SSE/EFI Working Paper Series in Economics and Finance
No. 556
February 2004

The Swedish ICT Miracle – Myth or Reality*

By

Harald Edquist‡

Abstract: This paper investigates the relative labor productivity level for total manufacturing in Germany, Sweden and the US for the period 1980–2001. The paper also presents estimates of labor productivity levels for 18 different manufacturing industries for the period 1993–2000. The results show that the Swedish manufacturing productivity caught up with German and US productivity in the 1990s, overtaking the German level in 1995 and coming very close to the US level by the end of the 1990s. It has been argued that much of the Swedish surge in labor productivity during the second half of the 1990s was due to the spectacular growth of the Radio, television and communication equipment (RTC) (ISIC 32) industry. However, this paper shows that since 1998 Swedish RTC productivity has been declining relative to the corresponding industry in Germany and the US. Moreover, it is shown that the productivity growth of the ICT-producing industries is very sensitive to the value added price deflators that areused to calculate real value added growth rates. Unlike Sweden, the US uses hedonic price indexes for semiconductors and microprocessors. These electronic components are important intermediate inputs in the RTC industry. Therefore estimates based on the US intermediate input price deflators for semiconductors and microprocessors suggest that the productivity growth of the Swedish RTC industry during the 1990s is partly a statistical artefact. This implies that the productivity growth of total manufacturing also has been overestimated.

JEL-codes: O10; O30; O47; O57

Keywords: Information and communication technology (ICT), Productivity, Technological change, Value added deflators

* I am especially grateful to Robert Inklaar, without whose help this paper never would have been written. I would also like to thank Bart van Ark, Edwin Stuivenwold, Marcel Timmer and Gerard Ypma at the Groningen Growth and Development Centre and Magnus Henrekson at the Stockholm School of Economics for providing valuable comments and data for this paper. Moreover, I am grateful to Göran Svensson, Bertil Klang and Per Ericson at Statistics Sweden and Arvid Wallgren and other participants at the seminar at the Swedish Central Bank for insightful comments. Financial support from the Jan Wallander and Tom Hedelius Foundation and the Carl Silvén Foundation is also gratefully acknowledged.
‡ Department of Economics, Stockholm School of Economics, PO Box 6501, SE-113 83 Stockholm, Sweden. Phone: +46 8 736 92 59, Fax: +46 8 31 32 07, E-mail: Harald.Edquist@hhs.se

Table of Contents

1. Introduction

During the 1990s productivity research increasingly came into focus. Comparisons of productivity across countries and industries are important for evaluating economic performance. Moreover, particular attention has been paid to productivity comparisons in industries with rapid technological change and falling prices such as the Information and Communication Technology (ICT) producing industry.

Comparing productivity in industries producing homogenous products is an easy task. For example, in the crude oil industry, output is arrived at by a mere counting of barrels of oil produced. However, measuring productivity in industries where technology changes rapidly is a totally different matter. According to “Moore’s law” microprocessors are halved in price and double in capacity every 18 months. A computer based on the latest technology might be obsolete within a year or two. Is it then reasonable to compare productivity in industries with rapidly changing technology and prices across countries? Nordhaus (1997) argues that capturing the impact of new technologies on living standards is beyond the practical capability of official Statistical Agencies. The essential difficulty is that high-tech goods and services consumed today may not even have existed a decade ago. Moreover, if they did, the quality of the goods that we consume today is much higher compared to the quality of “the same” good a decade ago.

The increase in productivity growth in the US economy since 1995 (see Council of Economic Advisers 2003) has resulted in an intense debate on the impact of ICT technology on productivity in different countries. In Sweden, ICT technology created an economic boom at the end of the 1990s. In 2000 Stockholm was named the Internet capital of Europe by the *Newsweek* Magazine. According to *Newsweek* the Stockholm phenomenon could be explained by “the looming marriage of the Internet and the third-generation mobile telephony in Europe” (Newsweek 2000). Figures from Statistics Sweden also supported the spectacular development of the Swedish Radio, television and communication equipment (RTC) (ISIC 32) industry. For the period 1996–2000 the labor productivity growth in RTC was approximately 35 percent per year.

