ICT Production and Productivity in Sweden and Finland, 1975-2004

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ABSTRACT

This article compares the development of labour productivity in the Swedish and the Finnish business sectors and the role of the information and communication technology (ICT) sector in this process. The results show that the Finnish productivity level has been converging towards the Swedish level, but that there is still a significant difference. This trend has coincided with the growing importance of the ICT sector, especially since the mid 1990s. Due to higher productivity and employment growth, the Finnish ICT sector has contributed to this convergence. This is explained by the electrical engineering industry. The Nokia effect has been stronger than the Ericsson effect.

DURING THE DECADES AFTER World War II, the Western European countries that are currently members of the EU experienced faster labour productivity (LP) growth than the United States. In the mid 1990s, this convergence turned into divergence. This occurred at the time when the production of information and communication technology (ICT) took off in the United States. Among a few countries that did not follow the European trend were Sweden and Finland. Both small, open economies combining high levels of competitiveness with high welfare ambitions. They are also at the forefront in the transition to the innovative knowledge society. Not the least is this expressed by extensive and advanced ICT production.

Macroeconomic research has tried to quantify how this production has affected productivity developments in Sweden and Finland. However, the two countries have never been compared systematically and thoroughly. The aim of this article is to fill this void. Four main questions will be answered: (1) has the LP level in the Finnish business sector been converging towards the Swedish level? (2) how important has ICT production been for LP growth in the business sector? (3) how important has ICT production been for the relative development of the LP level in the business sector? (4) has structural change in the labour market had any effect on the relative LP level?

In the Finnish context, using a shift-share-method, Jalava (2003) shows that the LP growth in the business sector in the latter part of the 1990s can be explained by a positive reallocation of labour, and that this was primarily a consequence of an increase in the employment share of ICT production. Jalava (2004) shows that over time manufacturing has become dependent on a smaller number of industries, and that LP growth

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in the period 1995-2003 to a large extent can be attributed to the ICT-producing industries. Daveri and Silva (2004) estimate the contribution of ICT production to LP growth in the economy in the period 1978-2000. The results indicate that there has been a gradual increase in this contribution and that it amounted to slightly more than 30 per cent in the period 1992 to 2000. Jalava and Pohjola (2007) estimate that close to 70 per cent of the total factor productivity (TFP) growth in manufacturing can be attributed to ICT production in the years 1995-2005.

In the Swedish context, Lind (2002) shows that the contribution of ICT production to LP growth in the business sector increased from 28 to 60 per cent between 1994-1997 and 1998-2001. Lindström (2003) finds that the high TFP-growth in the business sector in the period 1993-1999 is explained by the ICT-producing industries. According to Lind (2003), LP growth in the Swedish manufacturing industry exceeded the average in OECD countries between 1960 and 2001. This is explained by a favourable trend since the beginning of the 1990s. Using a shift-share-method, this upturn was found to be a combined consequence of high LP growth in ICT production and an increase in its employment share.

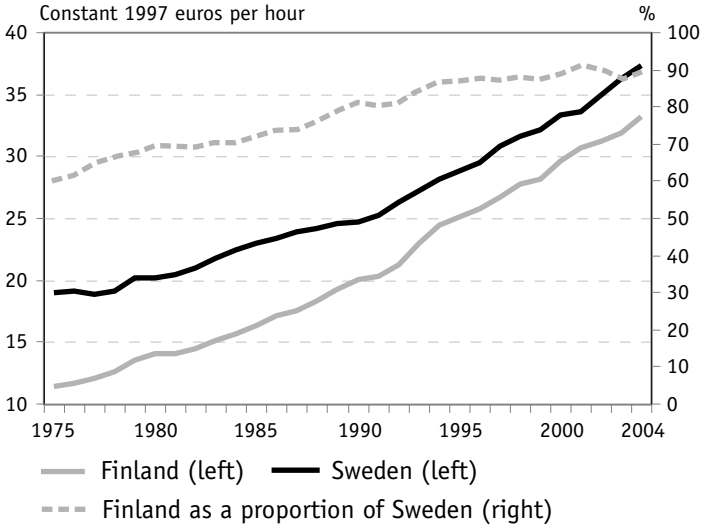
In an international, comparative perspective, van Ark (2001) shows that among ten OECD-countries, the contribution of ICT production to LP growth in the economy was largest in Finland in the latter part of the 1990s. Using a shift-share-method, it is shown that an important explanation for this is the favourable employment trend in the ICT-producing industries. Van Ark *et al.* (2002) increased the number of countries studied. They show that the trend in the OECD is an increase in LP growth in the ICT-producing industries in the 1990s. In a comparison among 16 countries, the contribution of ICT production was second largest in Finland in the latter part of the 1990s (Ireland came first). The Swedish contribution was more modest and amounted to somewhat less than the EU-average. Timmer and van Ark (2005) compare the development in the United States and the European Union between 1995 and 2001. Their results show that only in Ireland was the contribution of ICT production to the aggregate TFP-growth larger than in Finland and Sweden. In absolute terms, the Finnish contribution was somewhat larger than in Sweden, but in a relative perspective ICT production was more important in the latter country.

