

ICT Boosts Productivity But Is Not a Panacea



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The End of the New Economy?

In the late 1990s the 'new economy' became synonymous with bullish stock markets and incredible riches created by dotcom entrepreneurs out of thin air.

Simultaneously, and with considerably less fanfare, the use of information and communication technology (ICT) progressed in Finnish business. As late as 1995, firms with Internet access accounted for only one fourth of total business employment. By the end of the decade, this technology was nearly completely diffused.

Up until the mid-1990s the ICT-performance literature tended to conclude that ICT did not have measurable impacts. Many later studies find that ICT is indeed positively linked to performance. Since previous literature has been recently reviewed by, e.g., Dedrick et al. (2003) and Pilat (2003), we will only discuss it briefly.

Macro-level studies show that ICT has considerable economic effects through the expansion of ICT-related production of goods and services as well as via capital deepening. In the U.S., these effects are primarily driven by the use of ICT (Jorgenson, 2001; Oliner and Sichel, 2000), whereas in Finland they are primarily driven by the provision of ICT (Jalava, 2002; Jalava and Pohjola, 2002). Frictions in firms' operating environment – excessive regulatory burden, lack of qualified personnel, inflexible hiring and firing practices, generally low ability and/or willingness to adapt to change, as well as lack of

security and/or trust – hinder the diffusion and efficient use of ICT.

U.S. micro-level studies (see Brynjolfsson and Hitt, 2000 and references therein), in particular, show that at least since the mid-1990s the use of ICT has boosted firms' market shares and competitiveness. Technologies aiding value chain integration seem to be particularly valuable in this respect. Efficient use of ICT seems to require large amounts of (primary non-technical) co-invention, i.e., changes in organizational structures and in ways of working. Associated expenses, along with user training and support, form a considerable part of the total investment expenditure. It has been argued (Brynjolfsson et al., 2002; Brynjolfsson and Hitt, 2000) that because of these additional expenditures, the total investment may be up to ten times larger than its 'pure' ICT component.

Despite the fact that so far the main effects of the 'new economy' in Finland have been brought about by ICT provision, it is generally agreed that the long-run effects will be driven by ICT use (Koski et al., 2001, 2002). Even though the phenomenon and its macroeconomic effects are understood relatively well also in Finland, very little microeconomic work has emerged, not least because of lacking data. The Ministry of Trade and Industry commissioned Etlatiето and Statistics Finland to fill this gap (see Maliranta and Rouvinen, 2003). The project aimed to answer the following questions:

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- Does ICT have measurable productivity effects at the micro level?
- If so, how big are they in magnitude?
- Does the role of ICT differ between manufacturing and services?
- Does the potency of ICT vary by firm age?
- Is ICT complementary to education?
- What are the effects of various technologies (computers, Internet, local area network)?

In the spring of 2003, Statistics Finland conducted the fifth annual round of its Internet and electronic business survey. The four prior surveys are the statistical sources underlying our ICT indicators. We have exploited a range of statistical and econometric methods to analyze data on a sample of two thousand firms covering the period 1998–2001. The data are available for interested users at Statistic Finland's Research Lab.

Our theoretical model is based on the popular Cobb-Douglas production function. Our econometric specification effectively removes all industry and time effects. A rich set of background variables is included. We control for employees' educational levels and disciplines, age, and gender as well as for, e.g., the average age of firms' establishments. Thus, we attempt to capture the 'pure' productivity effect of ICT to the greatest extent possible.

Widespread Use of ICT Is a Relatively Recent Phenomenon

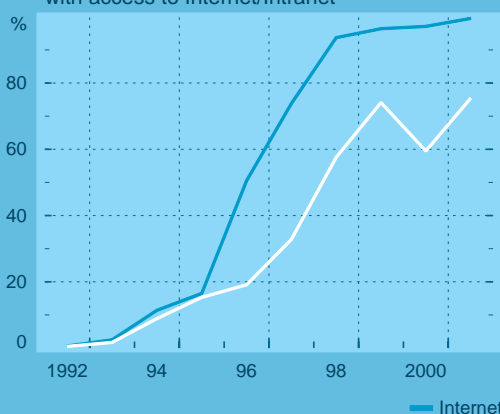
In 2001, a good forty percent of manufacturing and almost sixty percent of service-sector workers used the Internet at work. Firms with an Intranet in place accounted for three fourths of manufacturing and two thirds of service employment. The 'previous generation' inter-organizational electronic networking technology EDI (electronic data interchange) seems to be holding up in manufacturing but in services its use started to decline in 1999.