Four years later, it is evident that much of the Swedish Internet era of the late 1990s was a transient hype, partly created by media. However, it has been very difficult to explain the fundamental fact that productivity growth in Swedish manufacturing and particularly in the RTC industry increased so rapidly during the last years of the 1990s. Did the increased productivity growth in manufacturing and RTC of the late 1990s reflect some fundamental changes in the economy or was it largely a statistical artefact?

There have been a number of studies examining productivity development in Sweden during the 1990s. Most of them investigate productivity growth in Sweden compared to other countries (see Lundgren and Wiberg (2000), Edquist and Henrekson (2001, 2002), Lind (2002, 2003) and Apel and Lindström (2003)). So far much of this research has been focused on Swedish productivity growth, often in comparisons with productivity growth in other countries. The results have emphasized the spectacular growth and the increasing importance of the Swedish RTC industry. A common claim is that without the spectacular growth of the RTC industry the productivity growth in total manufacturing during the second half of the 1990s would have been much lower (Lind 2003). Moreover, the productivity performance of the total manufacturing industry during the 1990s has often been described as the "ICT miracle".

Much research has been carried out about Swedish productivity growth. However, the research on comparative productivity levels has been limited. Moreover, it has not been clarified to what extent the use of country specific value added price deflators have affected the growth in the RTC industry. The following questions have remained unanswered: How big is the gap in productivity level for different manufacturing industries between Sweden and other countries? Which industries have been catching up during the 1990s? What impact does the use of different value added price deflators and quality adjustments have on productivity growth and relative productivity levels in the ICT-producing industries?[1]

[1] For a definition of the ICT producing industries see OECD (2002).

The purpose of this paper is to answer the questions stated above. In sections 2 and 3 I present estimates of labor productivity levels for Swedish manufacturing relative to the corresponding levels in Germany and the US in 1980–2001. Moreover, I also provide estimates of labor productivity levels for 18 manufacturing industries at the 2-digit ISIC[2] level for the period 1993–2000. The method used for comparing productivity levels is based on the industry-of-origin approach.[3] In short, the industry-of-origin approach converts output by industry to a common currency with a producer price-based and industry specific Purchasing Power Parity, which is called Unit Value Ratio (UVR).[4] In section 4, the impact of value added price deflators for the ICT-producing industry is investigated. Section 4 also compares the intermediate input and gross output price deflators for ISIC 32 in Sweden and the US. Section 5 concludes.

2. Labor productivity levels in manufacturing

2.1 Currency conversion

In order to compare labor productivity levels between countries with different currencies, it is necessary to convert the value added of different countries into a common currency. Since price levels in different industries can vary substantially across countries, it is also necessary to find a conversion method that is industry specific (Scarpetta *et al*. 2000). The conversion can be made in a number of ways. One possibility is simply to use the existing exchange rate between the two countries. However, this implies several disadvantages. For example, the exchange rate is only based on traded goods, it is not industry specific, it is affected by exchange rate policies and currency market fluctuations and it does not adjust for international price differences (Monnikhof and van Ark 2002).

An alternative to the exchange rate is to use Purchasing Power Parities (PPPs). PPPs are obtained from the expenditure side and reflect the relative price levels for private

---

[2] ISIC stands for International Standard for Industry Classification and it is an UN based classification standard (see United Nations Statistics Division (2000))
[3] The industry-of-origin approach has been developed by the ICOP (International Comparisons of Output and Productivity) group at the University of Groningen since 1983 (see van Ark and Pilat 1993).
[4] The methodology of unit value ratios is discussed in more detail in section 2.1.

consumption, investment and government expenditure (van Ark and Timmer 2002). PPPs are constructed by gathering expenditure prices for a large sample of products in each country. The ratio between the expenditure prices for the same products in the two countries are then used to construct the PPPs. Finally, the ratios of expenditure prices for each product group are aggregated to a country specific PPP.

While PPPs are successfully used for comparisons of GDP and labor productivity at the aggregate level, there are a number of problems associated with the use of PPPs for industry level comparisons. One problem is that expenditure PPPs only apply to final output, so that intermediate output is not covered by PPPs. According to Monnikhof and van Ark (2002) intermediate products account for around one third of the value in manufacturing. Another drawback with using the expenditure PPPs for comparisons on the industry level is that they include margins, indirect taxes and subsidies. They also include import prices, while export prices are excluded (van Ark and Pilat 1993).