In this article labour productivity is defined as real value added per hour worked. Against the background of growing employment in ICT production, it is central to capture this structural change in the analysis. This is done using a shift-share method, in which the LP level is not only determined by the level within industries, but also by reallocation of labour between industries. The period studied is 1975-2004.[2] The statistics are from the EU KLEMS database.[3] The focus is on the business sector, but the part of the business sector that is most similar to activities in the public sector is excluded. Thus, the market-oriented part of the economy is defined in SNA-terms as sectors 01-74 and will be denoted as the business sector. According to the OECD (2002), ICT production is defined as the industries (1) office machinery and computers; (2) electrical engineering; (3) precision and optical instruments; (4) post and telecommunication; and (5) computer services. The first three belong to manufacturing, the latter two to the service sector. Together, they constitute the ICT sector.

2 After this article was completed data became available for 2005. Given the medium to long-term nature of the analysis, these new figures have no effect on the conclusions drawn.

3 See van Ark et al (2007) and Timmer *et al.* (2007) for a description of the database.

Chart 1
Business Sector Labour Productivity (LP) Levels in Sweden and Finland,1975-2004



Source: EU KLEMS and author calculations.

The article is divided into seven sections. The first section analyses the LP levels of the business sector in Sweden and Finland and how the relative level between the two countries has developed over time. The second section gives a comprehensive picture of the ICT sector in both countries, and in the third, the LP level in the ICT sector and its relation to the business sector are illustrated. Section four examines the LP level and LP growth in the different industries in the ICT sector. Section five presents estimates of the contribution of the ICT sector to LP growth in the business sector and section six analyses the importance of the ICT sector for the convergence of Finnish business sector labour productivity toward the Swedish level. The final section, discusses the productivity challenges faced by Finland and Sweden and proposes a future research agenda.

Has Finland Caught Up with Sweden?

What is the LP level in the Swedish and Finnish business sector and how has it developed over time? Chart 1 shows that the LP level in the Swedish business sector was 19 euros per hour worked in 1975 (constant 1997 euros). In the same year, the Finnish level was 11.5 euro. Thanks to a significantly higher average yearly Finnish LP growth in the period 1975-95, the difference in LP levels between the two countries decreased. In relation to Sweden, Finland was in a period of convergence.

However, there has been no further decrease in the absolute gap in productivity levels between Sweden and Finland in the last ten years. Instead, it increased by 0.3 euros between 1995 and 2004. This change is explained by the fact that the Swedish LP growth — after two weak decades both in relation to its own history and in comparison to other countries — increased after the crisis years at the beginning of the 1990s. At the same time the Finnish LP growth slowed down.

In 2004, the Swedish LP level was 37.3 euros and the Finnish level to 33.2 euros — a difference of 4.1 euros. This means that the LP level increased by 95 per cent in Sweden and by 190 per cent in Finland between 1975 and 2004. The average Swede today produces almost twice as much per hour as 30 years ago and the average Finn has almost tripled hourly production in the same period.

The third curve in the chart shows the Finnish LP level as a proportion of the Swedish level. Thirty years ago, this relative was 60.2 per cent, in 1995 to 86.8 per cent and in 2004 to 89.1 per cent. Despite the fact that the absolute difference has increased somewhat since 1995, the Finnish relative has — as a consequence of growing levels — increased by 2.3 percentage points.

