The Renewal of the Old Economy: An International Comparative Perspective

Bart van Ark[1],
University of Groningen and The Conference Board
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Abstract:
This paper presents international comparisons of the contribution of information and communication technology (ICT) to labour productivity growth during the 1990s. It makes a distinction between ICT-*producing* industries, intensive ICT-*using* industries and the rest of the economy (the "non-ICT" sector). The paper presents measures of the shares and contributions of each sector to growth and acceleration of growth of labour productivity for ten major OECD countries during the 1990s. The main findings are that the productivity growth differentials between the United States and most European countries are partly explained by a larger and more productive ICT-producing sector in the United States, but also by bigger productivity contributions from ICT-using industries and services in the U.S.. The main reason for the productivity deceleration in most European countries is due to the underperformance of the non-ICT sector. Most of the European employment expansion has taken place in the non-ICT sector but at the cost of a slowdown in productivity growth. In the case of Japan almost all of the remaining slow productivity growth of the second half of the 1990s is coming from the ICT-producing and ICT-using sectors and virtually nothing from the non-ICT sector. The final part of the paper briefly goes into the question how more intensive ICT-use increases concerns about measurement issues.

1. Introduction

The recent acceleration of production and investment related to information and communication technology (ICT) is a promising vehicle by which the slowdown in economic growth in the western world during the last quarter of the twentieth century may be reversed. So far, however, the empirical support for this viewpoint comes mainly from the U.S. experience. During the second half of the 1990s there has been a clear acceleration of growth in the American economy. For example, between 1995 and 2000, labour productivity growth in the US was 1.8% per year faster than between 1990 and 1995, and the rise in output was more than 2% faster (Conference Board, 2001). Some argue that the growth acceleration is mainly due to improved productivity growth in the ICT-producing sector (Jorgenson and Stiroh, 2000; Jorgenson, 2001). Others stress the increasingly productive use of ICT-goods and services elsewhere in the economy (Oliner and Sichel, 2000; Baily and Lawrence, 2001).

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

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[1] Faculty of Economics, University of Groningen, PO Box 800, 9700 AV Groningen, The Netherlands. Tel: +31 50 363 3674. Fax: +31 50 363 7337. Email: h.h.van.ark@eco.rug.nl.

[2] The complete version of this paper (van Ark 2000c) is downloadable from http://www.eco.rug.nl/MEDEWERK/ark/kvs10.pdf. This paper is based on earlier work paper presented at the annual meeting of the Netherlands Royal Economic Society on 8 December 2000 (Van Ark, 2000b). With financial support of the OECD, it has been updated and extended from 6 to 10 countries. OECD also provided unpublished data from the STAN database (http://www.oecd.org/dsti/sti/stat-ana/stats/).

Earlier studies have documented the growth contribution of ICT in OECD countries on the basis of a growth accounting framework using ICT investment as a separate input (Schreyer, 2000; European Commission, 2000; Goldman Sachs, 2000; Daveri, 2001; Roeger, 2001). However, as ICT investment series are – as yet – not available on a comprehensive basis for all OECD countries, these studies use proxies for ICT investment, usually derived from (private) data sources on ICT expenditures, including consumer expenditure. Moreover none of these studies has gone into the ICT contributions of individual industries to growth. As the data on investment are even more sparse at industry level, this paper follows an alternative approach. Section 2 sets out to distinguish the output and employment shares of ICT-producing industries, intensive ICT-using industries and the rest of the economy (the "non-ICT sector") for Canada, Denmark, Finland, Germany, France, Italy, Japan the Netherlands, the United Kingdom and the United States in 1990 and 1999. Next, the contributions of these sectors to labour productivity growth are shown in Section 3.

The dataset is based on the new (and as yet unpublished) STAN dataset of the OECD.[3] At some places the STAN database is not detailed enough to distinguish between the three sectors described above exactly. Further refinements are therefore made using information from production statistics and national accounts for individual countries, which is described in more detail in van Ark (2000c).[4] The final sector of the paper goes briefly into into measurement problems concerning output and inputs of ICT products and services.

