 1995-2000/1990-95	0.40**	0.38**	0.15
EU (1995-2000) over US (1990-95)	0.23	0.40**	0.48**
Service industries			
EU and US (1995-2000)	0.36**	0.35**	0.35**
EU and US Acceleration 1995-2000/1990-95	0.26	0.27*	0.22
EU (1995-2000) over US (1990-95)	0.50**	0.33**	0.38**

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

Reading across the top panel of Table 12, which shows the correlations when all industries are included, the relationships are positive and, when the productivity growth measure (in column 2) is used, in fact 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 semiconductors (ISIC 321) are dropped from the sample. While the Spearman coefficient (column 1) in the second panel 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 U.S. 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.[42]

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. While the correlation coefficients are somewhat smaller than in the other two panels, they are still significantly positive.

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[42] 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 U.S. industries since 1995 (see Table 11)

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 semiconductor industries, showed strong productivity growth and acceleration in virtually all countries. The contribution of these industries to aggregate productivity growth was 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.. This suggests support for countries that are primarily users and that do not rely on 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 insurance industry.

Clear patterns were less obvious among the non-ICT industries. Productivity performances were very mixed across industries, but on the whole 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 manufacturing 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 ICT-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.[43] Indeed business organization and the opportunities to exploit technologies depend on the constraints and restrictions that firms face. For example, McGuckin and van Ark (2001) 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 research 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 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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[43] A useful summary is in Scarpetta et al. (2000).

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7. Appendices

Appendix A: ICT Classifications and ICT Intensity

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 equipm	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 func	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

The main data on value added in current and constant prices and employment by industry for this study are obtained from the OECD STructural ANalysis (STAN) database.[44] 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.[45] 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 five of the six ICT producing industries (semiconductors, 321; communication equipment, 322, fiber optics, 313; radio and TV equipment, 323; and instruments, 331), for 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 four years, 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. However, this procedure is inadequate for ICT-producing industries (30, 313, 31ex313, 321, 322, 323, 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 price 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

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44 See http://www.oecd.org/EN/document/0,,EN-document-0-nodirectorate-no-1-3245-0,00.html. For the Netherlands, Ireland and Switzerland the national accounts of each country were used. In some cases (for example, for Sweden and the UK) STAN was supplemented with more recent data for the countries' national accounts.

45 In the remainder, any numbers that do not refer to years, are ISIC rev3 codes for the industries in question.

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 U.S..[46]. Since the ICT-producing industries are not separately distinguished in the U.S. NIPA, we constructed these deflators using price changes in output and intermediate inputs of ICT goods. We did this in a fashion that approximates the BEA procedures and results as closely as possible. We describe the details below in the overall description of the U.S. data.

Finally, in (re)calculating aggregates for industry groups and for the aggregate economy we used chain-weighted Törnqvist 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.

<u>Additional sources for individual countries</u>

Below more detailed information is provided on the specific procedures used for each country in the construction of the data, in addition to the general procedure outlined above.[47] Table B1 below shows for which industries additional data was used, the source of this data, how many years were available and the variables available from this source.

Austria

For industries in 31-33, the years that were not available were extrapolated with the change in shares over that period; 1996 was interpolated. For the industries in 50-52 and 74, the shares were assumed to have remained constant before 1997 and after 1998. For these industries, the deflator for the more aggregated industry from STAN was used (for 50-52 and 74 respectively).

Canada

In the STAN file for this country, miscellaneous manufacturing includes instruments, so these were split up using I&S. Repairs, securities trade and professional services could not be distinguished separately. Real estate only consists of owner-occupied dwellings so no corresponding employment figures are available. This industry has therefore been omitted from the database and the total economy figures have been adjusted accordingly. At present, value added in current prices is available only up to 1996 (the year of the most recent I/O table). Value added in constant prices has been extrapolated by Statistics Canada. To derive

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[46] 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

[47] In the following, the abbreviations Cur, Con and Emp refer to respectively value added in current prices, value added in constant prices and persons employed. I&S refers to the OECD *Structural Statistics for Industry and Services*, SerNA for the OECD *Service Statistics on Value Added and Employment* and PPI for weights from the producer price index.

estimates of value added at current prices, we use PPIs for manufacturing industries and data on value added in current prices for broad sectors directly obtained from Statistics Canada. For employment, only information for broad sectors are available, directly obtained from Statistics Canada. Shares at the lower levels of aggregation were extrapolated. For I&S data, shares were assumed to have remained constant before 1994 and after 1995. Shares from SerNA were extrapolated.

Denmark

Employment shares were used in 31-33 for value added in current prices as well. For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years

Finland

For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years

France

In the STAN file for this country, mining (10-14) is partly included in petroleum and coal products (23) and partly in non-metallic mineral products (26). We use detailed national accounts data to break out this industry. For 1990-1991, we use the shares from I&S to extrapolate. Similarly, private households (95) is included in personal & social services (90-93). This industry is also broken out with detailed national accounts data and extrapolated using SerNA. Finally, data on value added in constant prices were extrapolated for 1990 for a number of detailed industries using the average deflator change over the rest of the decade.

Germany

For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years. To split up business services (74) we (arbitrarily) assumed professional services (741-743) makes up half of the total.

Ireland

We used separate national accounts data for this country, since there is no data in STAN yet. The metal industry (27-28) and transport equipment (34-35) were split up using I&S. Missing years from I&S were extrapolated using the trend in the shares for the available years. The deflators from the more aggregated industries were used for each of the parts.

Italy

For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years. Detailed industries in other transport equipment (35) are not available from STAN for the period since 1995, so these were extrapolated using shares from I&S from then on. The I&S data for 1995 were interpolated. For employment in other transport equipment, only the number of full-time equivalents (FTEs) was available for the period until 1995. The share in FTEs was used for 1990 to 1995. Value added in constant prices and employment for 1990 and 1991 in textiles and wearing apparel (17-18), paper and publishing (21-22), the metal industries (27-28) and financial intermediation (65-67) were extrapolated using the data for the later years. This was also done for financial intermediation (65-67) for value added in current prices. Furthermore, real estate (70) includes rental of machinery (71) and computer services (72) includes research and development (73). These were split up using the distribution from Germany. To split up business services (74) we (arbitrarily) assumed professional services (741-743) makes up half of the total.

Japan

For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years. In addition, the industries in other transport equipment (35) as well as the division between education (80) and health (85) was extrapolated for 1998 and 1996-1998 respectively. Repair activities (50) are included with the individual manufacturing industries so could not be separately distinguished. Hotels and restaurants (55) are included in social and personal services (90-93) and could not be separately distinguished. Similarly, financial intermediation (65-67) could not be split up further. Other business activities (71-74) were (arbitrarily) split up according to the following Table.

	Value added	Employment [a)]
71, Renting of machinery	10% of 71-74	5% of BUS
72, Computer services	20% of 71-74	15% of BUS
73, R&D	20% of 71-74	20% of BUS
741-3, Professional services	30% of 71-74	60% of BUS
749, Other business activities	20% of 71-74	(71-74) – BUS

a) BUS is from the Labour Force Survey and calculated as finance, real estate and business services – real estate – finance.

Netherlands

For the Netherlands, we obtained newly revised data directly from the national accounts and the accompanying Input/Output tables, which are fully consistent with the national accounts. These I/O tables were used for a considerable number of manufacturing industries, but are not separately shown in Table B1 due to the consistency with the national accounts. To split up the industries in radio, TV and communication equipment (32), we had only one observation from the PPI weights, which we used for the whole decade. The I/O tables did not include the number persons employed, so here we used shares from the Census.

Norway

For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years. The same goes for trade and repairs (50-52) and other business activities (71-74) based on SerNA. In addition to these two sources, the Structure Statistics from Statistics Norway for 1998 and 1999 were used. For other years, shares were assumed to have remained constant. Furthermore, for most manufacturing industries, data on value added in current prices and employment for 2000 were extrapolated based on I&S (exceptions are food, wood, paper and publishing, basic metals and shipbuilding). For transport and communication (60-64) and real estate (70), data on value added in current prices and employment for 1990 was extrapolated based on SerNA. For value added in constant prices, additional extrapolations had to be made for chemical industries (23-26) based on the aggregate directly from the National Accounts. Textiles (17) and wearing apparel (18) were split up to obtain value added in constant prices by using their share in value added in current prices. Data on value added in constant prices for fabricated metal products (28) were calculated as a residual after subtracting basic metal (27) from the total of the two industries. For the industries in trade and repair (50-52) the deflator for the more aggregated industry was used. Finally, employment in community social and personal services (75-99) was extrapolated for 1998-2000 using trends from STAN for the earlier years.

Spain

For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years. The same goes for 50-52 based on SerNA. Business services (74) could not be split up any further. Industries in financial intermediation (65-67) and other business activities (71-74) were extrapolated for 1990-1994 and 1999 based on shares from STAN for the other years. The same was done for transport and communication (60-64) for 1999. Value added in constant prices for all manufacturing industries except food (15-16) and non-metallic mineral products (26) were also extrapolated for these years based on the deflators for more aggregated industries.

Sweden

The STAN data for Sweden currently run to 1998. We extended this to 2000 using detailed national accounts tables from Statistics Sweden. For 31-33, missing years in I&S were extrapolated using the trend in the shares for the available years. For 50-52, shares were assumed to have remained constant for years before 1997 and after 1998. Financial intermediation (65-67) and community, social and personal services (75-99) could not be split up further. For aggregating to the EU level, the average shares of the detailed industries for all other EU countries were applied. Research and development (73), professional services (741-743) and other business services (749) were split up using their composition in Denmark. Employment alone had to be split up for textiles and wearing apparel (17-18) and other transport equipment (35) using I&S. To obtain value added in constant prices for 1990-1992 for all manufacturing industries, shares were extrapolated using data for later years. For most services industries, the deflator for a more aggregated industry was used.

Switzerland

We used separate national accounts data for this country, since there is no data in STAN yet. For value added in current prices and employment the weight in the PPI was used to distinguish fiber optics (313) from the rest of electrical machinery (31ex313) and split up radio, TV and communication equipment (32). In instruments and watches (33), only watches (335) could be distinguished separately, so instruments (331) includes everything but watches. Business services (74) could not be split up.

United Kingdom

At present, the data from STAN only run up to 1999. Data for 2000 were obtained directly from the National Acounts in the ONS Blue Book (2001). For 1999 and 2000, Table B1 shows that the Annual Business Inquiry (ABI) was used for extrapolation in a number of industries. For value added in constant prices, deflators for more aggregated industries were used. The number of self-employed is only available for broad sectors, so the share of self-employed in the total number of persons employed is applied to all underlying industries.