It is hardly surprising that ICT-related services, communications and IT services and digital content provision, are also among the most intensive users of ICT. The provision of ICT equipment is the leading manufacturing branch in this respect.

We have also derived various industries' shares of the total ICT capital stock of the Finnish business sector. Although wholesale and retail trade is not among the most ICT-intensive branches, its considerable size leads us to conclude that it commands over one fifth of the overall ICT capital stock in Finnish business. Financial and business services also account for a considerable share of the overall capital stock. In manufacturing, machinery and equipment commands the largest share.

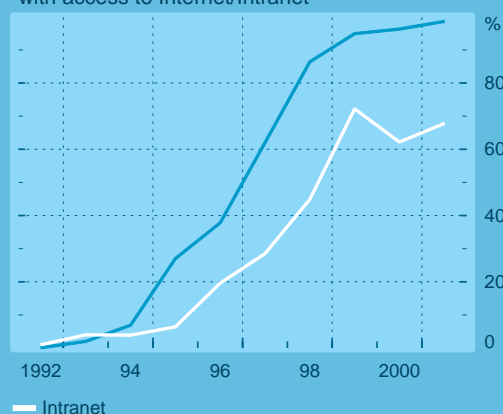
ICT Usage Exploded in the mid-1990s

Share of industrial workers working in a firm with access to Internet/Intranet



Source: Maliranta & Rouvinen, 2003.

Share of service-sector workers working in a firm with access to Internet/Intranet

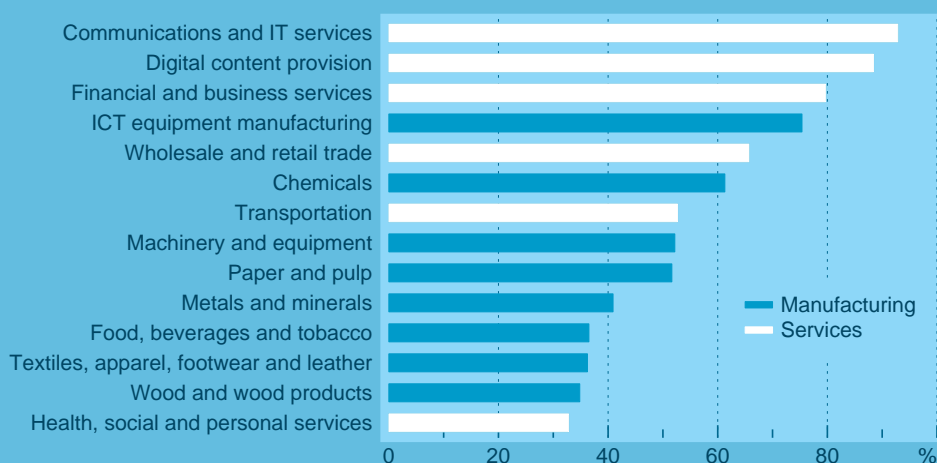


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Contrary to what was believed in the heyday of the 'new economy', structural change – faster growth of firms using ICT intensively – explains only a minor part of the increased aggregate ICT usage. From 1998 to 2001, the within-firm effect on the share of workers using the Internet at work was little over twenty percentage

points in manufacturing and slightly less than twenty percentage points in services. The corresponding between-firm effect was nearly non-existent in manufacturing and some three percentage points in services. Productivity-enhancing 'creative destruction' have nevertheless been strong among young ICT-intensive firms.

Share of Employees Who Use ICT at Their Work by Industry*



Source: Rouvinen & Maliranta, 2003.

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* The economic activities listed in the figure refer to the following NACE industries

- Chemicals (23-25)
- Communications and IT services (642, 72)
- Digital content provision (221, 744, 921, 922, 924)
- Financial and business services (65-67, 70, 71, 741-743, 745-748)
- Food, beverages and tobacco (15, 16)
- Health, social and personal services (55, 75, 85, 90, 91, 923, 925-927, 93)
- ICT equipment manufacturing (30, 313, 32, 332, 333)
- Machinery and equipment (29, 311, 312, 314-316, 331, 334, 335, 34, 35)
- Metals and minerals (26-28)
- Paper and pulp (21)
- Textiles, apparel, footwear and leather (17-19)
- Transportation (60-63)
- Wholesale and retail trade (50-52)
- Wood and wood products (20)

ICT Raises Worker Productivity by Eight to Eighteen Percent an average

On average the productivity of ICT-equipped labor is from eight to eighteen percent higher than for other workers. The effect is often much higher in younger firms and in ICT-providing branches, while in older firms at least the immediate effect can even be negative. The interesting findings with regard to firm age are consistent with the need for ICT-complementing organizational changes.