2. The share of ICT in the economy

Output and Employment Shares of the ICT-Producing Sector

The precise shares of ICT in total output and employment depend on the definition of ICT-producing industries.[5] The first two columns of Table 1 show the shares of ICT-producing industries in value added and employment in 1990 and 1998. The ICT-producing sector consist of IT hardware, radio, television and communication equipment, medical appliances and instruments and appliances for measurement (together the ICT industry) and telecommunication and computer services (together ICT services). This definition of the ICT-producing sector more or less matches the classification of the OECD.[6]

The Table shows that the shares of the ICT-producing sector are quite low. Even for the U.S. the percentage shares for the total economy in 1998 are less than 10 per cent. The differences in output shares are due to larger shares of ICT-manufacturing industries in Japan, the USA and Finland. Comparing output and employment shows that the shares of ICT-producing industries are generally higher for GDP than for employment, which suggests higher productivity levels in the ICT-producing sector compared to the rest of the economy. With the exception of Finland the shares of the ICT-producing sector in nominal output only slightly increased and is mainly due to the rising shares of ICT-producing services in the nominal output of all countries. So – with some exceptions – did the employment shares.

[3] See http://www.oecd.org/dsti/sti/stat-ana/stats/

[4] The data for this paper can also be downloaded from the website of the Groningen Growth and Development Centre: see http://www.eco.rug.nl/GGDC/ictdatabase.html

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

[6] The difference with the OECD classification is that wholesale trade in machinery and equipment and the renting of ICT goods is not included due to lack of data (OECD, 2000c). It also appeared not possible to separate postal services from telecommunications.

Table 1: GDP and Employment Shares of ICT-producing, ICT-using and non-ICT industries, 1990 and 1998

	ICT-producing industries as % of total economy		ICT-using industries as % of total economy		"Non-ICT" sector* as % of total economy	
	1990	1998	1990	1998	1990	1998
	as % of GDP at current basic prices					
Canada (a)	4.2	4.3	20.3	20.7	75.5	75.0
Denmark	4.3	4.7	18.5	18.7	77.2	76.6
Finland	4.6	8.5	16.3	16.1	79.1	75.4
France	5.0	5.3	19.6	19.4	75.4	75.3
Germany (b)	5.4	5.1	21.5	20.9	73.1	74.0
Italy	4.4	4.7	21.2	21.7	74.4	73.6
Japan	6.0	6.3	22.0	21.4	72.0	72.3
Netherlands	4.6	5.4	23.1	24.5	72.3	70.1
United Kingdom	5.7	6.7	21.6	22.8	72.7	70.5
United States	6.6	7.6	20.0	23.2	73.4	69.2
	as % of employment					
Canada	3.4	4.2	16.3	17.6	80.3	78.2
Denmark	4.1	3.7	15.8	14.0	80.1	82.3
Finland	3.8	5.5	12.7	13.7	83.5	80.8
France	3.8	3.7	14.7	15.7	81.5	80.6
Germany (b)	4.6	3.6	16.7	16.2	78.7	80.2
Italy	3.6	3.6	13.9	14.6	82.5	81.8
Japan	4.0	4.1	18.1	18.8	77.9	77.1
Netherlands	3.6	3.7	16.5	16.5	79.9	79.8
United Kingdom	4.6	5.1	17.0	18.8	78.4	76.1
United States	4.5	4.7	22.3	23.2	73.2	72.1

(a) "non-ICT" sector are about one third of the industries in manufacturing and services with the highest ICT-investment output ratios and/or shares of ICT capital in the total ICT capital stock (see van Ark, 2000c)
(b) For Canada, value added at current prices for 1990 and 1996
(c) For Germany for 1991 and 1997
Source: Groningen Growth and Development Centre ICT database (see also van Ark, 2000c).

Output and Employment Shares of the ICT-Using Sector

Unlike the ICT-producing sector there is no exact definition of which industries should be marked as being part of the ICT-using sector. Such a distinction between heavy users of ICT and less intensive ICT-users is necessarily arbitrary as there are few if any industries that do not use ICT at all. In this paper about one third of industries with the highest ICT-intensity and/or the highest shares in the ICT capital stock are defined as ICT-using industries.[7] These industries include publishing and printing, the chemical industry, electrical and electronic machinery and equipment, medical and measurement appliances, wholesale trade, post and telecommunication, the financial sector, the renting of machinery, computer services, research and development and part of business services (accountants, architectural firms, legal offices, consultants and marketing agencies). It needs to emphasized that, as the same classification is used for all countries, ICT-using industries do not necessarily invest equally heavily in ICT across countries. It only indicates that these are the industries that are the likely candidates to generate substantial output and productivity effects from ICT investment.

[7] See van Ark (2000c) for exact definitions. Although, according to the definition, ICT-producing industries are also ICT-using industries (as the producers themselves also invest heavily in ICT), ICT-producing industries are excluded from the ICT-using sector in the analysis below.