United States

Since the U.S. 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, it did not provide a further disaggregation to 3-digit level. For insulated wire and cable (313), semiconductors (321), communication equipment (322), radio and TV receivers (323), and medical and measurement instruments and industrial process control (331), 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.[48] For a number of 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 the 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 had to be made. First, value added and employment for wholesale trade, retail trade and repairs had to be separated. While these are separate industries in the BEA "GDP by Industry" data set, they are combined in STAN. According to 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 Hotels and restaurants (ISIC 55). Since gross output from this source is not consistent with the GDP by Industry figures, we scaled the figures down to equal the GDP by Industry totals.[49] We next used value added from the BLS 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. Employment figures were obtained from the BLS. These are employees figures instead of persons employed figures, and not completely consistent with the figures the BEA figures reported in the GDP by Industry data. We used employee shares to scale these up to the number of persons employed. It should be stressed that these adjustments for retail trade and restaurants do matter in an important way. It

[48] Here, the BEA "Shipments of Manufacturing Industries" 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, we extrapolated 31 and 313 as well as 33 and 331 with the growth rate of 31 and 33 respectively. For the years 1997-2000, we applied the growth rates from the NAICS based data.

[49] 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.

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, other business activities (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). Finally, post and telecommunications should not include radio and TV broadcasting (SIC 483) so we relocate this industry to ISIC 90-93 as well. The industries in other business activities (71-74) can now also be separately distinguished.

The next problem was that no separate price deflators are available for the machinery and electrical machinery industries (29-33), the other transport equipment industries (35) or for the industries in which we reclassified detailed industries. We therefore developed our own deflators for these industries. From the BEA data sets on "Gross Output by Detailed Industry" and "Shipments of Manufacturing Industries" we used value of shipments deflators for manufacturing industries and gross output deflators for non-manufacturing industries. We use a Törnqvist index to obtain gross output (value of shipments) deflators for each of the industries.

We then use the Input/Output (I/O) tables from the Bureau of Labor Statistics (BLS)[50] for 1990-2000 to calculate an intermediate input deflator for each ISIC industry. For each of the 190 I/O industries distinguished we calculated a gross output deflator series.[51] We use these deflators to calculate an intermediate input price index for each industry. For industry *i* this is done in the following way:

$$\Delta \ln P_i^M = \sum_j \bar{s}_{i,j}^M \Delta \ln P_{i,j}^M \qquad \text{(B1)}$$

In equation (B1) $P_{i,j}^M$ is the price of the j^{th} intermediate input used in industry *i*. The price change for this input is weighted by the average share of input *j* in total intermediate inputs in current prices of the industry over the two periods:

[50] Specifically from the Office of Occupational Statistics and Employment Projections (www.bls.gov/emp). We use these tables since they are available for each year in our sample and because the industry detail is much greater (190 versus 96 industries).

[51] If there is a many-to-one correspondence, we use a Törnqvist index to aggregate to the level of aggregation of the I/O table.

$$\bar{s}_{i,j}^{M} = \frac{1}{2}\left(\frac{P_{i,j}^{M,t} M_{i,j}^{t}}{\sum_{j} P_{i,j}^{M,t} M_{i,j}^{t}} + \frac{P_{i,j}^{M,t-1} M_{i,j}^{t-1}}{\sum_{j} P_{i,j}^{M,t-1} M_{i,j}^{t-1}} \right). \tag{B2}$$

Using the deflators for gross output and intermediate inputs, we calculate gross output and intermediate inputs at constant prices. These are combined to calculate value added in constant prices:

$$\Delta \ln V_i = \frac{1}{\bar{s}_i^{V}} \left(\Delta \ln Q_i - \bar{s}_i^{M} \Delta \ln M_i \right) \tag{B3}$$

Here, V_i, Q_i and M_i are the quantity indices of value added, gross output and intermediate inputs respectively. Furthermore:

$$s_i^{V} = 1 - s_i^{M} = \frac{P_i^t Q_i^t - P_i^{M,t} Q_i^{M,t}}{P_i^t Q_i^t} \tag{B4}$$

In other words, s_i^{V} is the share of current value added in current gross output. The average over the two periods is taken and used in equation (B3). While this procedure does not exactly replicate the BEA procedure, it serves as a good approximation since the aggregate deflators are close to the value added deflator from the national accounts.[52] Given these deflators, value added in constant prices all industries could be calculated.

[52] Differences exist for a number of reasons: the BEA uses the detailed source material of the I/O tables, which is even more disaggregated than the 532-industry detail benchmark table. Furthermore we use a single deflator for all inputs from a certain commodity category, while the BEA distinguishes between domestically produced and imported goods. Also, our price deflators correspond to the value of shipments of an *industry* not of the *commodities* that are used as inputs.

Table B1, Description of additional data used in the construction of the database

Industry	ISIC rev3	Austria		Canada		Denmark		Finland	
Agriculture	01-05								
Mining	10-14								
Food & beverages	15-16								
Textiles	17			I&S (94-95)	Cur, Emp				
Apparel	18			I&S (94-95)	Cur, Emp				
Leather	19			I&S (94-95)	Cur, Emp				
Wood	20								
Paper	21			I&S (94-95)	Cur, Emp				
Printing & Publishing	22			I&S (94-95)	Cur, Emp				
Petroleum & coal	23								
Chemicals	24								
Rubber & plastics	25								
Stone, clay & glass	26								
Basic metals	27								
Fabricated metals	28								
Machinery	29								
Office and Comp. Eq.	30								
Fiber optics	31.3	I&S (91-98ex96)	Cur, Emp	I&S (94-95)	Cur, Emp	I&S (93-98)	Emp	I&S (95-98)	Cur, Emp
Electrical machinery	31-31.3	I&S (91-98ex96)	Cur, Emp	I&S (94-95)	Cur, Emp	I&S (93-98)	Emp	I&S (95-98)	Cur, Emp
Semiconductors	32.1	I&S (91-98ex96)	Cur, Emp	I&S (94-95)	Cur, Emp	I&S (93-98)	Emp	I&S (95-98)	Cur, Emp
Communication eq.	32.2	I&S (91-98ex96)	Cur, Emp	I&S (94-95)	Cur, Emp	I&S (93-98)	Emp	I&S (95-98)	Cur, Emp
Radio and TV eq.	32.3	I&S (91-98ex96)	Cur, Emp	I&S (94-95)	Cur, Emp	I&S (93-98)	Emp	I&S (95-98)	Cur, Emp
Instruments	33.1	I&S (91-98ex96)	Cur, Emp	I&S (94-95)	Cur, Emp	I&S (93-98)	Emp	I&S (95-98)	Cur, Emp
Watches & instruments	33-33.1	I&S (91-98ex96)	Cur, Emp	I&S (94-95)	Cur, Emp	I&S (93-98)	Emp	I&S (95-98)	Cur, Emp
Motor vehicles	34								
Ships	351								
Aircraft	353								
Railroad and other	352+359								
Misc. manufacturing	36-37			I&S (94-95)	Cur, Emp				
Utilities	40-41								
Construction	45								
Repairs	50	I&S (97-98)	Cur, Emp			SerNA (90-99)	Cur, Con, Emp	SerNA (90-99)	Cur, Con, Emp
Wholesale trade	51	I&S (97-98)	Cur, Emp	SerNA (90-99)	Cur, Con, Emp	SerNA (90-99)	Cur, Con, Emp	SerNA (90-99)	Cur, Con, Emp
Retail trade	52	I&S (97-98)	Cur, Emp	SerNA (90-99)	Cur, Con, Emp	SerNA (90-99)	Cur, Con, Emp	SerNA (90-99)	Cur, Con, Emp
Hotels & restaurants	55								
Transport	60-63								
Telecommunications	64								
Banks	65			SerNA (90-99)	Cur, Con, Emp				
Insurance	66			SerNA (90-99)	Cur, Con, Emp				
Securities trade	67								
Real estate	70								
Renting of machinery	71								
Computer services	72			SerNA (90-99)	Cur, Con, Emp				
R&D	73			Residual					
Professional services	74.1-74.3	I&S (97-98)	Cur, Emp	SerNA (90-99)[a)]	Cur, Con, Emp	SerNA (90-97)	Cur, Con, Emp	SerNA (90-99)	Cur, Con, Emp
Other business services	74.9	I&S (97-98)	Cur, Emp			SerNA (90-97)	Cur, Con, Emp	SerNA (90-99)	Cur, Con, Emp
Government	75								
Education	80								
Health	85								
Personal & social serv.	90-93								
Private households	95								

a) All of 74
b) Arbitrarily assumed to have equal shares
c) 70 includes 71, 72 includes 73. Split up based on composition in Germany
d) See text for details on subdivision
e) Split up using shares for Denmark
f) All of 33, except watches is included under 331
g) See text for details on data used for these industries
h) For these industries new deflators are calculated

Table B1, Continued

Industry	ISIC rev3	France		Germany		Ireland		Italy	
Agriculture	01-05								
Mining	10-14	NA (92-99)	Cur, Con, Emp						
Food & beverages	15-16								
Textiles	17								
Apparel	18								
Leather	19								
Wood	20								
Paper	21								
Printing & Publishing	22								
Petroleum & coal	23	NA (92-99)	Cur, Con, Emp						
Chemicals	24								
Rubber & plastics	25								
Stone, clay & glass	26	NA (92-99)	Cur, Con, Emp						
Basic metals	27					I&S (91-97)	Cur, Emp		
Fabricated metals	28					I&S (91-97)	Cur, Emp		
Machinery	29								
Office and Comp. Eq.	30								
Fiber optics	31.3	I&S (90-98)	Cur, Emp	I&S (95-99)	Cur, Emp	I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Electrical machinery	31-31.3	I&S (90-98)	Cur, Emp	I&S (95-99)	Cur, Emp	I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Semiconductors	32.1	I&S (90-98)	Cur, Emp	I&S (95-99)	Cur, Emp	I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Communication eq.	32.2	I&S (90-98)	Cur, Emp	I&S (95-99)	Cur, Emp	I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Radio and TV eq.	32.3	I&S (90-98)	Cur, Emp	I&S (95-99)	Cur, Emp	I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Instruments	33.1	I&S (90-98)	Cur, Emp	I&S (95-99)	Cur, Emp	I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Watches & instruments	33-33.1	I&S (90-98)	Cur, Emp	I&S (95-99)	Cur, Emp	I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Motor vehicles	34					I&S (91-97)	Cur, Emp		
Ships	351					I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Aircraft	353							I&S(92-97ex95)	Cur, Emp
Railroad and other	352+359					I&S (91-97)	Cur, Emp	I&S(92-97ex95)	Cur, Emp
Misc. manufacturing	36-37								
Utilities	40-41								
Construction	45								
Repairs	50	SerNA (90-99)	Cur, Con, Emp	SerNA (91-98)	Cur, Con, Emp			SerNA (92-99)	Cur, Con, Emp
Wholesale trade	51	SerNA (90-99)	Cur, Con, Emp	SerNA (91-98)	Cur, Con, Emp			SerNA (92-99)	Cur, Con, Emp
Retail trade	52	SerNA (90-99)	Cur, Con, Emp	SerNA (91-98)	Cur, Con, Emp			SerNA (92-99)	Cur, Con, Emp
Hotels & restaurants	55								
Transport	60-63								
Telecommunications	64								
Banks	65								
Insurance	66								
Securities trade	67								
Real estate	70							c)	
Renting of machinery	71							c)	
Computer services	72							c)	
R&D	73							c)	
Professional services	74.1-74.3	SerNA (90-99)	Cur, Con, Emp	b)		a)		b)	
Other business services	74.9	SerNA (90-99)	Cur, Con, Emp	b)				b)	
Government	75								
Education	80								
Health	85								
Personal & social serv.	90-93	NA (92-99)	Cur, Con, Emp						
Private households	95	NA (92-99)	Cur, Con, Emp						

a) All of 74
b) Arbitrarily assumed to have equal shares
c) 70 includes 71, 72 includes 73. Split up based on composition in Germany
d) See text for details on subdivision
e) Split up using shares for Denmark
f) All of 33, except watches is included under 331
g) See text for details on data used for these industries
h) For these industries new deflators are calculated