Does the LP level difference between Sweden and Finland reflect reality or is it a statistical construct? With a difference of 11 percentage points, it should, even when error margins are taken into account (Schreyer, 2005), reflect reality — the LP level in the business sector is somewhat higher in Sweden than in Finland.[4]

Table 1

ICT Sector Share of the Business Sector in Sweden and Finland, Nominal Value Added and Hours Worked, 1975, 1995 and 2004

	Sweden			Finland		
Nominal value added	**1975**	**1995**	**2004**	**1975**	**1995**	**2004**
ICT sector	7.2	8.0	9.8	4.1	8.2	14.1
Of which manufacturing industry						
Office machinery and computers	0.3	0.2	0.2	0.1	0.2	0.02
Electrical engineering	2.3	2.2	1.5	1.6	3.3	6.3
Precision and optical instruments	1.1	1.0	1.1	0.2	0.6	0.7
Total ICT manufacturing	3.7	3.4	2.8	1.9	4.1	7.0
Of which service sector						
Post and telecommunication	2.8	3.1	3.5	1.8	2.9	4.6
Computer services	0.7	1.5	3.5	0.4	1.2	2.5
Total ICT services	3.5	4.6	7.0	2.2	4.1	7.1
Hours worked						
ICT sector	6.7	8.2	8.9	4.0	7.1	9.1
Of which manufacturing industry						
Office machinery and computers	0.3	0.2	0.1	0.07	0.02	0.01
Electrical engineering	2.2	2.4	2.2	1.5	2.5	3.1
Precision and optical instruments	1.0	1.0	0.9	0.3	0.6	0.7
Total ICT manufacturing	3.5	3.6	3.2	1.9	3.1	3.8
Of which service sector						
Post and telecommunication	2.6	3.0	2.7	1.8	2.7	2.5
Computer services	0.6	1.6	3.0	0.3	1.3	2.8
Total ICT services	3.2	4.6	5.7	2.1	4.0	5.3

Source: EU KLEMS and author calculations

A Comprehensive Picture of the ICT Sector

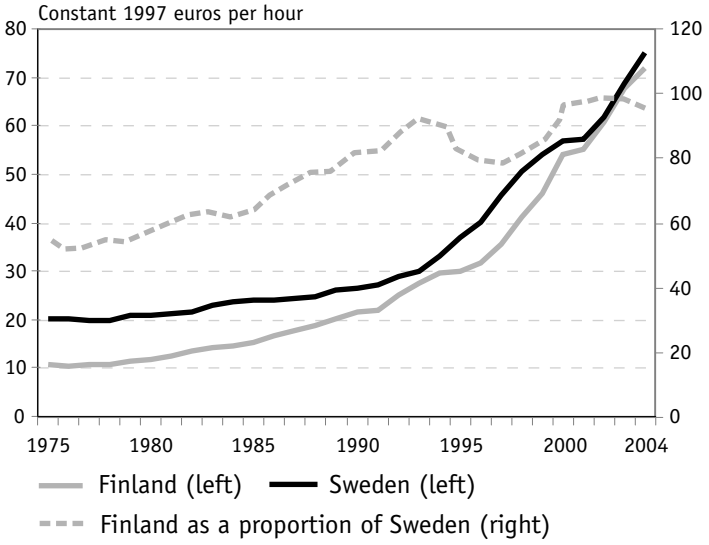
What role has the ICT sector played in the convergence of the Finnish business sector LP level toward the Swedish level? Has it changed over time, both in absolute and relative terms? A comprehensive picture of the ICT sector is a necessary condition for carefully prepared answers to these questions.

The ICT sector's share of business sector value added and hours worked is presented in Table 1. In 1975, the ICT sector's share of the Swedish business sector's nominal value added was 7.2 per cent and it has since grown to 9.8 per cent by 2004. With a share of 4.1 per cent, the Finnish ICT sector was considerably smaller than its Swedish counterpart in the mid 1970s. However, it has caught up with and overtaken its Swedish equivalent over the last 30 years. In 2004, the Finnish ICT sector's share of value added in the business sector was 14.1 per cent.

As is also shown, there has been a decrease in the manufacturing-related share of the Swedish ICT sector in the business sector between 1975 and 2004 — from 3.7 to 2.8 per cent. The opposite trend occured in Finland — the share of ICT manufacturing increased from 1.9 to 7.0 per cent. In both cases, it is electrical engineering that explains the major part of these diverging patterns. Both in Sweden and Finland, the

4 This conclusion seems reasonable, since OECD's calculations on the difference in GDP per hour do not deviate from the results presented here in any unreasonable way.