The third and fourth columns of Table 1 show the shares of ICT-using industries in value added and employment in 1990 and 1998. As for the ICT-producing sector, the United States is again characterized by larger output shares than other OECD countries (except the Netherlands). However, the relative difference in output shares of ICT-using sectors are smaller than for ICT-producing sectors For example, the ratio of the lowest to the highest value added share of the ICT-using sector is 0.66 compared to 0.50 for the ICT-producing sector. The coefficients of variation of percentual output shares of the ICT-using sector is 0.11 compared to 0.24 for the ICT-producing sector. The differences in shares between the ICT-using sectors are due to differences in industry composition across countries. The current output shares for the Netherlands are higher than for the USA, due to the larger shares of chemicals in ICT-using manufacturing and of business services in ICT-using services.

For employment the differences across countries are in fact somewhat bigger than for the ICT-producing sector. The United States has clearly higher employment shares in the ICT-using sector than the other countries. Compared to the output shares the higher employment shares suggest relatively lower labour productivity levels in the ICT-using sector than for the total economy, which is mainly caused by the greater employment share of ICT-using services in the U.S.. As for the ICT-producing sector, the rise in the share of ICT-using sector in GDP and employment is limited and is largely concentrated in ICT-using services.

3. The Contribution of ICT to Labour Productivity Growth

The Contribution of the ICT-Producing and the ICT-Using Sectors to Labour Productivity Growth
Table 2 shows the contribution of the ICT-producing sector, the ICT-using sector and the rest of the economy (the "non-ICT sector") to the growth of GDP from 1990 to 1999, with the period being divided into two subperiods.[8] The contributions are computed by weighting the annual change in each sector's labour productivity at the employment share of that sector in the previous year.[9] In the U.S. ICT-production and ICT-use combined accounted for almost two thirds of labour productivity growth during the most recent period 1995-1999. In other countries, such as Denmark, Italy, Japan, the Netherlands and the United Kingdom the *relative* contribution was even higher than the two-third contribution in the U.S., but overall labour productivity growth in these countries was much slower. The relatively rapid productivity growth in Finland was largely accounted for by ICT-production.

The table shows that in almost all countries ICT-production (with the exception of Canada) and ICT-use (with the exception of Italy, and to a lesser extent Japan and the United Kingdom) contributed positively to the acceleration in labour productivity growth during the second half of the 1990s compared to the first half. However, in several European countries, notably in Denmark, Finland, Germany, Italy, the Netherlands and the United Kingdom, the non-ICT sector contributed negatively to labour productivity acceleration offsetting the positive effects from ICT-production and ICT-use. The mirror-image of the slowdown in productivity growth in the non-ICT sector is the rapid acceleration in employment growth during the period 1995-99.

In Japan the ICT-producing sector contributed 0.1 to productivity acceleration but this was offset by a productivity decelatation of 0.1 percentage point in ICT-using industries. The acceleration in employment growth in Japan was very limited and restricted to some expansion in ICT-using industries. Only for the U.S. employment expansion went together with a substantial labour productivity gain. These effects may relate to differences in the pace structural reforms in labour and product markets (McGuckin and van Ark, 2001, forthcoming)..

[8] For France, Germany and Japan sme data for 1999 were missing, so that the figures refer to 1995-98. For Germany the period starts in 1991 and refers to unified Germany.

[9] For details of this method see the methodological footnote to Table A.5 in van Ark (2000c). The use of annual shifting employment weights minimizes the distortion due to deviations of the share in the current year compared to the base year. In fact seven sectors instead of three are distinguished in the weighting scheme, i.e. ICT-producing manufacturing, ICT-producing services, ICT-using manufacturing, ICT-using services, other manufacturing, other services and remaining sectors (such as agriculture, mining, construction and public utilities).

Table 2: % -point contribution by sector to labour productivity growth, 1990-1995 and 1995-1999