Industry	ISIC rev3	Japan		Netherlands		Norway		Spain	
Agriculture	01-05								
Mining	10-14								
Food & beverages	15-16								
Textiles	17			Census(93-99)	Emp				
Apparel	18			Census(93-99)	Emp				
Leather	19			Census(93-99)	Emp				
Wood	20			Census(93-99)	Emp				
Paper	21								
Printing & Publishing	22								
Petroleum & coal	23								
Chemicals	24								
Rubber & plastics	25								
Stone, clay & glass	26			Census(93-99)	Emp				
Basic metals	27								
Fabricated metals	28								
Machinery	29								
Office and Comp. Eq.	30			Census(93-99)	Emp				
Fiber optics	31.3	I&S(94-98)	Cur, Emp	I&S(92-98)	Cur, Emp	I&S(91-99)	Cur, Emp	I&S(93-98)	Cur, Emp
Electrical machinery	31-31.3	I&S(94-98)	Cur, Emp	I&S(92-98)	Cur, Emp	I&S(91-99)	Cur, Emp	I&S(93-98)	Cur, Emp
Semiconductors	32.1	I&S(94-98)	Cur, Emp	PPI(95)		I&S(91-99)	Cur, Emp	I&S(93-98)	Cur, Emp
Communication eq.	32.2	I&S(94-98)	Cur, Emp	PPI(95)		I&S(91-99)	Cur, Emp	I&S(93-98)	Cur, Emp
Radio and TV eq.	32.3	I&S(94-98)	Cur, Emp	PPI(95)		I&S(91-99)	Cur, Emp	I&S(93-98)	Cur, Emp
Instruments	33.1	I&S(94-98)	Cur, Emp	I&S(92-98)	Cur, Emp	I&S(91-99)	Cur, Emp	I&S(93-98)	Cur, Emp
Watches & instruments	33-33.1	I&S(94-98)	Cur, Emp	I&S(92-98)	Cur, Emp	I&S(91-99)	Cur, Emp	I&S(93-98)	Cur, Emp
Motor vehicles	34			Census(93-99)	Emp				
Ships	351			Census(93-99)	Emp				
Aircraft	353			Census(93-99)	Emp				
Railroad and other	352+359			Census(93-99)	Emp				
Misc. manufacturing	36-37			Census(93-99)	Emp				
Utilities	40-41								
Construction	45								
Repairs	50					Struc(98-99)	Cur, Emp	SerNA(95-97)	Cur, Con, Emp
Wholesale trade	51	SerNA(90-98)	Cur, Con, Emp			Struc(98-99)	Cur, Emp	SerNA(95-97)	Cur, Con, Emp
Retail trade	52	SerNA(90-98)	Cur, Con, Emp			Struc(98-99)	Cur, Emp	SerNA(95-97)	Cur, Con, Emp
Hotels & restaurants	55								
Transport	60-63								
Telecommunications	64								
Banks	65					SerNA(90-97)	Cur, Con, Emp		
Insurance	66					SerNA(90-97)	Cur, Con, Emp		
Securities trade	67					SerNA(90-97)	Cur, Con, Emp		
Real estate	70	d)							
Renting of machinery	71	d)				SerNA(90-97)	Cur, Con, Emp		
Computer services	72	d)				SerNA(90-97)	Cur, Con, Emp		
R&D	73	d)				Struc(98-99)	Cur, Emp		
Professional services	74.1-74.3	d)				Struc(98-99)	Cur, Emp	a)	
Other business services	74.9	d)				Struc(98-99)	Cur, Emp		
Government	75								
Education	80								
Health	85								
Personal & social serv.	90-93								
Private households	95								

a) All of 74
b) Arbitrarily assumed to have equal shares
c) 70 includes 71, 72 includes 73. Split up based on composition in Germany
d) See text for details on subdivision
e) Split up using shares for Denmark
f) All of 33, except watches is included under 331
g) See text for details on data used for these industries
h) For these industries new deflators are calculated

Industry	ISIC rev3	Sweden		Switzerland	UK		US		
Agriculture	01-05								
Mining	10-14								
Food & beverages	15-16								
Textiles	17	I&S(91-98)	Emp		I&S(93-98), ABI(99-00)	Cur, Emp	ASM(00)	Cur, Emp	
Apparel	18	I&S(91-98)	Emp		I&S(93-98), ABI(99-00)	Cur, Emp	ASM(00)	Cur, Emp	
Leather	19				I&S(93-98), ABI(99-00)	Cur, Emp			
Wood	20								
Paper	21				I&S(93-98), ABI(99-00)	Cur, Emp			
Printing & Publishing	22				I&S(93-98), ABI(99-00)	Cur, Emp			
Petroleum & coal	23								
Chemicals	24								
Rubber & plastics	25								
Stone, clay & glass	26								
Basic metals	27				ABI(99-00)	Cur, Emp			
Fabricated metals	28				ABI(99-00)	Cur, Emp			
Machinery	29								
Office and Comp. Eq.	30				ABI(99-00)	Cur, Emp	ASM(00)	Cur, Emp	h)
Fiber optics	31.3	I&S(91-98)	Cur, Emp	PPI(93)	I&S(93-98), ABI(99-00)	Cur, Emp	ASM(90-00)	Cur, Emp	h)
Electrical machinery	31-31.3	I&S(91-98)	Cur, Emp	PPI(93)	I&S(93-98), ABI(99-00)	Cur, Emp	ASM(90-00)	Cur, Emp	h)
Semiconductors	32.1	I&S(91-98)	Cur, Emp	PPI(93)	I&S(93-98), ABI(99-00)	Cur, Emp	ASM(90-00)	Cur, Emp	h)
Communication eq.	32.2	I&S(91-98)	Cur, Emp	PPI(93)	I&S(93-98), ABI(99-00)	Cur, Emp	ASM(90-00)	Cur, Emp	h)
Radio and TV eq.	32.3	I&S(91-98)	Cur, Emp	PPI(93)	I&S(93-98), ABI(99-00)	Cur, Emp	ASM(90-00)	Cur, Emp	h)
Instruments	33.1	I&S(91-98)	Cur, Emp	f)	I&S(93-98), ABI(99-00)	Cur, Emp	ASM(90-00)	Cur, Emp	h)
Watches & instruments	33-33.1	I&S(91-98)	Cur, Emp	f)	I&S(93-98), ABI(99-00)	Cur, Emp	ASM(90-00)	Cur, Emp	h)
Motor vehicles	34				ABI(99-00)	Cur, Emp			
Ships	351	I&S(91-98)	Emp		ABI(99-00)	Cur, Emp	ASM(00)	Cur, Emp	h)
Aircraft	353	I&S(91-98)	Emp		ABI(99-00)	Cur, Emp	ASM(00)	Cur, Emp	h)
Railroad and other	352+359	I&S(91-98)	Emp		ABI(99-00)	Cur, Emp	ASM(00)	Cur, Emp	h)
Misc. manufacturing	36-37								
Utilities	40-41								
Construction	45								
Repairs	50	I&S(97-98)	Cur, Emp		SerNA(92-98), ABI(99-00)	Cur, Con, Emp	g)		h)
Wholesale trade	51	I&S(97-98)	Cur, Emp		SerNA(92-98), ABI(99-00)	Cur, Con, Emp			
Retail trade	52	I&S(97-98)	Cur, Emp		SerNA(92-98), ABI(99-00)	Cur, Con, Emp	g)		h)
Hotels & restaurants	55						g)		h)
Transport	60-63								
Telecommunications	64						g)		h)
Banks	65								
Insurance	66								
Securities trade	67								
Real estate	70								
Renting of machinery	71				ABI(99-00)	Cur, Emp	g)		h)
Computer services	72				ABI(99-00)	Cur, Emp	g)		h)
R&D	73	e)			ABI(99-00)	Cur, Emp	g)		h)
Professional services	74.1-74.3	e)		a)	SerNA(92-98), ABI(99-00)	Cur, Emp	g)		h)
Other business services	74.9	e)			SerNA(92-98), ABI(99-00)	Cur, Emp	g)		h)
Government	75								
Education	80								
Health	85								
Personal & social serv.	90-93						g)		h)
Private households	95								

a) All of 74
b) Arbitrarily assumed to have equal shares
c) 70 includes 71, 72 includes 73. Split up based on composition in Germany
d) See text for details on subdivision
e) Split up using shares for Denmark
f) All of 33, except watches is included under 331
g) See text for details on data used for these industries
h) For these industries new deflators are calculated

Appendix C: Contributions of industry groups and industries to productivity growth

Appendix Table C1: Contribution of industry groups to labor productivity growth, 1990-1995 and 1995-2000