Chart 2
ICT Sector Labour Productivity Levels (LP) in Sweden and Finland, 1975-2004



Source: EU KLEMS and author calculations.

service-related ICT-industries have increased their share of business sector value added in the last 30 years. In Sweden, this means an increase from 3.5 to 7.0 per cent, in Finland from 2.2 to 7.1 per cent. Thus, the Finnish service-related industries were smaller than the Swedish ones in 1975, but today the shares are approximately the same. This means that the smaller Swedish ICT sector is explained by the manufacturing industries — and electrical engineering is the relevant industry among these.

The lower part of Table 1 presents the ICT sector and its industries shares of the business sector's hours worked. A few points are worth mentioning. First, in terms of share of hours worked it is clear that the size difference between the two countries' ICT sectors disappears. With shares around nine per cent in 2004 they are of equal importance. Second, between 1975 and 2004 the share of hours worked in the ICT manufacturing in Sweden fell, while at the same time it doubled in Finland. Third, the very rapid LP growth which occurred in both the Swedish and the Finnish electrical engineering-industry, as we will discover later on in this article, went together with an increased share of hours worked in Finland in this industry, but not in Sweden. Thus, the greater importance of ICT manufacturing in Finland is, again, explained by electrical engineering. Finally, in contrast to valued added shares, the share of hours worked in ICT services was in 2004 slightly larger in Sweden than in Finland.

The ICT Sector's Labour Productivity Level

How productive are the Swedish and the Finnish ICT sectors? Together with their relative shares of hours worked and value added, productivity levels provide the basis for assessing the contribution of the ICT sector to LP growth in the business sector, and the role the ICT sector has played in the Finnish productivity convergence.

Chart 2 presents the LP levels of the ICT sector between 1975 and 2004. It shows that the LP level of the Swedish ICT sector was slightly more than 20 euros in 1975. In the same year, the Finnish level was slightly more than half this amount — 11 euros.

Up to the early 1990s there was a significant reduction in the gap in ICT sector LP levels between Sweden and Finland. In 1993, the Finnish level was 93 per cent of the Swedish level. After 1993 the Swedish LP growth increased and there was an increase in the LP gap. Yet, the gap decreased once again later in the decade and, after 2000, the gap had disappeared almost entirely.

Average annual LP growth in the ICT sector in the period 1995-2004 was two percentage points higher in Finland than in Sweden — 10.2 and 8.2 per cent, respectively. Due to these extraordinary growth rates, the LP levels in 2004 amounted to 75.3 euros in Sweden and 73.8 euros in Finland. This means that the LP level in the Finnish ICT sector was slightly more than 95 per cent of the

Table 2

Labour Productivity Levels and Growth in ICT Industries in Sweden and Finland

	Sweden			Finland		
LP level (constant 1997 euros per hour)	**1975**	**1995**	**2004**	**1975**	**1995**	**2004**
Office machinery and computers	20.5	28.6	66.0	3.3	21.1	41.6[1]
Electrical engineering	9.0	20.7	85.3	10.7	37.6	129.2
Precision and optical instruments	22.4	31.5	47.0	9.9	28.4	21.0
Total ICT manufacturing	13.9	24.4	68.4	10.3	35.4	118.6
Post and telecommunication	35.5	79.9	148.0	9.8	26.2	67.6
Computer services	47.0	34.9	32.6	28.4	24.9	25.8
Total ICT services	37.8	65.4	90.1	13.0	25.8	53.1
LP growth (compound annual average)	**1975-2004**	**1975-95**	**1995-2004**	**1975-2004**	**1975-95**	**1995-2004**
Office machinery and computers	4.1	1.5	9.7	11.2	11.3	18.5[1]
Electrical engineering	8.1	3.2	17.1	9.0	6.8	14.7
Precision and optical instruments	2.6	1.9	4.6	2.6	5.6	-3.3
Total ICT manufacturing	5.7	2.9	12.2	8.8	6.4	14.4
Post and telecommunication	4.0	3.7	7.1	6.9	5.2	11.1
Computer services	-1.2	-1.4	-0.8	-0.3	-0.1	0.4
Total ICT services	3.0	2.8	3.6	5.0	3.5	8.3

1 There is no real value added in this industry after 1999. For this reason, this is the 1999 year level. In a similar way, average yearly LP growth in the lower part of the table is the average for the period 1995-99. The average for 1975-2004 is the average for the period 1975-99.

