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Can double deflation explain the ICT growth miracle?

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HIGHLIGHTS

- I investigate labor productivity in the ICT-industry in ten countries in 1995–2010.
- Productivity differs substantially in the ICT-industry across countries.
- The Swedish and Dutch ICT-industry differs by over 14 000 percentage points.
- Double deflation is an important explanation to the apparent Swedish ICT miracle.
- The high productivity in the Swedish ICT-industry is partly a statistical illusion.

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ABSTRACT

It is unclear why productivity growth in the information and communication technology (ICT) industry differs considerably among countries. This paper shows that, for Sweden, it is primarily the use of the double deflation method that has created the apparent ICT-miracle.

1. Introduction

In the 1980s it was still true that you could "see the computer age everywhere but in the productivity statistics" as famously remarked by Robert Solow (Solow, 1987, p. 36). Despite increased productivity growth at the macro level in the US and some other countries since the mid-1990s, the economic impact of information and communication technology (ICT) has remained a debated issue. Gordon (2000) claimed that, outside of the ICT-producing industry, the acceleration in productivity growth in the US economy was cyclical.

Since then new evidence has shown that the economic impact of ICT has been more profound than was suggested on the basis of macro data in the late 1990s. Stiroh (2002) found that there was significantly higher productivity growth in industries using ICT intensively, even after controlling for macroeconomic cycles. Moreover, the contribution from ICT-capital deepening continued to be considerable in the US economy in 2000–2005, although the impact of ICT decreased compared to the period 1995–2000 (Jorgenson et al., 2008). In many EU-countries the effect of ICT-capital deepening was smaller compared to the US, but still not negligible (van Ark et al., 2008). Finally, evidence from firm-level data suggests that ICT has been important for explaining differences in productivity growth across firms (see Brynjolfsson and Hitt, 2003; van Reenen et al., 2010).

Even though the economic impact of ICT remains less questionable, the reason why productivity growth in the ICT-producing industry has been exceptionally high in some countries, while it is almost negligible in others, has not been thoroughly investigated. For example, the annual productivity growth in the Swedish ICT-producing industry in manufacturing was 40% in 1995–2010, while it was only 1% in the Netherlands (see Table 1). This implies that labor productivity growth was approximately 14 000 percentage points higher in the ICT producing industry in Sweden compared

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Table 1
Annual labor productivity growth in the ICT-producing industry in 9 western EU-countries and the US from 1995–2010.
Source: OECD (2013).

Country	LP growth based on value added (VA)	LP growth based on gross output (GO)	Difference between VA and GO
Austria	4.1	4.0	0.1
Belgium	3.2	2.5	0.7
Denmark	6.5	4.2	2.3
Finland	14.2	11.1	3.0
France	10.1	5.7	4.5
Germany	12.6	n.a.	n.a.
Italy	1.1	1.6	−0.4
Netherlands	1.0	2.1	−1.3
Sweden	40.0	13.2	26.8
United States	26.8	11.3	15.5

Note: LP = labor productivity, VA = value added and GO = gross output. The ICT-producing industry in manufacturing is defined as computer, electrical and optical equipment (ISIC 26). The 9 European countries have been chosen based on data availability. Labor productivity is defined as value added or gross output per person engaged. Due to data limitations, ICT services industries are not included in the analysis.

to the Netherlands in the same period. Thus, Moore's law only appears to be at work in the ICT-producing industry in some countries.[1]

It has been argued that the use of quality-adjusted, so-called hedonic, price indexes can be one explanation for the high growth in the ICT-producing industry (Pakes, 2003; Schreyer, 2002; Triplett, 2006). Some countries use hedonic price indexes for ICT-products while others do not. In the US the hedonic method is applied for different types of computers and peripheral equipment, semiconductors and software, while Sweden, for example, only uses the hedonic method for imported computers (Deremar and Kullendorff, 2006; Moulton, 2001).

This paper finds that Sweden had the highest productivity growth in the ICT-producing industry in manufacturing compared to the US and 8 other EU-countries. A closer inspection shows, however, that the exceptional productivity performance by the ICT-producing industry can largely be explained by double deflation, i.e. the method used to deflate value added.