1990-1995	Austria	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden	UK	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy	2.30	1.62	3.38	1.00	2.15	3.03	1.81	0.66	1.62	2.84	2.89	**1.88**	1.07	0.79	3.34	-0.11	**1.08**
ICT Producers	0.27	0.34	0.32	0.24	0.34	0.89	0.10	0.17	0.15	0.25	0.54	**0.33**	0.14	0.50	0.13	0.08	**0.51**
ICT-producing manufacturing	0.12	0.07	0.16	0.15	0.13	0.82	0.05	0.09	0.07	-0.01	0.30	**0.17**	0.12	0.39	0.05	0.03	**0.40**
ICT-producing services	0.15	0.27	0.16	0.10	0.21	0.07	0.05	0.07	0.08	0.26	0.24	**0.16**	0.02	0.11	0.07	0.05	**0.11**
ICT Users	0.58	0.29	0.42	0.28	0.44	0.42	0.61	0.18	-0.06	0.76	0.67	**0.42**	0.59	0.19	1.01	-0.51	**0.43**
ICT-using manufacturing	0.11	0.17	0.31	0.18	0.22	0.37	0.24	0.09	0.08	0.32	0.13	**0.20**	0.08	-0.09	0.06	0.00	**-0.01**
ICT-using services	0.47	0.12	0.11	0.10	0.21	0.05	0.37	0.09	-0.14	0.44	0.54	**0.23**	0.51	0.29	0.95	-0.51	**0.45**
Non ICT	1.25	1.00	2.35	0.48	1.35	1.48	0.99	0.47	1.37	1.88	1.92	**1.10**	0.47	0.00	2.79	0.41	**0.23**
Non-ICT manufacturing	0.60	0.28	0.85	0.42	0.66	1.29	0.38	0.43	0.47	0.78	0.52	**0.51**	0.27	0.04	0.16	0.47	**0.31**
Non-ICT services	0.02	0.24	0.94	-0.13	0.40	-0.27	0.25	-0.10	0.38	0.76	0.63	**0.25**	-0.05	-0.08	0.29	-0.05	**-0.15**
Non-ICT other industries	0.63	0.48	0.57	0.19	0.29	0.45	0.36	0.14	0.52	0.34	0.76	**0.34**	0.25	0.03	2.34	-0.01	**0.07**
Shift effect	0.20	-0.02	0.29	0.00	0.02	0.24	0.11	-0.16	0.16	-0.06	-0.23	**0.03**	-0.13	0.10	-0.58	-0.09	**-0.10**
1995-2000	Austria[b]	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden	UK	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy	2.29	1.89	2.57	1.17	1.36	5.46	0.81	0.94	0.37	2.10	1.77	**1.41**	1.43	0.88	1.73	1.06	**2.52**
ICT Producers	0.16	0.28	0.86	0.46	0.67	2.75	0.27	0.16	0.23	0.18	0.56	**0.47**	0.32	0.73	0.35	-0.11	**0.75**
ICT-producing manufacturing	0.17	0.06	0.55	0.22	0.20	2.77	0.06	-0.03	0.10	0.03	0.32	**0.22**	0.19	0.61	0.04	-0.09	**0.68**
ICT-producing services	-0.01	0.21	0.31	0.24	0.46	-0.02	0.21	0.18	0.13	0.15	0.24	**0.25**	0.13	0.12	0.31	-0.03	**0.07**
ICT Users	0.82	0.51	0.56	0.24	0.35	0.89	0.24	0.56	0.03	0.67	0.66	**0.42**	0.78	0.04	0.84	0.48	**1.42**
ICT-using manufacturing	0.34	0.01	0.10	0.09	0.18	0.56	0.10	0.13	0.05	0.10	0.10	**0.13**	0.05	0.04	-0.06	0.24	**0.05**
ICT-using services	0.48	0.51	0.46	0.15	0.18	0.33	0.14	0.43	-0.01	0.57	0.56	**0.29**	0.73	0.00	0.90	0.24	**1.37**
Non ICT	1.02	1.10	0.96	0.46	0.24	1.65	0.19	0.23	0.09	1.18	0.60	**0.48**	0.25	-0.01	0.68	0.71	**0.36**
Non-ICT manufacturing	0.61	0.37	0.41	0.32	0.07	1.76	0.08	0.20	-0.04	0.44	0.04	**0.18**	0.19	-0.03	0.13	0.57	**0.13**
Non-ICT services	-0.14	0.57	0.28	0.03	-0.05	-0.31	-0.16	0.02	-0.06	0.69	0.39	**0.08**	-0.12	0.22	0.18	0.27	**0.18**
Non-ICT other industries	0.55	0.15	0.27	0.11	0.22	0.19	0.27	0.00	0.19	0.05	0.17	**0.21**	0.18	-0.20	0.36	-0.13	**0.05**
Shift effect	0.29	0.00	0.18	0.01	0.09	0.17	0.11	-0.01	0.01	0.08	-0.04	**0.05**	0.09	0.12	-0.14	-0.02	**-0.01**

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; b) 1995-99; c) 1995-98; d) excluding ICT-producing industries

Appendix Table C2: Contribution of industries to productivity growth in the EU and the U.S. for 1995-2000

		EU	US	Difference
Total Economy		**1.40**	**2.49**	**1.09**
Total ICT-producing manufacturing		**0.25**	**0.73**	**0.48**
30	Office and Comp. Eq.	0.14	0.24	0.10
313	Fiber optics	0.00	0.00	0.00
321	Semiconductors	0.14	0.50	0.36
322	Communication eq.	0.02	0.02	0.00
323	Radio and TV eq.	-0.02	0.00	0.01
331	Instruments	-0.03	-0.03	0.00
Total ICT-producing services		**0.35**	**0.26**	**-0.09**
64	Telecommunications	0.20	0.16	-0.04
72	Computer services	0.14	0.09	-0.05
Total ICT-using manufacturing		**0.01**	**-0.08**	**-0.09**
18	Apparel	-0.01	-0.02	0.00
22	Printing & Publishing	0.00	-0.03	-0.03
29	Machinery	0.00	-0.02	-0.02
31-31.3	Electrical machinery	0.01	-0.01	-0.02
33-33.1	Watches & instruments	0.00	0.00	-0.01
35.1	Ships	0.00	0.00	-0.01
35.3	Aircraft	0.00	-0.01	-0.01
35.2+35.9	Railroad and other	0.00	0.00	0.00
36-37	Misc. manufacturing	0.00	0.01	0.01
Total ICT-using services		**0.41**	**1.30**	**0.89**
51	Wholesale trade	0.07	0.30	0.23
52	Retail trade	0.06	0.38	0.32
65	Banks	0.06	0.10	0.04
66	Insurance	-0.01	-0.03	-0.02
67	Securities trade	0.02	0.37	0.35
71	Renting of machinery	0.03	0.04	0.01
73	R&D	0.00	0.01	0.01
74.1-74.3	Professional services	0.16	0.11	-0.05
Total Non-ICT manufacturing		**0.04**	**-0.05**	**-0.09**
15-16	Food products	-0.02	-0.09	-0.07
17	Textiles	-0.01	-0.01	0.00
19	Leather	-0.01	0.00	0.00
20	Wood products	0.00	0.00	-0.01
21	Paper products	0.00	-0.01	-0.02
23	Petroleum & coke	-0.01	0.00	0.01
24	Chemicals	0.05	0.04	-0.01
25	Rubber and plastics	0.01	0.02	0.00
26	Stone, clay & glass	0.00	0.01	0.01
27	Basic metals	-0.01	0.01	0.02
28	Fabricated metal products	0.01	0.00	-0.01
34	Motor vehicles	0.03	0.01	-0.02
Total Non-ICT services		**0.38**	**0.23**	**-0.14**
50	Repairs	0.03	-0.02	-0.05
55	Hotels & restaurants	0.02	0.01	-0.01
60-63	Transportation	0.09	0.07	-0.02
70	Real estate	0.05	0.14	0.09
74.9	Other business services	0.12	0.14	0.02
75	Government	-0.03	-0.09	-0.06
80	Education	-0.01	0.00	0.01
85	Health	0.05	-0.01	-0.06
90-93	Personal & social services	0.05	-0.01	-0.06
Total Non-ICT other industries		**-0.03**	**0.10**	**0.13**
01-05	Agriculture	0.01	0.06	0.05
10-14	Mining	-0.02	-0.05	-0.03
40-41	Utilities	0.02	-0.02	-0.04
45	Construction	-0.05	0.11	0.16

Notes: these contributions include both the intra-effect and the shift-effect from equation (2)