	ICT-producing sector	ICT-using sector	non-ICT sector	Total
Canada (1990-1995)	0.2	0.3	0.7	1.2
Canada (1995-1999)	0.0	0.4	0.6	1.0
Acceleration/deceleration	-0.2	0.0	-0.1	-0.2
Denmark (1990-1995)	0.3	0.2	1.5	2.0
Denmark (1995-1999)	0.2	0.6	0.2	0.9
Acceleration/deceleration	-0.1	0.4	-1.4	-1.1
Finland (1990-1995)	0.6	0.1	2.7	3.3
Finland (1995-1999)	1.4	0.6	0.7	2.7
Acceleration/deceleration	0.8	0.5	-2.0	-0.6
France (1990-1995)	0.2	0.2	0.8	1.1
France (1995-1998)	0.4	0.2	0.7	1.3
Acceleration/deceleration	0.2	0.0	-0.1	0.2
Germany (1991-1995)	0.1	0.5	1.5	2.1
Germany (1995-1998)	0.4	0.5	0.7	1.7
Acceleration/deceleration	0.3	0.0	-0.7	-0.4
Italy (1990-1995)	0.2	0.5	1.1	1.8
Italy (1995-1999)	0.3	0.2	0.1	0.6
Acceleration/deceleration	0.1	-0.3	-1.0	-1.2
Japan (1990-1995)	0.3	0.4	0.1	0.8
Japan (1995-1998)	0.4	0.3	0.1	0.8
Acceleration/deceleration	0.1	-0.1	0.0	0.0
Netherlands (1990-1995)	0.1	0.3	0.9	1.3
Netherlands (1995-1999)	0.5	0.6	-0.2	0.9
Acceleration/deceleration	0.4	0.3	-1.1	-0.3
United Kingdom (1990-1995)	0.4	0.6	1.5	2.5
United Kingdom (1995-1999)	0.6	0.5	0.1	1.2
Acceleration/deceleration	0.2	-0.1	-1.4	-1.3
United States (1990-1995)	0.3	0.4	0.7	1.4
United States (1995-1999)	0.6	1.0	1.0	2.6
Acceleration/deceleration	0.3	0.6	0.3	1.3

Source: Groningen Growth and Development Centre ICT database (see also van Ark, 2000b).

4. Sources of Measurement Problems

In the past few years there have been increasing concerns about whether the macroeconomic statistics correctly trace the changes in the information society. Griliches (1994) showed a striking difference between the acceleration of labour productivity growth in 'measurable' sectors of the U.S. economy (agriculture, mining, manufacturing, transport and communication, and public utililities) and the slowdown in 'unmeasurable' sectors (like construction, trade, the financial sector, 'other' market services and government). Indeed for all advanced countries the nominal share of 'difficult to measure' industries has rapidly increased. For most European countries and Japan these nominal shares are in between the higher share of 72% in the United States in 1998 and the lower shares of around 60 per cent in Canada and Finland (both characterized by large natural resource sectors). All countries experienced a substantial slower growth in labour productivity growth in the 'unmeasurable' sector of the economy compared to the 'measurable' sector.[10]

There are various reasons for slower productivity growth in the 'unmeasurable' sector. As it consists mainly of services, the 'cost-disease' hypothesis of Baumol applies strongly in this sector. The larger size of the service sector as such is therefore one cause of increased measurement error at the aggregate level. Van Ark (2000a) estimates an increase in measurement error related to the shift of labour towards the 'unmeasurable' sector in France, Germany, Netherlands, the United Kingdom and the United States at 0.2 to 0.4 percentage point per year during 1985-96 relative to 1960-73.[11]

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

Measurement problems due to the greater role of ICT can be divided into four categories, namely measurement problems with regard to output in manufacturing (which is the major industry of the 'measurable' sector of the economy) and output in services (which dominate the 'unmeasurable' sector) vis-à-vis measurement problems concerning the inputs (production factors and intermediate inputs) in manufacturing and services.[12] The diagram below presents a summary of the major problems in each quadrant as well as the most desirable and feasible solutions.

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

[10] See van Ark (2000c), Table A.7.

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

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

The measurement problems in the northwest quadrant of the diagram are largely confined to the need to measure changes in prices in of ICT with the hedonic price index method. This approach relates the prices of each good to changes in selected characteristics of the product rather than the product itself. In the case of a personal computer such characteristics involve, for example, the type of processor, memory capacity, disk drives, CD-rom stations, etc. (Triplett, 1989). Since 1986 this method is used in the US National Income and Product Accounts (NIPA). More recently hedonic methods are also used in the national accounts of Canada. The Danish and French national accounts apply modified versions of the U.S. hedonic deflator adjusted for exchange rate developments. The lattter procedure may lead to serious biases, however, so that it is desirable to increase effort for new hedonic price approaches in ICT production in many countries.

Except adjusting the deflator for computer output, it is also necessary to make an adjustment for the most important ICT inputs in industry (the southwest quadrant of the diagram above). Triplett (1996) shows that almost all of the productivity increase in the computer industry can be traced to productivity gains in the semiconductor industry when its prices are properly measured. In addition, in many OECD countries semiconductors (or even computers) are hardly domestically produced but imported. As services are the most important user of computer input the deflation procedures proposed for manufacturing output of ICT also needs to be applied to inputs in services. It is therefore necessary to make a comprehensive adjustments of output, input and import of ICT products and services.