Overall, the ICT-induced boost to productivity seems to be somewhat higher in services than in manufacturing. Manufacturing firms benefit in particular from ICT-induced efficiency in internal (LAN) whereas service firms benefit from efficiency in external (Internet) communication. We find weak evidence for the complementarity of ICT and human capital, although the issue should be studied in more detail.

The best is yet to come...

Although our findings suggest that ICT does, indeed, have sizable effects, to the best of our understanding the results most likely constitute

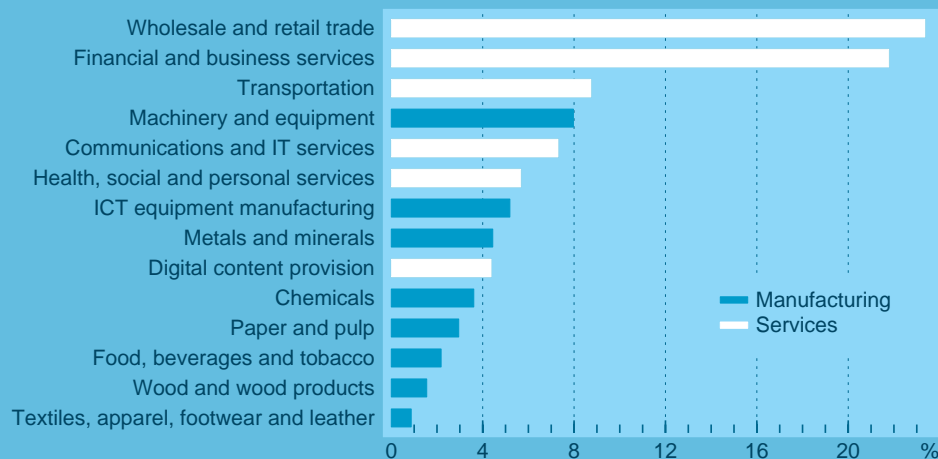
a 'lower bound' of the actual effects. In part this relates to the modeling and econometric techniques used.

A more fundamental reason for our belief is the newness of ICT and possibly considerable time lags between its initial introduction and the effects that it generates. The ultimate effects of the technology will be realized once we have adjusted our organizational structures, ways of working, and 'mental models' accordingly.

There is little research and certainly no consensus on the timing of performance gains from a given ICT investment, but according to Cisco Systems Inc. CEO John T. Chambers "... the greatest payoff doesn't come until seven to nine years after an investment is made" (Business Week, 17 February 2003, p. 45). Brynjolfsson and Hitt (2002) indirectly suggest that the lag might be from three to seven years.

Most of the international ICT-performance literature measures the elasticity of ICT-capital. If we derived a similar measure from our results, it would be in the five to six percent range, which is roughly the average calculated from dozens of studies done abroad.

Share of Total Business Sector (Industry + Services) ICT Capital Stock by Industry*



Source: Rouvinen & Maliranta, 2003.

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A comparison of the productivity effects of ICT and the related expenses reveals that the two are roughly equal, i.e., on average ICT capital does not seem to earn 'excess returns' in Finnish business.

ICT Promotes New Ways of Organizing Activities

At least cutting-edge implementation of ICT may be likened to R&D – the process is experimental and risky. The associated investments may bear fruit beyond expectations but they may also be wasted. In a well-functioning market those with the best implementations will succeed and achieve faster growth than the market on average. Indeed, we find that this market selection process has been particularly intense among young ICT-intensive firms.

Due to the fact that most innovations related to the use of ICT cannot be patented or otherwise protected, we can expect that the best practices will eventually spread to other firms and to the rest of the economy. Thus, during the ongoing experimentation phase, a wide spectrum of approaches is in society's best interest since the best successes define the efficiency frontier.

Our results show that ICT is indeed important. It should nevertheless be emphasized that it does not boost productivity alone, directly, automatically, or immediately. ICT is an enabling technology, the effects of which are brought about by new ways of organizing activities made possible by its use.

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