According to van Ark and Timmer (2002) there are two alternatives to construct reliable industry level PPPs. The first approach is to transform expenditure PPPs to industry groups by "peeling off" indirect taxes and transport and distribution margins and thereby create producer price level PPPs.[5] The second approach is the industry-of-origin approach that will be used in this paper. The industry-of-origin approach converts the currency by using output data instead of expenditure data. The conversion is made by calculating unit value ratios (UVRs).

Unit values (UV) are computed by dividing the ex factory value of output for a product category by the produced quantities. The information is most often based on production censuses or industrial surveys. In practice, products or product groups that are similar in both countries are matched against each other. Unit values for the two countries are then divided in order to obtain a product unit value ratio (UVR). Each product UVR indicates the relative producer price of the matched product in the two countries. Product UVRs

[5] This method was pioneered by Jorgenson and associates. For a more detailed description of the method see van Ark and Timmer (2002).

are aggregated step by step to higher levels; from the product level to the industry level and finally to the total manufacturing level.[6]

The industry-of-origin methodology also has some drawbacks. According to van Ark (1996) there are three major problems[7] with the UVR-method that affect the comparability of the estimates across countries:

- In many sectors and industries UVRs are based on a limited sample of items. For example, in manufacturing where the average percentage of output covered by unit value ratios is between 15 and 45 percent, it is usually assumed that UVRs for matched items within a manufacturing industry are representative for non-matched items.

- Comparisons of unit values are affected by differences in product mix. Often output values are only calculated for product groups instead of specific products. This leads to problems on a disaggregated level because of the lack of harmonized product coding systems between different countries.

- The unit value ratios also have to be adjusted to differences in product quality across countries. However, it is even more serious in international comparisons since the frequency of "unique products" that are only available in one country, is higher than for comparisons over time.

Despite these caveats the industry-of-origin methodology appears to be the preferred method for comparing productivity levels across countries. Nonetheless, it is important to keep in mind that the industry-of-origin methodology has limitations and that results for industries with low coverage ratios must be interpreted with caution.

[6] For a detailed and more formal explanation of the industry-of-origin approach see appendix 1.
[7] Another problem that is not discussed by van Ark (1996) is that UVRs are often used in a single deflation procedure, which means that intermediate products are not included in the estimation of UVRs.

2.2 Unit value ratio data

The unit value ratios presented in this paper are based on two bilateral investigations for the year 1997. The first investigation compares the unit value ratios between Germany and Sweden and the second compares the unit value ratios between Germany and the US. This allows for comparisons of Sweden and the US by using Germany as a link. The unit value ratios between Sweden and Germany are based on data from the Eurostat Prodcom-database (Europroms 2001). The unit value ratios between Germany and the US have been calculated by Inklaar *et al*. (2003a) and are based on the Eurostat Prodcom-database and the US manufacturing census for 1997.

Before aggregating the UVRs, outliers were removed from the Prodcom-database.[8] For the comparison between Germany and Sweden products with deviation more then 200% and less than 75% of the EU average[9] were removed. For the comparisons between Germany and the US products with deviations more that 100 percent and less than 50% of the EU average were removed. The reason for allowing a larger boundary for Germany and Sweden is that Sweden is a smaller country with an economy characterized by a high degree of specialization.[10] Moreover, some product groups were deleted since it was obvious that the product groups were not comparable across countries.[11]

The quantity of the Swedish product group Radio transmission apparatus with reception apparatus (Prodcom 32201170) is missing. Since this product group has significant importance for the RTC industry (ISIC 32) an estimation of the quantity has been made. *Table 1* shows the values of gross output and quantity for the Radio transmission apparatus with reception apparatus (Prodcom[12] 32201170) divided into three different subgroups. Quantity data only exists for the subgroup Transmission apparatus,

[8] To remove outliers is a standard procedure in calculations of unit value ratios.
[9] The average of the EU is based on at least four EU countries.
[10] If a larger boundary is not used for Sweden and Germany, a very large number of product groups would be removed since Sweden has a very specialized economy compared to the EU average.
[11] For example, the product group Other machines and appliances for testing materials (Prodcom 33206259) was dropped since it was obvious that it contained different products that were not comparable between Sweden and Germany.
[12] Prodcom is a classification code for industry products at the 8-digit industry level.