Source: EU KLEMS and author calculations.

Swedish level. Accounting for established margins of error, one should be careful in deriving far-reaching conclusions from this. What is obvious, however, is that LP growth has been considerably faster in the ICT sector than in the business sector since 1975. The LP level in the ICT sector was on the same level as in the business sector in that year; in 2004, the level measured in constant 1997 euros is more than twice as high in both Sweden and Finland.

LP Levels and LP Growth in the ICT Industries

What have been the trends in LP levels and growth rates in the five industries that make up the ICT sector? As is clear from Table 2, electrical engineering, at 9.0 euros per hour worked, had the lowest LP level in Sweden in 1975. The highest level, 47.0 euros, was found in computer services. This means that the LP level in electrical engineering was about half that of the business sector, while the level of LP in computer services was more than twice as high. Average LP growth of 8.1 per cent per year between 1975 and 2004 resulted in a LP level in electrical engineering of 85.3 euros in 2004. This substantial increase occurred primarily in the last ten years — with an average yearly LP growth rate of 17.1 per cent. Thus, the LP level of this industry increased more than nine times since 1975 and more than four times in the last decade.

Computer services showed an opposite trend. Table 2 shows an average LP decline of 1.2 per cent per year between 1975 and 2004. The LP level fell from 47.0 to 32.6 euros. The performance of other industries fell between these extremes.

The LP level of the ICT manufacturing industries increased from 13.9 euros to 68.4 euros between 1975 and 2004. During the last decade alone the level almost tripled — from 24.4 euros to 68.4 euros. In the services sector LP growth has

been more modest, but the level still increased by almost 40 per cent since 1995.

In comparison with Sweden, the Finnish LP level in 1975 was lower in all industries except in electrical engineering. This pattern still holds 30 years later. The higher LP growth in the Finnish ICT sector — an implication of the convergence in Chart 2 — has not resulted in any industries overtaking their Swedish counterparts. In 2004, the Finnish LP level was less than 50 per cent of the Swedish level in precision and optical instruments and in post and telecommunication. In sum, without the high LP level in electrical engineering, which also generates the high LP level for the aggregate ICT manufacturing industries, there would have been a considerable deterioration in the relative position of the Finnish ICT sector. Not only due to its size, but also in terms of LP, electrical engineering is crucial for the interpretation of the picture of the ICT sector.

As in Sweden, the Finnish computer services industry experienced negative LP growth between 1975 and 2004. In the period 1995-2004, LP growth in the Finnish ICT sector was highest in office machinery and computers, closely followed by electrical engineering. With an average of -3.3 per cent per year, the trend since the mid 1990s has been particularly unfavourable for precision and optical instruments. In electrical engineering, the Finnish LP level is currently more than 40 euros higher than the Swedish level.

The ICT Sector's Contribution to LP Growth in the Business Sector

The previous sections have shown that the importance of the ICT sector for the business sector LP growth has grown since 1975, and especially since the mid 1990s. But more precisely, how important is this sector for the business sector?

According to OECD (2001), this question can be answered using equation (1). The LP growth of the business sector, ΔLP, is defined as the weighted sum of the LP growth of the industries, where the weights, $\bar{w}_i$, consist of the industries' shares of the nominal value added of the business sector (Thörnqvist index). The contribution of the ICT sector to the LP growth of the business sector is defined as the sum of the contributions of the ICT-producing industries.

$$1) \qquad \Delta LP = \sum_i \bar{w}_i \Delta LP_i \,.$$

Let us start by analysing the period 1975-2004. From Table 3, it appears that the average LP growth of the Swedish business sector — estimated from equation (1) – was 1.9 per cent per year in this period. The average yearly contribution of the ICT sector was 0.35 percentage points. This means that 18.4 per cent of the LP growth of the business sector can be attributed to the ICT sector (0.35/1.9). In Finland, the average LP growth of the business sector was 3.1 per cent per year in the same period. The contribution of the ICT sector amounted to 0.52 percentage points, but due to the higher LP growth of the business sector, the share was only 16.8 per cent (0.52/3.1).