Appendix D: Productivity growth by industry and country

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

1990-1995		Austria	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden	UK	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy		**2.3**	**1.6**	**3.3**	**1.0**	**2.1**	**3.0**	**1.8**	**0.7**	**1.6**	**2.8**	**2.8**	**1.9**	**1.1**	**0.8**	**3.3**	**-0.1**	**1.1**
Total ICT-producing manufacturing		**7.6**	**6.5**	**8.9**	**10.0**	**6.8**	**17.1**	**4.6**	**5.7**	**8.3**	**-0.7**	**15.8**	**11.1**	**11.8**	**12.4**	**8.4**	**1.4**	**15.1**
Office and Comp. Eq.	30	24.2	24.3	11.0	26.2	26.8	29.1	28.7	34.2	28.4	25.2	33.8	33.2	16.6	26.9	33.7	27.8	28.6
Fiber optics	31.3	4.5	11.8	9.2	5.0	6.5	13.6	6.3	10.5	11.1	18.3	-0.3	6.9	4.9	13.3	7.1	2.6	5.6
Semiconductors	32.1	24.7	28.9	22.8	32.3	41.9	32.0	33.4	31.0	26.5	19.0	36.1	37.7	29.7	23.5	33.5	31.5	36.8
Communication eq.	32.2	5.1	2.4	9.8	3.2	11.3	0.5	-4.1	4.4	-3.2	-3.6	13.0	5.0	6.2	2.0	10.5	4.9	6.6
Radio and TV eq.	32.3	1.6	-0.8	-1.3	-5.0	-10.9	-12.6	4.9	1.2	-3.1	-13.7	7.4	-2.6	13.5	-2.2	1.1	1.7	-4.6
Instruments	33.1	-3.1	1.3	-0.4	-4.0	-2.7	-10.9	-5.6	-1.8	-3.7	-17.2	-1.7	-2.6	-3.0	-6.9	-0.5	-2.2	-4.5
Total ICT-producing services		**4.8**	**7.9**	**4.8**	**2.6**	**5.9**	**2.2**	**1.6**	**2.3**	**3.1**	**6.8**	**5.6**	**4.4**	**0.4**	**4.2**	**2.1**	**1.5**	**3.1**
Telecommunications	64	5.8	5.1	6.6	2.5	7.7	4.8	4.4	4.0	4.0	8.0	6.2	5.7	2.1	4.7	2.3	3.2	3.3
Computer services	72	1.3	12.3	0.0	2.8	0.5	-3.5	-3.4	-1.6	0.9	3.3	5.3	1.5	1.6	3.7	1.5	-3.3	2.7
Total ICT-using manufacturing		**1.9**	**2.7**	**4.7**	**3.3**	**2.6**	**6.1**	**3.4**	**1.8**	**1.7**	**5.6**	**2.1**	**3.1**	**2.1**	**-1.1**	**1.3**	**0.0**	**-0.3**
Apparel	18	2.8	3.2	2.0	3.2	3.6	-6.6	8.0	1.3	4.1	5.8	3.6	5.2	4.1	-5.9	1.8	-10.5	3.4
Printing & Publishing	22	-0.7	-0.7	3.7	1.5	2.7	6.4	0.2	1.9	-1.1	8.2	0.2	1.9	-0.8	-2.5	1.3	-3.1	-2.6
Machinery	29	1.9	2.6	4.4	5.3	4.6	7.5	3.2	3.0	2.9	3.1	2.6	4.2	2.7	-1.8	0.8	1.6	0.9
Electrical machinery	31-31.3	4.5	11.8	9.2	5.0	6.5	13.6	6.3	10.5	11.1	18.3	-0.3	6.9	4.9	13.3	7.1	2.6	5.6
Watches & instruments	33-33.1	5.4	9.7	7.9	6.3	4.2	2.2	2.9	4.4	4.7	14.0	23.1	7.5	4.2	1.5	-2.8	1.4	2.1
Ships	351	7.8	10.6	8.9	0.7	-1.2	-5.5	2.6	0.0	3.1	-4.2	10.7	4.1	5.8	14.6	0.2	-13.5	-3.8
Aircraft	353			4.0	6.5	-8.1		-5.8	-1.5	-3.0	-2.5	1.3	0.5	-0.1	4.7	8.3		-1.0
Railroad and other	352+359	7.8	0.6	-7.4	8.0	0.7	-6.8	8.7	1.6	7.9	-2.2	2.7	5.9	10.1	5.8	6.5		-2.0
Misc. manufacturing	36-37	-0.3	0.8	3.1	0.9	-0.7	6.0	3.9	0.2	0.1	5.6	-0.9	1.1	4.7	-2.6	-2.1	4.1	1.3
Total ICT-using services		**2.1**	**0.6**	**0.7**	**0.5**	**1.1**	**0.2**	**1.6**	**0.4**	**-0.7**	**2.5**	**2.5**	**1.1**	**1.9**	**1.4**	**5.2**	**-2.0**	**1.9**
Wholesale trade	51	0.7	2.6	-1.9	2.9	3.1	-0.6	4.1	-0.4	0.7	3.8	4.9	2.9	3.7	2.0 [f]	5.3	-6.0	3.4
Retail trade	52	0.7	2.6	4.3	1.3	0.2	-0.6	0.7	0.1	1.6	3.8	2.6	1.1	1.1	0.0	5.3	2.9	2.3
Banks	65	5.3	-1.1	-0.3	-2.1	1.4	4.8	0.6	4.3	-2.9	3.1 [d]	2.2	0.4	2.3	0.0 [d]	5.1	-0.9	1.3
Insurance	66	-0.4	-6.5	-3.5	0.3	3.0	4.8	3.3	0.8	-11.9		1.4	0.2	2.5		8.8	4.1	3.0
Securities trade	67	-3.1	1.9	7.0	3.4	-2.2	4.8	1.6	-0.7	1.0		0.9	1.1			9.8	-10.2	3.2
Renting of machinery	71	5.9		0.4	-0.3	0.7	-3.5	0.0	-3.8	1.1	-6.3	5.5	2.4		3.7	8.6	-5.0	6.7
R&D	73	13.6	-2.5	0.1	-0.1	0.5	-3.5	-1.4	-3.8	-1.7	-0.6	2.3	-0.2	1.1	3.7	5.3	-4.8	1.0
Professional services	74.1-74.3	1.6	-2.0	3.7	-0.9	-2.2	-3.5	-0.5	0.5	0.5	-0.6	2.1	-0.4	-0.3	3.7	5.3	-5.4	-0.7

Appendix Table D1 (cont.)

1990-1995		Austria	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden	UK	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Non-ICT manufacturing		**4.6**	**2.9**	**6.2**	**3.4**	**4.4**	**7.8**	**2.7**	**3.7**	**3.5**	**6.3**	**4.0**	**3.8**	**2.1**	**0.4**	**2.2**	**4.4**	**3.0**
Food & beverages	15-16	3.7	3.1	5.9	2.2	3.6	3.9	2.1	6.1	1.2	6.5	3.1	2.9	1.4	-1.7	3.3	4.1	3.5
Textiles	17	0.5	2.8	8.6	5.4	4.3	2.1	1.3	1.4	4.1	4.8	2.5	3.5	3.0	0.6	1.7	5.8	3.0
Leather	19	1.4	1.7	3.6	1.5	8.3	-4.5	3.8	2.1	2.1	4.7	0.1	3.3	2.8	-2.7	8.3	-0.2	4.9
Wood	20	1.2	4.5	5.5	2.9	5.7	0.5	3.0	1.3	2.2	1.1	0.8	2.5	-2.0	-2.7	-2.9	1.1	-2.8
Paper	21	8.3	5.8	7.6	1.2	0.6	1.5	3.5	3.2	3.1	3.8	3.8	3.5	-0.8	-2.6	3.7	1.1	0.0
Petroleum & coal	23	51.5	-18.9	5.9	15.7	-1.6	17.1	5.7	4.0	5.2	11.9	8.6	9.6	4.0	-3.0	-15.9	-22.3	5.0
Chemicals	24	3.4	5.2	4.4	5.9	8.3	10.5	3.5	5.3	3.9	6.7	7.6	6.8	3.6	2.4	1.9	11.5	3.4
Rubber & plastics	25	4.9	-3.7	3.2	4.3	3.2	5.9	2.2	1.5	3.1	6.3	2.4	3.2	3.6	0.8	0.7	-0.6	4.6
Stone, clay & glass	26	-0.7	1.7	3.9	0.1	6.7	6.9	1.4	-0.4	2.8	2.0	4.3	2.5	0.0	0.1	4.6	-1.1	2.8
Basic metals	27	3.9	4.9	7.9	3.9	10.6	-5.0	4.3	2.7	7.5	9.1	4.5	6.9	3.8	1.7	-3.8	3.5	3.9
Fabricated metals	28	4.4	3.4	4.9	1.3	1.8	0.5	4.3	2.0	2.1	6.1	0.9	2.2	2.0	2.2	12.2	-0.6	3.2
Motor vehicles	34	7.9	-3.3	0.7	2.8	2.4	-3.6	0.1	5.8	8.1	8.8	3.1	3.2	5.0	-1.3	8.9	-10.1	4.9
Total Non-ICT services		**0.1**	**0.5**	**2.0**	**-0.3**	**0.9**	**-0.9**	**0.6**	**-0.2**	**0.9**	**1.5**	**1.5**	**0.6**	**-0.2**	**-0.2**	**0.7**	**-0.2**	**-0.4**
Repairs	50	0.7	-20.2	4.0	-1.9	-3.1	-0.6	5.4	-0.7	-0.4	3.8	1.4	-0.1			5.3	-1.4	-1.4
Hotels & restaurants	55	-1.0	2.1	3.1	-4.6	-5.2	-1.5	-1.4	-3.8	0.6	1.5	-0.6	-1.8	0.1		0.9	-5.8	-1.1
Transport	60-63	-0.3	2.3	4.0	0.8	4.9	4.8	5.5	0.8	3.2	-0.3	3.6	3.2	1.4	-2.1	4.0	-3.3	2.1
Real estate	70	-0.4	1.6	6.9	1.4	-3.3	-3.5	0.0	-1.8	5.1	6.3	-5.0	-0.7		1.1	-3.3	6.2	1.6
Other business services	74.9	1.6	1.5	-0.2	-1.7	-2.2		-2.2	2.0		-0.6	2.7	-1.1		10.1	5.3		-1.0
Government	75	1.2	1.8	-0.2	1.2	2.2	0.7	2.5	0.9	1.2	0.9 e)	-0.1	1.4	1.3	0.4	2.0	2.7	0.0
Education	80	-1.4	1.7	0.4	0.4	0.4	-3.7	0.0	1.2	0.7		2.6	0.9	-1.4	1.2	0.4	-7.5	-0.2
Health	85	0.7	1.4	0.0	0.5	1.6	-1.3	-1.4	-0.7	1.6		2.9	0.8	-0.6	1.4	0.0	-1.0	-2.2
Personal & social serv.	90-93	-0.2	1.3	0.0	-3.0	-1.1	-2.4	-0.7	-0.4	-1.3		3.7	-0.4	-1.5	-1.6	0.5	-0.6	0.3
Private households	95	1.3	-0.7	0.7	0.1	-0.1	-0.5	-1.4	-0.4								0.8	2.2
Extra-terr. org.	99																	
Total Non-ICT other industries		**4.5**	**4.1**	**4.2**	**1.6**	**2.7**	**2.9**	**3.0**	**0.9**	**2.9**	**2.8**	**6.1**	**2.7**	**1.4**	**0.2**	**9.3**	**-0.2**	**0.7**
Agriculture	01-05	6.8	7.2	5.1	4.4	10.1	3.9	7.1	3.3	1.8	2.0	2.1	5.2	0.6	0.4	7.5	-0.8	-1.0
Mining	10-14	-1.2	8.1	5.4	-36.7	10.4	8.4	5.8	1.5	9.3	4.4	23.6	7.5	3.8	-0.9	8.2	-2.1	5.4
Utilities	40-41	2.0	5.5	7.2	2.2	4.0	5.6	2.8	3.1	1.6	2.5	9.8	4.5	1.1	0.7	1.7	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	3.3	0.4	-1.4	-1.9	4.9	-2.3	0.5