incorporating reception apparatus, for cellular networks "mobile telephones" (CN[13] 85252091). It is therefore assumed that the Radio transmission apparatus with reception apparatus (Prodcom 32201170) has the same gross output/quantity ratio as this subgroup. This assumption appears to suggest that apples should be compared with oranges. However, the intuition behind this assumption is that the production value for Radio transmission apparatus with reception apparatus does not differ very much whether it is used for radio-telephony, radio-broadcasting, television or cellular networks. This view is supported by officials at the Swedish company Ericsson that is the largest supplier of Radio, transmission apparatus with reception apparatus (Prodcom 32201170). According to specialists[14] at Ericsson the prices and technical specifications are approximately the same for the two largest subgroups[15] in *table 1* (i.e. CN 85252091 and CN 85252099).

2.3 Productivity level results

2.3.1 Unit value ratio results

Table 2 and *3* present the results for the calculations of the unit value ratios. The unit value ratios for 18 manufacturing industries in Sweden and Germany are shown in *table 2*. In total there were 802 matches between product groups in manufacturing. Food products (ISIC 15–16), Wood and products of wood and cork (ISIC 20), Paper products (ISIC 21) and Radio, television and communication equipment (ISIC 32) are the industries with the highest coverage ratios. Office accounting and computing machinery (ISIC 30), Medical, precision and optical instrument (ISIC 33) and Other transport equipment (ISIC 35) have low coverage ratios. Medical precision and optical instrument (ISIC 33) has the highest UVR with 15.83 SEK/EUR, while Office accounting and computing machinery has the lowest with 5.83 SEK/EUR. For manufacturing the Fisher[16]

[13] CN stands for Combined Nomenclature and is a classification code for industry products that is used by Statistics Sweden. The CN code is compatible with the Prodcom classification code.
[14] Interview with Olle Zimmerman 2004-01-13.
[15] The radio, transmission apparatus with reception apparatus for civil aircrafts is such a small part of the total production value of the industry that the assumed price has a very small effect on the total gross output/quantity ratio for the total Radio, transmission with reception apparatus (Prodcom 32301170).
[16] The Fisher exchange rate is derived by taking the square root of the product of the Paasche exchange rate and the Laspeyres exchange rate.

exchange rate is 9.41 SEK/EUR which is higher than the average exchange rate of 8.65 SEK/EUR in 1997.

Inklaar *et al*. (2003a) also provide estimates of unit value ratios for manufacturing in Sweden and Germany. Their results are based on 250 matches compared to 802 for the study presented here. Moreover, the coverage ratios for Sweden are higher for all industries except Chemicals (ISIC 22).[17] The unit value ratios estimates for different industries do not differ much between the results in this article and those by Inklaar *et al*. However, there is a large difference for Medical precision and optical instrument (ISIC 33). In *table 2* the UVR is 15.83 SEK/EUR for Medical precision and optical instrument, while it is only 7.18 SEK/EUR in Inklaar *et al*. One reason for the difference is that Inklaar *et al's* UVR estimates are based on 3 matches, while the results in *table 2* are based on 16 matches.

Table 3 presents the estimates of the unit value ratios for Germany and the US. Food products (ISIC 15–16), Textile, clothing, leather and footwear (ISIC 17–19), Paper products (ISIC 21) and Basic metals (ISIC 27) have high coverage ratios. The lowest coverage ratios are found for Printing and publishing (ISIC 22), Fabricated metal products (ISIC 28) and Other transport equipment (ISIC 35). Printing and publishing (ISIC 22) has the highest UVR with 2.12 Dollar/EUR and Textile clothing, leather and footwear (ISIC 17–19) has the lowest with 0.66 Dollar/EUR. The Fisher exchange rate for the whole manufacturing industry is 1.11 Dollar/EUR.