As concerns the industries in the ICT sector, the picture is similar in both countries. Electrical engineering and post and telecommunication were the only industries with substantial impacts. In both countries, the former was the industry that contributed most in the period 1975-2004.

In a comparison between the two subperiods, one finds since 1995 a sharp increase in the contribution of the ICT sector to the LP growth in the business sector. In Sweden, the contribution more than tripled between the periods — from 0.19 to 0.64 percentage points. In Finland, the contribution was multiplied by four — from 0.31 to 1.25 percentage points. This increased importance means that 22.1 per cent of the LP growth in the Swedish business sector since the mid

1990s can be attributed to the ICT sector. In a similar way, the contribution amounts to 41.7 per cent in Finland. This means that for Finland, 12 per cent of the value added of the business sector — calculated as the average for the period 1995-2004 in Table 1 — has generated more than 40 per cent of the LP growth. In both absolute and relative terms, the contribution of the ICT sector has been about twice as large in Finland as in Sweden between 1995 and 2004.

Table 3 also shows, once more, that it is electrical engineering and post and telecommunication that explain these results. In Sweden, there was a fivefold increase in the contribution from electrical engineering — from 0.07 to 0.35 percentage points. This means that this industry on its own contributed 12 per cent to the LP growth in the business sector between 1995 and 2004 (0.35/2.9). The contribution doubled for post and telecommunication. In Finland, there was a sevenfold increase in the contribution from electrical engineering — from 0.12 to 0.83 percentage points. This means that over the 1995-2004 period 28 per cent of the LP growth in the business sector can be attributed to this industry (0.83/3.0) and thus, that this industry is more important for the Finnish LP growth than what the entire ICT sector is for Sweden.

Table 3
The Contribution of the ICT Sector to Business Sector Labour Productivity Growth in Sweden and Finland
(Annual percentage point change unless otherwise noted)

Sweden	1975-2004	1975-95	1995-2004
LP growth in the business sector	1.9	1.5	2.9
Contribution of the ICT sector	0.35	0.19	0.64
Of which			
Office machinery and computers	0.01	0.00	0.02
Electrical engineering	0.17	0.07	0.35
Precision and optical instruments	0.03	0.02	0.05
Post and telecommunication	0.16	0.11	0.24
Computer services	-0.02	-0.01	-0.02
Contribution Share of the ICT sector (%)	18.4	12.7	22.1
Finland			
LP growth of the business sector	3.1	3.3	3.0
Contribution of the ICT sector	0.52	0.31	1.25
Of which			
Office machinery and computers	0.02	0.03	0.02
Electrical engineering	0.28	0.12	0.83
Precision and optical instruments	0.01	0.02	-0.02
Post and telecommunication	0.21	0.14	0.42
Computer services	0.00	0.00	0.01
Contribution Share of the ICT sector (%)	16.8	9.4	41.7

Source: EU KLEMS and authorcalculations.

The Contribution of the ICT Sector to the Finnish Productivity Convergence

According to the shift-share method, the difference in business sector LP levels between countries at a given point in time is either explained by differences in levels *within* industries or by differences in the employment structure *between* industries. In the latter case, this relates to how employment is distributed between high- and low-productivity level industries. Timmer and Szirmai (1999) show that this can be analysed using equation (2). The difference in LP levels between the Swedish and the Finnish business sectors, $LP^S - LP^F$, is defined as the sum of two terms. In the first, the industry-wise difference in LP levels is weighted with the average employment share (L) of the industry $\frac{1}{2}(L_i^F + L_i^S)$. In the second, the difference in employment shares in the business sector is weighted with the average LP level $\frac{1}{2}(LP_i^F + LP_i^S)$.

$$2)\ LP^S - LP^F = \sum_{i=1}^{n}(LP_i^S - LP_i^F)\frac{1}{2}(L_i^F + L_i^S) + \sum_{i=1}^{n}(L_i^S - L_i^F)\frac{1}{2}(LP_i^F + LP_i^S)$$

If the first term after the equals sign — the LP effect — is zero, then the entire difference in LP levels is due to differences in the employment structure. If the second term — the employment effect — is zero, then the entire LP gap is explained by differences in LP levels between industries.