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

d) Refers to total finance (65-67); e) Refers to total non-market services (75-99) f) 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	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden	UK	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Economy		**2.3**	**1.9**	**2.5**	**1.2**	**1.3**	**5.3**	**0.8**	**0.9**	**0.4**	**2.1**	**1.8**	**1.4**	**1.4**	**0.9**	**1.7**	**1.1**	**2.5**
Total ICT-producing manufacturing		**9.6**	**5.7**	**13.2**	**15.0**	**13.7**	**42.3**	**6.0**	**-1.9**	**13.1**	**1.1**	**16.1**	**13.8**	**16.9**	**19.5**	**4.9**	**-4.3**	**23.7**
Office and Comp. Eq.	30	87.4	54.4	-0.1	45.7	54.8	49.1	41.0	45.2	50.7	57.2	45.7	49.3	46.2	54.7	50.9	57.4	52.3
Fiber optics	31.3	7.5	3.6	4.8	3.5	7.0	-3.0	-0.4	-4.0	-3.3	5.4	1.6	2.9	12.8	3.4	-13.5	10.7	5.7
Semiconductors	32.1	47.0	56.2	52.6	53.9	66.3	82.0	53.5	53.6	48.0	40.9	55.2	56.4	56.0	47.7	56.1	48.7	52.1
Communication eq.	32.2	3.3	0.6	10.5	0.4	10.9	-12.3	-6.1	-2.0	-10.2	-4.8	3.3	3.5	0.7	-3.1	6.1	-6.9	-0.4
Radio and TV eq.	32.3	-12.1	-9.7	-7.7	-12.8	-18.6	-12.4	-11.9	-12.3	-16.0	-13.4	-13.2	-13.9	-10.5	-15.7	-20.3	-17.2	-12.5
Instruments	33.1	-4.5	-5.4	-6.3	-8.6	-3.2	-1.1	-9.6	-10.5	-6.7	-5.5	-11.8	-7.2	-4.9	-7.7	-6.7	-9.0	-5.9
Total ICT-producing services		**-0.4**	**5.9**	**8.1**	**6.2**	**11.9**	**-0.2**	**6.2**	**4.5**	**4.1**	**3.3**	**5.2**	**6.5**	**2.8**	**4.0**	**9.2**	**-0.7**	**1.8**
Telecommunications	64	3.6	6.6	13.5	9.8	16.3	-0.6	8.6	7.7	6.2	5.6	9.1	9.9	6.9	6.8	13.8	1.1	6.5
Computer services	72	-9.8	5.4	-1.3	0.4	4.9	-2.1	3.9	1.1	0.3	-0.6	0.3	1.5	1.1	0.7	-1.9	-3.6	-4.5
Total ICT-using manufacturing		**6.0**	**0.1**	**1.5**	**1.9**	**2.4**	**8.7**	**1.5**	**2.7**	**1.1**	**1.7**	**1.7**	**2.1**	**1.1**	**0.5**	**-1.3**	**3.3**	**1.2**
Apparel	18	5.4	11.2	-0.1	4.4	6.1	2.2	2.2	3.9	0.7	-1.1	3.7	2.9	0.9	-0.8	0.4	6.6	3.8
Printing & Publishing	22	7.4	-1.3	2.6	0.7	2.5	8.0	1.9	4.3	0.9	3.8	1.2	2.5	-1.4	1.6	-3.8	3.6	-0.2
Machinery	29	5.3	1.2	0.7	2.5	0.9	-3.1	0.4	2.2	1.3	0.6	-1.4	1.0	-5.4	-1.2	-0.5	2.3	0.3
Electrical machinery	31-31.3	7.5	3.6	4.8	3.5	7.0	-3.0	-0.4	-4.0	-3.3	5.4	1.6	2.9	12.8	3.4	-13.5	10.7	5.7
Watches & instruments	33-33.1	7.6	5.0	1.1	3.1	5.8	13.3	3.6	4.3	3.8	3.8	2.0	5.1	5.6	7.1	5.7	5.8	14.2
Ships	351	-1.1	-15.7	-2.7	15.3	-0.8	2.4	2.8	-0.5	-1.0	-2.7	-8.1	0.4	7.7	0.1	0.8	-12.3	-0.2
Aircraft	353			1.6	-9.7	9.9		1.9	11.0	6.1	-4.9	18.8	6.4	6.3	-2.3	11.8		1.1
Railroad and other	352+359	-1.1	0.5	3.6	-0.4	6.6	14.7	1.3	25.9	7.4	4.2	-6.0	3.1	-13.4	-11.0	-1.4		-0.1
Misc. manufacturing	36-37	3.7	0.2	2.5	2.9	0.9	-1.3	3.0	0.3	0.8	4.6	-0.9	1.5	4.9	2.9	-2.6	2.5	2.4
Total ICT-using services		**2.1**	**2.5**	**3.0**	**0.7**	**0.9**	**1.4**	**0.6**	**1.9**	**-0.1**	**3.3**	**2.6**	**1.4**	**2.8**	**0.0**	**4.8**	**0.8**	**5.4**
Wholesale trade	51	2.2	0.3	2.1	1.6	-0.3	6.2	-0.2	4.2	0.3	3.6	0.4	1.2	2.9	0.2 [f)]	6.1	-2.3	6.1
Retail trade	52	2.7	0.8	1.6	0.9	-0.2	6.2	0.6	0.8	1.4	3.0	3.5	1.4	2.9	-2.7	6.3	0.0	6.9
Banks	65	4.4	5.2	11.9	-1.3	8.3	-1.9	4.9	-0.1	0.1	5.4 [d)]	1.3	3.0	3.7	1.7 [d)]	7.0	5.0	2.8
Insurance	66	4.1	8.9	0.4	-0.8	-9.4	-1.9	-3.2	-2.3	-11.0		3.6	0.2	4.8		4.8	0.8	-1.0
Securities trade	67	-5.9	-13.3	16.5	1.1	1.0	-1.9	-2.7	2.4	5.1		6.5	2.0			12.9	4.3	15.3
Renting of machinery	71	0.8	-1.9	2.0	-1.0	2.5	-2.1	-0.6	3.1	0.5	7.4	0.8	0.5		0.7	5.4	0.2	5.7
R&D	73	-2.2	4.1	-0.8	-1.2	6.3	-2.1	3.9	-3.2	-3.0	-0.4	-5.8	-0.5	0.4	0.7	-1.8	-7.1	3.1
Professional services	74.1-74.3	-2.2	5.8	-0.2	2.3	-3.4	-2.1	-1.4	0.7	-0.2	-0.4	4.6	0.4	0.0	0.7	0.6	-2.3	1.0

Appendix Table D2 (cont.)

1995-2000		Austria	Denmark	Finland	France[b]	Germany[a]	Ireland	Italy	Nether-lands	Spain[b]	Sweden	UK	**EU**	Canada[b]	Japan[c]	Norway	Switzer-land	**US**
Total Non-ICT manufacturing		**4.6**	**3.8**	**3.0**	**2.7**	**0.5**	**10.4**	**0.6**	**2.0**	**-0.3**	**3.3**	**0.5**	**1.5**	**1.3**	**-0.3**	**1.7**	**4.4**	**1.4**
Food & beverages	15-16	2.4	0.8	3.0	-1.8	0.3	2.4	0.7	1.4	-0.2	1.8	-1.0	0.0	-0.4	0.4	-1.9	-0.7	-4.5
Textiles	17	5.4	7.0	2.1	0.8	1.6	-3.9	1.5	6.4	-0.6	3.9	0.3	1.4	0.9	-4.7	0.2	2.5	3.3
Leather	19	5.8	11.4	2.4	0.6	2.8	-2.3	-0.9	4.8	0.5	2.5	12.0	0.7	0.9	-1.0	-0.9	1.1	1.3
Wood	20	5.4	0.0	5.5	1.9	2.3	6.5	3.5	1.8	0.9	6.3	-1.7	2.7	-0.5	-6.7	4.3	1.7	0.3
Paper	21	5.1	3.0	4.3	5.8	5.4	1.1	0.1	3.2	-3.1	4.6	-2.3	2.3	-1.4	1.4	5.7	2.3	0.2
Petroleum & coal	23	16.9	19.0	-0.3	2.7	11.9	25.7	-13.1	-3.2	0.2	3.6	0.2	0.2	4.4	4.0	9.0	16.6	1.5
Chemicals	24	5.6	11.2	4.7	4.8	2.6	17.0	1.6	3.9	0.6	5.3	3.7	4.7	1.8	2.3	4.3	9.6	4.4
Rubber & plastics	25	7.2	8.8	0.0	3.1	1.3	-3.3	0.1	3.2	0.8	2.2	-0.2	1.6	3.3	-0.8	-3.3	0.0	4.1
Stone, clay & glass	26	4.4	-0.2	2.1	4.2	0.9	3.9	1.0	2.7	0.7	-0.8	-0.2	1.4	6.1	-0.1	-2.7	2.1	2.6
Basic metals	27	8.8	1.6	4.3	0.6	2.7	-3.8	-1.7	2.7	-3.4	3.2	-1.6	0.9	1.4	-0.6	3.9	1.8	3.1
Fabricated metals	28	2.1	0.6	0.7	1.2	1.0	-4.8	0.6	0.6	-0.8	0.7	1.9	0.9	0.8	-2.2	8.8	1.8	0.6
Motor vehicles	34	0.3	5.4	5.5	12.0	-5.2	6.2	3.4	2.9	1.2	4.5	-1.8	0.9	3.7	-4.4	-1.0	0.9	1.4
Total Non-ICT services		**-0.4**	**1.2**	**0.6**	**0.1**	**-0.1**	**-1.2**	**-0.4**	**0.1**	**-0.1**	**1.4**	**0.9**	**0.2**	**-0.4**	**0.6**	**0.4**	**0.8**	**0.4**
Repairs	50	2.2	20.7	1.4	-3.2	0.2	6.2	0.5	1.6	-1.1	2.2	3.1	1.0			5.1	1.4	-2.5
Hotels & restaurants	55	0.5	-1.3	-0.6	-0.4	-5.2	4.2	0.1	0.8	-0.6	2.5	-2.1	-1.2	0.6		2.4	0.9	0.4
Transport	60-63	2.5	3.3	2.2	3.0	3.1	-0.6	-1.8	1.8	0.8	1.7	2.1	1.7	1.5	-0.7	0.7	2.5	1.6
Real estate	70	-1.6	0.1	0.7	-0.5	-2.7	-2.1	-0.6	-0.4	-6.4	3.0	1.1	-0.8		1.7	-0.3	1.5	1.7
Other business services	74.9	-2.4	2.7	-2.0	-1.3	-3.4		-1.5	0.7		-0.4	5.9	-0.3		13.8	2.3		1.4
Government	75	0.1	0.0	1.1	1.2	1.2	-0.8	0.8	1.2	1.1	1.9 e)	0.3	1.1	1.3	1.8	1.0	0.3	0.2
Education	80	-0.1	-0.1	-0.3	0.8	0.0	-5.8	-0.6	0.3	0.4		-1.0	-0.1	-1.6	1.9	1.5	-3.7	-1.2
Health	85	-3.5	0.2	-0.1	0.3	-0.2	-1.8	0.6	-1.2	-0.2		2.6	0.4	-0.8	0.2	-0.5	0.0	-0.3
Personal & social serv.	90-93	-1.0	0.8	0.6	-2.5	-0.4	-1.1	0.4	0.1	-0.3		-0.8	-0.5	-0.6	-1.1	2.1	-1.3	-0.9
Private households	95	-3.1	1.3	-0.9	-2.7	-0.3	17.0	-0.5	3.2								-1.7	0.7
Extra-terr. org.	99																	
Total Non-ICT other industries		**4.0**	**1.2**	**2.3**	**1.1**	**2.3**	**1.2**	**2.5**	**0.0**	**1.3**	**0.5**	**1.5**	**1.9**	**1.1**	**-1.5**	**1.4**	**-1.3**	**0.6**
Agriculture	01-05	3.9	5.0	4.5	4.8	5.2	2.9	4.8	2.2	3.4	1.8	1.9	4.0	4.1	0.1	2.4	-4.0	6.3
Mining	10-14	4.3	8.8	-3.3	-5.9	-3.6	-0.7	-0.4	1.6	0.3	0.8	0.8	3.5	-0.5	5.0	2.9	4.0	-1.8
Utilities	40-41	5.0	-0.5	4.7	4.6	5.8	7.4	3.8	2.5	6.0	-0.4	6.4	4.9	1.6	4.1	6.0	1.0	2.3
Construction	45	2.4	-1.4	0.0	-2.7	1.0	-1.4	0.5	-0.3	-1.1	0.0	0.8	0.2	0.9	-4.2	-3.9	-0.7	0.2