2.3.2 Productivity level benchmark results for 1997

Table 4 reports the labor productivity levels[18] for the benchmark year 1997. The differences in labor productivity level among industries within the same country depend heavily on the capital intensity among industries. Therefore the interesting results are the differences in relative productivity in the same industry across countries. According to *table 4* the Swedish Chemicals (ISIC 24) industry had the highest labor productivity level

[17] For Chemicals the difference in coverage ratio is 5 percentage points between the result in *table 2* and Inklaar *et al* (2003a).

[18] In this paper labor productivity is defined as value added per number of persons engaged.

relative to Germany and the US. Paper products (ISIC 21) also had very high levels of labor productivity relative to Germany and the US. The Swedish manufacturing recycling (ISIC 36–37) industry had the lowest labor productivity level relative to Germany, while manufacturing recycling (ISIC 36–37) and RTC (ISIC 32) had the lowest productivity level relative to the US. The highest labor productivity level for Germany relative to the US was found for Printing and publishing (ISIC 22). The highest labor productivity level in the US relative to Germany was found for RTC.

3. Extending labor productivity levels by growth rates

3.1 Time series data

3.1.1 Data description

The results of the relative productivity level for the benchmark year (1997) can be extended to other years by using labor productivity growth rates (based on value added in fixed prices). Labor productivity growth rates are calculated by using time series with value added, value added deflators[19] and employment. The labor productivity growth rates are then used to calculate the change in relative productivity performance based on the benchmark year. The Swedish time series data has been taken from the Swedish National Accounts (Statistics Sweden 2003b). Due to changes in industrial classification and the introduction of the new 1993 system of National Accounts (SNA), the Swedish data only covers the period 1993–2001. This limits the estimation of the relative labor productivity levels at a detailed industry level[20] to the period 1993–2000. However, for total manufacturing it has been possible to link time series of value added, value added deflators and employment of the Swedish National Accounts with industry data from the STAN database for 1980–1992 (OECD 2001b). This makes it possible to present estimates of the productivity level in Swedish manufacturing for the period 1980–2001. The data for Germany and the US are based on the 60-industry database (GGDC 2003).

[19] A definition of value added deflators and how they are calculated can be found in section 4.2.
[20] This paper presents estimates for most manufacturing industries at the 2-digit ISIC industry level.

Furthermore, all aggregation for the US and Germany have been based on Törnqvist weights.[21]

3.1.2 Price deflators

One of the major problems with comparing productivity growth and levels across countries is to construct similar and reliable deflators. All three countries use double deflation[22] in order to calculate the value added in fixed prices for the production side of the economy. Double deflation means that the production value (gross output) is deflated with an output price index[23], while intermediate inputs are deflated with an input price index. Since double deflation is used in all three countries there should not be a major problem to compare the value added growth rates across countries. However, the value added in fixed prices for Sweden is based on a Laspeyres volume index with moving average based on year t–1, while value added in fixed prices for Germany and the US are based on the Törnqvist index with moving averages based on the average of the year t–1 and t. The way these indexes are weighted influences the value added deflator. This is further discussed in appendix 2. Appendix 2 also shows how the Swedish data is approximated to provide estimates that closely approximate estimations based on Törnqvist weights.

Another major problem when comparing productivity levels for different industries is the different policies used by Statistical Offices to account for quality changes. In the US hedonic price indexes are used extensively to account for the quality changes for the ICT-producing industries. Sweden only uses hedonic price indexes for imports of computers, while Germany does not use any hedonic measures (Scarpetta *et al*. 2000). Due to the differences of price deflation in the ICT-producing industries I will use the US ICT-deflators for the ICT-producing industries in Sweden and Germany. By applying the US ICT-deflators also on Sweden and Germany one implicitly assumes that the industry structure and price changes for the ICT-producing industry would be identical across

[21] See appendix 2.
[22] A thorough description of how value added price deflators are calculated and its implications for productivity growth is made in section 4.2.
[23] In this article gross output price deflators are based on producer price indexes.

countries. The empirical validity of these assumptions is questionable. In section 4, I therefore analyze the effects of relaxing these assumptions on the productivity development in RTC.