Table 4

The Finnish Productivity Convergence and the Contribution of the ICT Sector

(Average annual percentage points unless otherwise noted)

1975-2004	LP effect (1)	Employment effect (2)	Contribution to convergence (1)+(2)	Share of convergence (%)
ICT sector	0.28	5.36	5.62	19.5
Of which				
Office machinery and computers	0.18	0.14	0.31	1.1
Electrical engineering	3.38	3.44	6.82	23.6
Precision and optical instruments	-0.16	0.45	0.28	1.0
Post and telecommunication	-3.02	0.67	-2.35	-8.1
Computer services	-0.10	0.66	0.56	1.9
Business sector	23.4	5.5	28.9	
1995-2004				
ICT sector	0.69	2.07	2.76	123.2
Of which				
Office machinery and computers	0.04	-0.02	0.02	0.7
Electrical engineering	1.24	1.76	3.00	133.8
Precision and optical instruments	-0.35	0.20	-0.16	-7.1
Post and telecommunication	-0.21	-0.02	-0.23	-10.4
Computer services	-0.02	0.15	0.14	6.1
Business sector	-0.15	2.39	2.24	

Source: EU KLEMS and author calculations.

Using equation (2) as the starting point, the contribution of the ICT sector to the percentage convergence — from 60.2 to 89.1 per cent of the Swedish level between 1975 and 2004 — of the Finnish business sector can be estimated. The difference between the Finnish share of the Swedish business sector at two points in time is, in accordance with equation (3), explained by how the LP effect and the employment effect in equation (2) relate to the Swedish LP level at the two points in time.

$$3)\quad \frac{LP^{F,T}}{LP^{S,T}} - \frac{LP^{F,0}}{LP^{S,0}} = \frac{Intra^{0}}{LP^{S,0}} - \frac{Intra^{T}}{LP^{S,T}} + \frac{Struc^{0}}{LP^{S,0}} - \frac{Struc^{T}}{LP^{S,T}}$$

$$Intra = \sum_{i=1}^{n} (LP_i^{\,S} - LP_i^{\,F}) \frac{1}{2} (L_i^F + L_i^S)$$

and

$$struc = \sum_{i=1}^{n} (L_i^S - L_i^F) \frac{1}{2} (LP_i^{\,F} + LP_i^{\,S})$$

How is the Finnish convergence distributed between the LP- and the employment effect and what has the contribution of the ICT sector looked like? In Table 4, calculations using equation (3) show that 23.4 percentage points of the Finnish business sector productivity convergence of 28.9 percentage points between 1975 and 2004 can be attributed to the LP effect — that is to a decrease in the difference in LP levels within industries.[5] The remaining share, 5.5 percentage points, can be attributed to changes in relative employment shares. Structural change on the Finnish labour market — sometimes defined as creative destruction — has thus reduced the LP gap; almost a fifth of the convergence can be explained by these shifts in employment.

5 The calculations according to equation (3) never exactly correspond to the trend in Chart 1. Thus, the statistics in Table 4 have been normalised.

The contribution of the ICT sector was 5.62 percentage points. This corresponds to 19.5 per cent of the decreased LP gap. Almost all of this, or 5.36 percentage points, is explained by the employment effect. This implies that the positive employment effect of the Finnish business sector is due to a favourable relative structural change in the ICT sector. Note that the share of ICT hours worked increased from 4.0 per cent to 9.1 per cent between 1975 and 2004. The LP effect is not as favourable; only 0.28 of 23.4 percentage points in convergence can be attributed to the ICT sector. This means that a decreased LP gap between the Finnish and Swedish ICT sectors has not been of any decisive importance for the Finnish productivity convergence toward the Swedish level.

At the industry level, it is clear that more than the entire contribution of the ICT sector can be attributed to electrical engineering. On its own, the contribution of this industry amounts to 6.82 percentage points. This corresponds to 23.6 per cent of the productivity convergence of the Finnish business sector toward the Swedish level and is the result of both a favourable LP and employment effect. More than 60 per cent of the employment effect in the business sector can be attributed to electrical engineering (3.44/5.5). As concerns the LP effect, 14 per cent can be attributed to the same industry (3.38/23.4). The other ICT industries have not contributed to the convergence in any substantial way, even if the employment effect is positive for all industries. The negative LP effect in post and telecommunication is a consequence of an increased Sweden-Finland gap in the LP level of that industry from 26 euros in 1975 to 80 euros in 2004.