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

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

Appendix E: Decomposing the U.S-EU Productivity Growth Differential

As we show in the main text, shift-share analysis can be used to trace aggregate labor productivity growth to individual industries within countries, but also to compare the industry contribution to the difference in aggregate productivity growth across countries. Of course this can be simply done by comparing the total percentage-point contributions of an industry to the aggregate. For example, between 1995 and 2000 the retail industry in the United States contributed 0.38 percentage point to the aggregate average annual labor productivity growth of 2.5 per cent. In the European Union the contribution was only 0.06 percentage point out of 1.4 per cent aggregate labor productivity growth over the same period. One may also break the aggregate U.S-EU productivity growth differential down into the following four components:

- A difference due to faster (or slower) productivity growth in any given industry in the U.S. compared to the EU
- A difference due to a higher (or lower) productivity level in the U.S. than in the EU relative to the aggregate productivity level
- A difference due to a faster rise (or a slower fall) of the employment share of any given industry in the U.S. compared to the EU
- A difference due to a bigger (or smaller) employment share of any given industry in in the U.S. compared to the EU

To carry out this decomposition, we start with the basic shift-share analysis as described in the main text. Equations (E1a) and (E1b) replicate equation (2) from the main text and add country subscripts A and B respectively. Aggregate productivity growth in country A can be decomposed into industry contributions:

$$\Delta P_A = \frac{P_A^T - P_A^0}{P_A^0} = \sum_{i=1}^{n} \frac{(P_{i,A}^T - P_{i,A}^0)\cdot \overline{S}_{i,A}}{P_A^0} + \sum_{i=1}^{n} \frac{(S_{i,A}^T - S_{i,A}^0)\cdot \overline{P}_{i,A}}{P_A^0} \quad \text{(E1a)}$$

Aggregate productivity growth in country B can similarly be decomposed into industry contributions:

$$\Delta P_B = \frac{P_B^T - P_B^0}{P_B^0} = \sum_{i=1}^{n} \frac{(P_{i,B}^T - P_{i,B}^0)\cdot \overline{S}_{i,B}}{P_B^0} + \sum_{i=1}^{n} \frac{(S_{i,B}^T - S_{i,B}^0)\cdot \overline{P}_{i,B}}{P_B^0} \quad \text{(E1b)}$$

The first term on the right-hand side of each equation, the "intra-effect", shows the contribution of an industry due to its own growth in productivity, weighted by its average employment share over the two periods 0 and T. The second term, the "shift-effect" shows the contribution due to a change in the relative size of the industry, weighted by the average productivity level.

If we want to compare the difference in industry contributions to the aggregate productivity differential, we can simply take the difference of equations (E1a) and (E1b):

$$\Delta P_A - \Delta P_B = \sum_{i=1}^{n}\left(\frac{\Delta P_{i,A}\cdot \overline{S}_{i,A}}{P_A^0} - \frac{\Delta P_{i,B}\cdot \overline{S}_{i,B}}{P_B^0}\right) + \sum_{i=1}^{n}\left(\frac{\Delta S_{i,A}\cdot \overline{P}_{i,A}}{P_A^0} - \frac{\Delta S_{i,B}\cdot \overline{P}_{i,B}}{P_B^0}\right) \text{(E2)}$$

Equation (E2) shows that the difference in aggregate productivity growth is due to the different contributions of the intra-effect of each industry and different contributions of the shift-effect. We can take this decomposition one step further and split the difference in intra-effect and shift-effect into effects which are related to productivity growth (ΔP) or levels ($\overline{\mathrm{P}}$) and effects which are related to the employment share ($\overline{\mathrm{S}}$) or the change in share of employment (ΔS) by industry. More precisely, if the intra-effect of industry *i* in country A is larger than in B, this can be due to a higher productivity growth or due to a larger employment share over the two periods. Likewise, if the shift-effect of industry *i* in country A is larger than in B, this can be due to a bigger change in the employment share or due to a higher productivity level relative to the aggregate productivity level. To separate these different causes, we define two counterfactual shift-share equations by imposing the employment structure of country A on country B and vice-versa. If we impose country B's structure on country A, the two terms on the right-hand side of (E1a) become:

$$\Delta \mathrm{P}_{\mathrm{A}}^{*} = \sum_{i=1}^{n} \frac{(\mathrm{P}_{\mathrm{i,A}}^{\mathrm{T}} - \mathrm{P}_{\mathrm{i,A}}^{0}) \cdot \overline{\mathrm{S}}_{\mathrm{i,B}}}{\mathrm{P}_{\mathrm{A}}^{0}} + \sum_{i=1}^{n} \frac{(\mathrm{S}_{\mathrm{i,B}}^{\mathrm{T}} - \mathrm{S}_{\mathrm{i,B}}^{0}) \cdot \overline{\mathrm{P}}_{\mathrm{i,A}}}{\mathrm{P}_{\mathrm{A}}^{0}} \qquad \text{(E3a)}$$

With the first counterfactual (imposing country B's employment shares on country A) the decomposition is carried out as follows:

- The difference between the first term of (E3a) and the first term of (E1b) shows the difference in contribution of industry *i* to aggregate productivity growth because of a faster (or slower) productivity growth in country A compared to country B, i.e. the "productivity growth effect" (ΔP)
- The difference between the first term of (E3a) and the first term of (E1a) shows the difference in contribution of industry *i* to aggregate productivity growth because of a higher (or lower) employment share of industry *i* in country A compared to country B, i.e. the "employment share effect" ($\overline{\mathrm{S}}$).
- The difference between the second term of (E3a) and the second term of (E1a) reflects the difference in contribution of industry *i* to aggregate productivity growth because of a higher (or lower) productivity level in country A compared to country B relative to the aggregate productivity level, i.e the "productivity level effect" ($\overline{\mathrm{P}}$).
- The difference between the second term of (E3a) and the second term of (E1b) reflects the difference in contribution of industry *i* to aggregate productivity growth because of a faster rise (or slower fall) in the employment share of industry *i* in country A compared to country B, i.e. the "change in employment share effect" (ΔS).

Alternatively we can also impose country A's employment structure on country B, which transforms equation (E1b) into:

$$\Delta \mathrm{P}_{\mathrm{B}}^{*} = \sum_{i=1}^{n} \frac{(\mathrm{P}_{\mathrm{i,B}}^{\mathrm{T}} - \mathrm{P}_{\mathrm{i,B}}^{0}) \cdot \overline{\mathrm{S}}_{\mathrm{i,A}}}{\mathrm{P}_{\mathrm{B}}^{0}} + \sum_{i=1}^{n} \frac{(\mathrm{S}_{\mathrm{i,A}}^{\mathrm{T}} - \mathrm{S}_{\mathrm{i,A}}^{0}) \cdot \overline{\mathrm{P}}_{\mathrm{i,B}}}{\mathrm{P}_{\mathrm{B}}^{0}} \qquad \text{(E3b)}$$

This second counterfactual results in the same four effects described above, but will obviously give a different result because we now assume country A's employment structure instead of that of country B. As there is no a priori reason to prefer one or the other employment structure for the counterfactual, we take a simple unweighted average of each of the four effects based on country A's or country B's structure.

To gain a fuller understanding of the procedure, we show an example of this decomposition for the case of the computer industry (ISIC 30). For the period 1995-2000, productivity growth in this industry was 49.3% on average per year in the EU, compared to 52.3% in the U.S. On average the industry employed 0.14% of total employment in the EU and 0.18% in the United States, but between 1995 and 2000 the employment share went down by 0.03% in the EU and by 0.05% in the U.S.. To trace the effects of these differences on the industry's contribution to aggregate productivity growth differential between the U.S. and the EU we run the counterfactuals as in equations (E3a) and (E3b). Looking at the intra-effect (the first term in each equation), this leads to the following matrix:

Table E.1, Intra-effects for the computer industry (ISIC 30) in the U.S. and the EU with different employment structure, 1995-2000 (%-point contributions)

Intra-effect	U.S.	EU	Difference due to different productivity growth
U.S. shares	0.274	0.207	0.066
EU shares	0.199	0.154	0.045
Difference due to different employment structure	0.075	0.053	

Table E.1 shows the intra-effects for both countries under both sets of employment shares as well as the differences between the U.S. and EU. Taking the U.S. as country A (and the EU as "country" B), this means that the computer industry in the U.S. has an intra-effect contribution to productivity growth of 0.274 percentage-point (according to the first term of equation E1a), which would have been 0.199 % in case the U.S. had the same employment structure as the European Union (according to the first term of equation E3a). Hence the U.S.-EU productivity differential is 0.074 percentage points due to a bigger share of the U.S. computer industry in total employment ($\bar{S}$). However, this difference would have been 0.053 percentage points had we looked at the EU intra-effects, as is shown in the second column of Table E.1 (comparing the first terms of equations E1b and E3b). If we compare across the columns instead of across the rows in Table E.1, we find that the contribution to the U.S.-EU productivity growth differential due to faster productivity growth in the U.S. computer industry (ΔP) is 0.066 percentage points when imposing the U.S. employment structure on both the U.S. and the EU (comparing the first terms of equations E1a and E3b). It becomes 0.044 when assuming the EU employment structure for both the U.S. and the EU (comparing the first terms of equations E1b and E3a).

Overall the intra-effect contributed 0.120 percentage points (0.274-0.154) to the aggregate U.S.-EU productivity differential. A straightforward way to calculate the average productivity growth effect is then to take an unweighted average of the two figures in the right column of Table E1 which comes to 0.056%. The remainder of the difference in intra-effect is then due to differences in size. This is equal to the average of the figures in the row

"Difference due to different employment shares" or 0.064%. Together, these two effects exactly add up to the total difference in intra-effect of 0.120%-points.

We can run a similar analysis which focuses on the second terms of equations (E1a), (E1b) and (E3a) and (E3b). The four possible comparisons between these second terms lead to another matrix (Table E.2), that results in contributions to the productivity growth differential because of differences in productivity levels ($\overline{P}$) or because of differences in the change in employment shares (ΔS).