3.2 Productivity level results for the manufacturing industry

3.2.1 Total manufacturing

The labor productivity level estimates[24] for total manufacturing for Germany, Sweden and the US are presented in *figure 1*. The results in *figure 1* indicate that the productivity level in Swedish manufacturing was well below that of Germany and the US at the beginning of the 1980s. During the 1980s Sweden caught up slightly with Germany, while the productivity gap between Sweden and the US increased. During the late 1980s and the beginning of the 1990s relative productivity levels remained unchanged. However, from 1993 to 2001 Sweden was catching up with Germany and the US. In 1995 Sweden overtook Germany in terms of labor productivity and the productivity gap between the two countries was increasing during the period 1995–2000. Moreover, labor productivity gap between Sweden and the US was only 5 percent in 2001 compared to 33 percent in 1993.

The results for total manufacturing seem to correspond well with the growth patterns of total manufacturing presented by Lind (2003). However, Inklaar *et al*. (2003b) present estimates of labor productivity levels in manufacturing for EU countries and the US. According to the results by Inklaar *et al*. the labor productivity level in manufacturing in Sweden increased from 93.5 percent of the US level in 1979–81 to 99.3 percent in 1994–1996. However, labor productivity fell to 86.6 percent for 1999–01. The fall in Swedish labor productivity for manufacturing in the late 1990s is not supported by the results presented here. One possible explanation is that Inklaar *et al*. use harmonized US

[24] The labor productivity level results for total manufacturing are based on domestic deflators.

deflators for ICT producing industries,[25] while the results in *figure 1* are based on national deflators.

3.2.2 Industry level

Estimates of labor productivity levels at the industry level (2-digit ISIC level) are less certain than those of total manufacturing. It is important to keep in mind that the results presented for the industry level are based on the assumption that the unit value ratios also apply for unmatched product groups. This implies that the result for industries with low coverage ratios must be interpreted with caution (see *table 2* and *3*). Nevertheless, labor productivity level estimates for different manufacturing industries at the more disaggregated level are important in order to understand the dynamics of productivity changes in manufacturing. *Table 5* and *6* present labor productivity estimates at the industry level for Germany, Sweden and the US for the years 1993 and 2000. These estimates were calculated by extending the benchmark estimates for 1997 with labor productivity growth rates (in fixed prices).

The results in *table 5* show that in 1993 Sweden had its highest labor productivity level relative to Germany and the US in Chemicals (ISIC 24). Labor productivity in this industry was approximately 80 percent higher than in the US and Germany. Paper products (ISIC 21), Fabricated metal products (ISIC 28) and Office, accounting and computing machinery (ISIC 30) were other industries where relative productivity was high in Sweden. Electric machinery and computing (ISIC 31), Radio, television and communication equipment (ISIC 32), Motor vehicles, trailers and semi-trailers (ISIC 34) and Manufacturing recycling (ISIC 36–37) were industries where Swedish relative productivity was low compared to Germany and the US.[26]

In 2000, Chemicals (ISIC 24) and Paper products (ISIC 21) still had the highest labor productivity relative to Germany and the US. Radio, television and communication equipment (ISIC 32), Motor vehicles, trailers and semi-trailers (ISIC 34) and

[25] The use of different value added deflators will be discussed in detail in section 4.2.
[26] It is important to keep in mind that labor productivity level results for industries with low coverage ratios must be interpreted with caution.

Manufacturing recycling (ISIC 36–37) had the lowest labor productivity levels relative to the US, while Electrical machinery and computing (ISIC 31), Medical, precision and optical instrument (ISIC 33) and Other transport equipment (ISIC 36–37) had the lowest productivity level relative to Germany.

Tables 4–6 show that the relative labor productivity level for Swedish manufacturing industries throughout the period 1993–2000 was high for Chemicals (ISIC 21) and Paper products (ISIC 21). However, it was not these industries that had the highest growth rates throughout the period. As documented by Edquist and Henrekson (2001) it was the ICT-producing industries that experienced the highest growth during the latter part of the 1990s in Germany, Sweden and the US.