In the mid 1990s, there was an acceleration in the pace of growth of the ICT sector. In both countries, the share of valued added of the ICT sector and its LP grew faster than in earlier periods. The pattern was more accentuated in Finland, resulting in a greater relative importance of the ICT sector to the convergence since 1995 than in 1975-1995.

The lower part of Table 4 also shows this to be the case. Of the 2.24 percentage points productivity convergence of the Finnnish business sector toward that of Sweden between 1995 and 2004, -0.15 percentage points can be attributed to the LP effect and 2.39 percentage points to the employment effect. In the former case, this means that there was an increase in the difference in the LP level within industries in the business sector, and hence that the entire convergence can be attributed to a positive Finnish structural change on the labour market.

The ICT sector contributed 2.76 percentage points to the business sector productivity convergence between Finland and Sweden in 1995-2004. Thus, more than the actual fall in thegap (2.24 points) — or 123.2 per cent — can be explained by this sector. Without this contribution, the convergence would have turned into divergence. This is the result of a positive LP effect of 0.69 percentage points and a positive employment effect of 2.07 percentage points. Once more, it was the ICT sector that constituted almost all of the positive structural change in the Finnish business sector from 1995 to 2004.

Electrical engineering is crucial for these results. The LP effect for this industry was 1.24 percentage points or almost twice as much as the contribution of the entire ICT sector. If the relationship between the LP levels in this industry had been constant between the countries — and the LP effect had been zero — the LP effect for the business sector would have deteriorated to -1.39 percentage points. In the same way, there would have been a dramatic reduction in the employment effect if the positive contribution from electrical engineering were to have been excluded. A crucial part of the positive structural change on the Finnish labour market can be attributed to electrical engineering. Alto-

gether, 133.8 per cent of the 2.2 percentage points productivity convergence between 1995 and 2004 is explained by this industry alone. This implies that the other ICT industries have negatively contributed to the LP gap.

Conclusion

This article confirms that in both Sweden and Finland the ICT sector has become increasingly important for aggregate productivity growth, and that it has played a crucial role since the mid 1990s. When comparing the two countries, it is obvious that in absolute terms, the sector has been more important in Finland than in Sweden. This is a conclusion that also finds support in earlier research. Partly as a consequence of different definitions, methods and time periods, research has, however, not succeeded in establishing any uniform answer to the question of how important the ICT sector has been in relative terms. This article indicates that, also from this perspective, the ICT sector has played a larger role in Finland than in Sweden since the mid 1990s. This leads to the conclusion that Finland is unambiguously more dependent on ICT production than Sweden, and that the main explanation for this is the electrical engineering industry.

The larger relative importance of the Finnish ICT sector is also reflected by the convergence in LP levels in the business sector. The explanation for this is not primarily faster LP growth, but rather a more positive structural change on the labour market in Finland than in Sweden. This means that a growing Finnish ICT sector has, since the mid 1990s, lead to a continuation of the convergence process, although at a much slower pace. However, only the telecom equipment manufacturing industry is hiding behind this aggregate. The Nokia effect has been stronger than the Ericsson effect.[6]

The large dependence on these firms — and the high-technology clusters by which they are surrounded — is an interesting stepping stone for a future research agenda. How long can we rely on this technical paradigm? Are enough resources invested in moving the research frontier forward? How are we affected by the increased share of services and by the fact that manufacturing tends to offshore? Can this uncertainty be compensated by more efficient ICT use? Is there a hidden productivity growth potential in the service sector? Does such growth require further complementary investments in in-service training and organisational change? Does this require that a new, more ICT-oriented generation becomes established on the labour market? Without claiming to have the correct answers, we should — in conclusion — give a thought to the employees in the telecom industry who in a crucial way have contributed to the favourable LP growth since the mid 1990s.

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6 In Finland attempts have been made to estimate the direct contribution of Nokia to the aggregate development. Between 1995 and 2000 around 80 per cent of the contribution from the ICT sector to GDP growth can be attributed to Nokia. Nokia's share of GDP was around 3 per cent in the beginning of the 21st century. Nokia also accounted for around 20 per cent of total exports and a third of total investment in research and development during the same years. Finally, Nokia's employment share was one per cent and in 2006 the revenues exceeded the state budget. Sources: http://info.worldbank.org/etools/docs/library/145283/IC_for_Finland.pdf and http://en.wikipedia.org/wiki/Nokia.

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