Table E.2, Shift-effects for the computer industry (ISIC rev. 30) in the U.S and the EU with different employment structure, 1995-2000 (%-point contributions)

Shift-effect	U.S.	EU	Difference due to different productivity levels
U.S. shares	-0.029	-0.022	-0.007
EU shares	-0.017	-0.013	-0.004
Difference due to different change in employment structure	-0.011	-0.008	

Table E.2 shows that in the case of the computer industry the shift-effects are always negative. This is a consequence of the declining employment share of the computer industry in both Europe and the United States in combination with a strongly positive productivity growth rate. The bottom row and right hand columns in the Table furthermore show that the U.S. shift-effect is more strongly negative due to both a larger decline in employment share in the U.S. (–0.011 and –0.008) and a higher productivity level relative to the aggregate productivity level for the U.S. economy (–0.007 and –0.004).[53] In Table E.3 we summarize the results from Tables E.1 and E.2 for the computer industry, and we add similar computations for the semiconductor industry (ISIC 321) and retail trade (ISIC 52).

Table E.3, Decomposition of the difference in contribution to productivity growth differential between the U.S. and the EU and U.S. for several industries, 1995-2000

[53] The higher productivity level relative to the aggregate productivity level gives a larger weight to the decline in employment share.

	Computer *(ISIC 30)*	Semiconductors *(ISIC 321)*	Retail *ISIC (52)*
U.S.	0.245	0.505	0.377
EU	0.141	0.144	0.061 -
Difference	0.104	0.361	0.317
due to different			
Productivity growth	0.056	0.132	0.282
Employment shares	0.064	0.212	0.054
Productivity levels	-0.006	-0.001	0.000
Change in shares	-0.010	0.018	-0.019

Table E.3 shows how semiconductors and retail trade make a very large contribution to the productivity growth differential between the U.S. and the EU. For retail trade, this difference is dominated by the much faster productivity growth in the U.S. compared to the EU. There is a small offsetting effect from changes in employment shares, which negatively contributed to the U.S.-EU aggregate productivity growth differential. The employment share of the industry decreased in the U.S., while it slightly increased in the EU, leading to a negative contribution from the change in shares. The higher productivity level of the industry compared to the aggregate in the U.S. (61% of the aggregate in the U.S. versus 55% in the EU) also led to a slightly negative contribution because of the larger change in employment share in the U.S.[54]

For the other two industries (semiconductors and computers), larger employment shares in the U.S. were equally (in the case of computers) or even more (in the case of semiconductors) important for the U.S.-EU productivity differential as the faster productivity growth in the U.S.. In contrast to retail and computers, changes in employment shares in semiconductors contributed positively to U.S.-EU productivity growth differential because the employment share of the industry increased in the U.S., while it decreased in the EU.

Finally, in Table E.4 we show the top 5 and the bottom 5 industries in terms of contributions to the U.S.-EU productivity differential. This Table replicates some of the findings from the main text, but adds some new insights. If we look at the top 5 industries that were the largest contributors to the U.S-EU growth differential, it becomes clear that much faster productivity growth in the U.S. is the most important reason for their higher contributions. Only in semiconductors is the employment share effect the dominant factor. Securities and retail also have bigger productivity contributions in the U.S. due to their larger size, but this is much less important for both. Construction is the fifth industry in this top group because its employment share expanded from 5.1 to 5.8 percent of total employment in the U.S., while it decreased in the EU from 5.9 to 5.5 percent.

The bottom 5 industries, or (in other words) those industries that most strongly offset the overall widening of the U.S.-EU productivity growth gap, show a very different picture in

[54] The changes in employment share in retailing declined at a faster rate in the U.S. than it increased in the EU, making the average effect negative.

terms of contributions from the four different effects. First of all, higher productivity growth in the EU compared to the U.S. seems to have been relatively unimportant. In the case of food products, it is mainly the negative productivity growth rate for the U.S. that explains the large negative effect. The exception is the computer services industry, where productivity growth in the EU has been relatively strong versus a decline in productivity in the U.S.. For the other industries in the bottom 5 category, the productivity growth effect is much smaller in an absolute sense than for the top 5. In the case of social and personal services, productivity growth actually still favors the United States, but offsetting effects mainly come from changes in employment structure. Changes in employment shares have almost all contributed to offsetting the U.S.-EU productivity growth differential, although for different reasons. In the case of health, and social and personal services, the employment share grew faster in the EU than in the U.S. while in both food products and government, the employment share shrunk less rapidly in the EU than in the United States. The exception to this pattern comes from computer services, where employment in the U.S. expanded at a faster rate than in the EU.

Table E4, The top and bottom 5 industry contributions to the U.S.-EU productivity growth gap and the importance of the four effects, 1995-2000

Top 5	*Industry*	*Total*	*Productivity growth*	*Employment shares*	*Productivity levels*	*Change in shares*
1	Semiconductors	0.361	0.132	0.212	-0.001	0.018
2	Securities	0.355	0.235	0.078	0.018	0.024
3	Retail trade	0.317	0.282	0.054	0.000	-0.019
4	Wholesale trade	0.233	0.257	0.016	0.000	-0.040
5	Construction	0.157	-0.002	-0.003	0.003	0.159

Bottom 5	*Industry*	*Total*	*Productivity growth*	*Employment shares*	*Productivity levels*	*Change in shares*
1	Food products	-0.067	-0.092	0.029	-0.003	-0.001
2	Health	-0.064	-0.041	0.000	0.000	-0.023
3	Government	-0.061	-0.073	0.037	0.000	-0.024
4	Social/personal services	-0.061	0.002	-0.003	-0.006	-0.054
5	Computer services	-0.052	-0.087	-0.004	-0.010	0.050

Appendix Table E5: The difference in contribution to total productivity growth for 1995-2000 for U.S.-EU decomposed into four effects

		Total	Productivity growth	Employment share	Productivity level	Emp. share change
Total Economy		**1.087**	**0.688**	**0.350**	**-0.074**	**-0.025**
Total ICT-producing manufacturing		**0.478**	**0.108**	**0.273**	**-0.005**	**0.011**
30	Office and Comp. Eq.	0.104	0.049	0.051	-0.007	-0.009
313	Fiber optics	0.005	-0.002	-0.001	0.001	-0.005
321	Semiconductors	0.361	0.075	0.206	0.001	0.016
322	Communication eq.	-0.002	-0.017	0.000	0.002	0.009
323	Radio and TV eq.	0.013	0.000	0.018	-0.001	0.004
331	Instruments	-0.003	0.003	-0.001	-0.001	-0.003
Total ICT-producing services		**-0.092**	**-0.109**	**0.012**	**-0.008**	**0.107**
64	Telecommunications	-0.040	-0.087	0.011	-0.001	0.052
72	Computer services	-0.052	-0.022	0.001	-0.006	0.055
Total ICT-using manufacturing		**-0.092**	**-0.050**	**-0.011**	**-0.009**	**-0.011**
18	Apparel	-0.005	0.002	-0.004	0.002	-0.005
22	Printing & Publishing	-0.031	-0.033	-0.001	0.003	-0.002
29	Machinery	-0.021	-0.014	-0.004	-0.005	0.002
31-31.3	Electrical machinery	-0.020	0.001	-0.001	-0.006	0.004
33-33.1	Watches & instruments	-0.007	0.018	-0.006	-0.005	-0.015
35.1	Ships	-0.005	-0.001	0.000	0.000	-0.004
35.3	Aircraft	-0.011	-0.026	0.010	0.003	-0.001
35.2+35.9	Railroad and other	0.001	-0.003	0.000	0.000	0.004
36-37	Misc. manufacturing	0.007	0.006	-0.005	0.000	0.005
Total ICT-using services		**0.893**	**0.765**	**0.148**	**0.022**	**-0.106**
51	Wholesale trade	0.233	0.261	0.016	-0.002	-0.038
52	Retail trade	0.317	0.280	0.055	0.000	-0.020
65	Banks	0.035	-0.001	-0.002	-0.001	0.039
66	Insurance	-0.020	-0.012	-0.003	0.001	-0.007
67	Securities trade	0.355	0.239	0.079	0.018	0.024
71	Renting of machinery	0.013	0.015	0.004	-0.013	-0.004
73	R&D	0.011	0.010	0.000	-0.001	-0.003
74.1-74.3	Professional services	-0.049	-0.027	-0.001	0.019	-0.096
Total Non-ICT manufacturing		**-0.088**	**-0.010**	**-0.049**	**-0.026**	**-0.004**
15-16	Food products	-0.067	-0.094	0.030	-0.004	0.000
17	Textiles	-0.003	0.007	-0.003	0.003	-0.011
19	Leather	0.002	0.000	-0.001	-0.001	0.005
20	Wood products	-0.008	-0.011	0.000	-0.001	0.003
21	Paper products	-0.016	-0.008	0.000	0.000	-0.009
23	Petroleum & coke	0.009	0.013	0.000	0.000	-0.003
24	Chemicals	-0.006	0.028	-0.039	-0.018	0.023
25	Rubber and plastics	0.004	0.016	-0.005	0.000	-0.006
26	Stone, clay & glass	0.007	0.009	-0.010	-0.001	0.009
27	Basic metals	0.019	0.015	-0.003	-0.002	0.009
28	Fabricated metal products	-0.007	-0.001	-0.007	-0.002	0.003
34	Motor vehicles	-0.023	0.015	-0.011	0.001	-0.027
Total Non-ICT services		**-0.144**	**0.029**	**0.047**	**-0.053**	**-0.266**
50	Repairs	-0.050	-0.057	0.007	-0.001	-0.006
55	Hotels & restaurants	-0.012	0.047	-0.008	-0.011	-0.043
60-63	Transportation	-0.019	-0.010	-0.016	-0.006	0.013
70	Real estate	0.089	0.232	0.007	-0.004	-0.144
74.9	Other business services	0.021	0.028	0.002	-0.030	0.004
75	Government	-0.061	-0.074	0.037	0.001	-0.026
80	Education	0.013	-0.020	0.014	0.001	0.018
85	Health	-0.064	-0.041	0.000	0.003	-0.027
90-93	Personal & social services	-0.061	-0.075	0.003	-0.006	-0.055
Total Non-ICT other industries		**0.133**	**-0.045**	**-0.069**	**0.005**	**0.243**
01-05	Agriculture	0.048	0.055	-0.057	-0.008	0.059
10-14	Mining	-0.031	-0.049	0.005	0.007	0.005
40-41	Utilities	-0.041	-0.049	-0.014	-0.004	0.026
45	Construction	0.157	-0.002	-0.003	0.010	0.154

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