The largest measurement problems, however, relate to the measurement of output in the service sector. The current methodology of splitting the change in output value into a quantity component and a price component is difficult to apply to many service activities, as no clear quantity component can be distinguished. Moreover possible changes in the quality of services are also difficult to measure. These problems are not new, and improvements in measurement of service output have been a topic on the agenda of statisticians and academics for a long time.[13] In many service industries information on inputs (such as labour income) was and still is used as a proxy for output. As long as the price or cost developments are not too much affected by changes in the quality of the services, the traditional method suffice at least to measure the change in real output as the statistical bias remains relatively constant (Hulten, 2000). However, the increased importance of ICT may have accelerated quality changes in services. Multiple dimensions of a service should be taken into account, including the service concept, the client interface and the service delivery system (den Hertog, 2001). This implies that the real output of a particular service cannot be so easily measured on the basis of one exclusive quantity indicator. For example, improved inventory management in the trade sector makes it possible to differentiate supply of goods in terms of time, place and type of product. The application of ICT has supported the customization of financial products or combinations of those products (like an insurance, an investment fund and a mortgage). Services in the public sector, such as health care, are also increasingly characterized by diversity and differentiation in time, place and type of treatment. Even though such changes have not exclusively led to upward adjustments of real output, on balance the bias is probably towards an understatement of the growth in real service output (Triplett and Bosworth, 2000).

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

References

Ark, B. van (2000a), 'Measuring Productivity in the "New Economy": Towards a European Perspective', *De Economist*, Vol. 148, No. 1, pp. 87-105.

Ark, B. van (2000b), 'De vernieuwing van de oude economie: Nederland in een internationaal vergelijkend perspectief', in L. Soete, ed., *ICT en de Nieuwe Economie*, Royal Netherlands Economic Society, Lemma.

Ark, B. van (2000c), 'The Renewal of the Old Economy: An International Comparative Perspective', Groningen Growth and Development Centre, mimeographed (http://www.eco.rug.nl/MEDEWERK/ark/kvs10.pdf). Forthcoming as working paper with OECD Directorate for Science, Technology and Industry (http://www.oecd.org/dsti/sti/)

Baily, M.N. and R.J. Gordon (1988), 'The Productivity Slowdown, Mesurement Issues, and the Explosion of Computer Power,' *Brookings Papers on Economic Activity 2*, pp. 347-431.

Baily, M.N. and R.Z. Lawrence (2001), "Do We Have a New Economy?", NBER Working Paper No. W8243, April, Cambridge Mass..

Conference Board (2001), *Performance 2000: Productivity, Employment and Income in the World's Economies*, New York,.

Griliches, Z., ed. (1992), *Output Measurement in the Service Sectors, Studies in Income and Wealth*, Volume 56, National Bureau of Economic Research, Chicago University Press.

Hertog, P. den (2001), 'Knowledge Intensive Business Services as Co-producers of Innovation', *International Journal of Innovation Management*, forthcoming.

Hulten, C.R. (2000), 'Measuring Innovation in the New Economy', paper presented at OECD, Paris, 20 June

Jorgenson, D.W (2001), 'Information Technology and the U.S. Economy,' *The American Economic Review*, Vol. 91, pp. 1-32.

Jorgenson, D.W. and K.J. Stiroh (2000), 'Raising the Speed Limit: U.S. Economic Growth in the Information Age,' *Brookings Papers on Economic Activity*, Vol. 2.

McGuckin, R.H. and B. van Ark (2001), *Perspectives on a Global Economy Exploiting the Productivity Benefits of the Information Age: Prospects and Problems*, The Conference Board, New York.

Oliner, S.D. and D.E. Sichel (2000), 'The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?,' *Journal of Economic Perspectives*, Vol. 14, no. 4, pp. 3-22.

Scarpetta, S., A. Bassanini, D. Pilat and P. Schreyer (2000), 'Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level,' *Economics Department Working Papers*, No. 248, OECD, Paris.

Sichel, D.E. (1997), 'The Productivity Slowdown: Is A Growing Unmeasurable Sector the Culprit?,' *Review of Economics and Statistics*, pp. 367-370.

Triplett, J.E. (1989), 'Price and Technological Change in a Capital Good: A Survey of Research on Computers', in D.W. Jorgenson and R. Landau, eds., *Technology and Capital Formation*, MIT Press, Cambridge, MA.

Triplett, J.E. (1996), 'High Tech Industry Productivity and Hedonic Price Indices', in OECD, *Industry Productivity. International Comparison and Measurement Issues*, OECD Proceedings, Paris, pp. 119-142.

Triplett, J. and B. Bosworth (2000), Productivity in the Services Sector, Brookings Institutions, mimeographed (http://www.brookings.edu/views/papers/triplett/20000112.pdf)