2. Productivity performance in the ICT-producing industry

This paper defines the ICT-producing industry in manufacturing at the 2-digit level as the computer, electronic and optical equipment industry (ISIC 26).[2] Table 1 shows the average labor productivity growth, based on two different measures, for the ICT-producing industry in manufacturing for 9 western EU-countries and the US for the period 1995–2010.[3] Thus, labor productivity is either defined as value added or gross output per person engaged.

According to Table 1, Sweden had the highest labor productivity growth rate in the ICT-producing industry with 40% per year

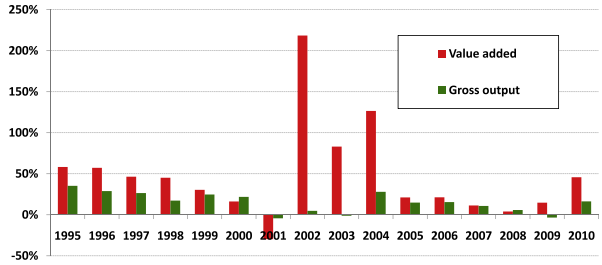

Fig. 1. Annual labor productivity growth for the Swedish ICT-producing industry in 1995–2010 (percent). *Note*: Labor productivity is defined as value added and gross output per hour worked. The ICT-producing industry is defined as computer, electronic and optical equipment (ISIC 26). Due to data limitations, ICT services industries are not included in the analysis.
Source: Statistics Sweden (2012) and own calculations.

based on the value-added measure. The second highest growth rate was found for the ICT-producing industry in the US with an annual growth rate of 27%, while Finland had the third highest annual growth rate of 14%. The lowest figure was found for the Dutch ICT-producing industry with a growth rate of 1%/year during the investigated period. Thus, the differences in labor productivity growth for the same industry in different countries are enormous.

Table 1 also shows the productivity growth based on gross output. The Swedish ICT-producing industry still had the highest annual labor productivity growth with 13%, followed by the US and Finland with 11% each. Moreover, Table 1 shows the difference between the value added and gross output based measures. For Sweden this difference was 27 percentage points per year in the ICT-producing industry, followed by the US and France with 16 and 4 percentage points, respectively.

Since the annual labor productivity growth based on the two measures differs so much for the Swedish ICT-producing industry, it is important to investigate this industry in more detail. Fig. 1 shows labor productivity growth for the Swedish ICT-producing industry on an annual basis when labor productivity is defined either as gross output or value added per hour worked. Exceptionally large differences are found for the years 2001–04; for example, for the period 2001–02 the difference in labor productivity growth was 202 percentage points.

3. Double and single deflation

What can explain the differences in labor productivity growth based on either value added or gross output for the Swedish ICT-producing industry in manufacturing? One possible explanation could be that different deflation methods are used for gross output and value added. According to the OECD (2001), deflation of gross output is conceptually simple. An index of the nominal value is divided by an output price index to obtain a volume index of gross output. Thus, single deflation is used for gross output.

When value added is deflated the method used in the national accounts is based on double deflation, implying that the gross output and intermediate inputs of an industry are deflated separately. The OECD (2001) definition of the volume change in value added is:

$$dlnVA/dt = [PQ/P_{VA}VA] * [dlnQ/dt - (P_M M/PQ) * (dlnM/dt)] \quad (1)$$

where $dlnVA/dt$ is the volume change in value added, $dlnQ/dt$ is the volume change in gross output and $dlnM/dt$ is the volume change in intermediate inputs. The volume change of intermediate inputs is weighted by the share of intermediate inputs in gross output ($P_M M/PQ$) and the whole expression is multiplied by the inverted share of value added in gross output ($PQ/P_{VA}VA$). Thus,

[1] Moore's law was introduced by Gordon Moore in 1965 and initially stated that the number of transistors on integrated circuits should double every year, but this was later changed to approximately every 18 months.

[2] According to the OECD (2007, p. 8), ICT-producing industries "must primarily be intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display". Thus, the OECD defines the ICT-producing industry in manufacturing as the following industries: Electronic components and boards (ISIC 2610), computers and peripheral equipment (ISIC 2620), communication equipment (ISIC 2630), consumer electronics (ISIC 2640) and magnetic and optical media (ISIC 2680). Since data is not available at the 3-digit ISIC level, this paper will simply define the ICT-producing industries in manufacturing at the 2-digit level as the computer, electronic and optical equipment (ISIC 26).

[3] Due to data limitations this paper does not analyze ICT services industries.