Tables 4–6 also indicate that there was a relative increase in the labor productivity level of the Swedish RTC industry relative to Germany and the US for the period 1993–1997. However, from 1997 to 2000 the German RTC industry caught up with and forged ahead of its Swedish counterpart in terms of labor productivity level. The same pattern can be found for the US RTC industry, even though relative labor productivity was higher in the US throughout the period 1993–2000. Lind (2003) argues that RTC has been crucial for economic growth in Swedish manufacturing. The results in *table 4–6* do not imply that the growth rate was low in the Swedish RTC industry for the period 1997–2000. Instead the results indicate that for the period 1997–2000 labor productivity growth for this industry was higher in both Germany and the US compared to Sweden. From 1997–2000 Sweden lost much of its labor productivity edge in RTC compared to Germany and the US.

There is a well known hypothesis that productivity growth rates vary inversely with productivity level. This has to do with the level of technology embodied in a country's capital stock. When a leader in technology invests in new capital the accompanying productivity increase is limited by the advance of knowledge between the time when the old capital was installed and the time it is replaced (Abramovitz 1986). However, a lagging country has the opportunity to embark on a catching-up process by borrowing superior techniques from the more advanced economies. This implies that the larger the gap between leader and follower the greater the follower's potential for productivity growth.

This catching-up hypothesis can also be applied to industries. *Figures 2* and *3* show the correlation of the difference in the Swedish productivity level relative to Germany and the US in 1993 and the average Swedish labor productivity growth rate for industries at the 2-digit ISIC level. The results in *figures 2* and *3* indicate a negative correlation. However, the correlation evidence is not very strong. One possible reason to that there is no strong correlation is that the period investigated is very short. Many articles that investigate the catching up hypothesis use time periods of at least 25 years. There are also several other reasons why there is no catching up at the industry level. According to Gerschenkron (1962) different countries have different productive and organizational structures of industry. For example, Hansson and Henrekson (1994) found that competition could explain that the Swedish tradadables sector was catching up 1970–85, but not the nontradables sector.

4. ICT deflators and relative labor productivity

4.1 ICT deflators

The results for the ICT-producing industries presented in *tables 4–6* are based on the US ICT deflators (see section 3.1.2). Applying the US deflators for all three countries automatically assumes that the industry structure of the Swedish and German ICT-producing industries are identical to the US and that the price decline for all products would be the same in all three countries. These assumptions are not empirically valid. In this section, I will therefore try to relax these assumptions by comparing deflators for the three countries. An interesting question then is what effect the use of different value added deflators has on measured productivity?

Table 7 shows the deflators based on the calculations from each country's statistical office.[27] The approximation of the Swedish deflators to the German and US deflators are described in appendix 2. T*able 7* shows that the US deflators for Office, accounting and computing machinery (ISIC 30) are m7uch more negative than those for Sweden and Germany. Interestingly, the German deflators are more negative than the Swedish ones for Office, accounting and computing machinery. One reason to this could be that the structure of the industry is very different in the two countries. For example, the US Office, accounting and computing machinery industry could be producing more semiconductors and microprocessors, while the corresponding industry in Sweden produces other types of computer equipment. For RTC (ISIC 32) the Swedish deflators are more negative than both the US and German deflators for all years except for 1998 when the US deflator is slightly more negative than the Swedish one. The deflators for Electric machinery and computing (ISIC 31) and for Medical, precision and optical instruments (ISIC 33) do not differ as much as the other two ICT-producing industries in the three countries.

What effects does the use of different deflators have for the estimates of relative labor productivity? *Table 8* presents the result for relative labor productivity for Sweden and Germany when different ICT-deflators are used. The results indicate that the use of different deflators have large impacts on labor productivity levels for Office, accounting and computing machinery (ISIC 30) and for Radio, television and communication equipment (ISIC 32). If the US deflators are used for the German Office, accounting and computing machinery industry, while the Swedish deflators are applied to the same industry in Sweden, this results in a substantial decline in the relative labor productivity level for the Swedish Office, accounting and computing machinery industry. According to *table 8* the labor productivity level for Office, accounting and computing machinery went from being 18 times higher than the German level in 1993 to becoming only one half of the German labor productivity level in 2000. There is no empirical evidence that can justify these results. Nevertheless, the results clearly show how sensitive productivity calculations are to large differences in value added deflators over a longer time period. In the other two cases (see *table 8*), the productivity level in the Swedish Office, accounting

[27] An exact description of how value added price deflators are calculated is presented in section 4.2.

and computing machinery industry remains higher relative to the same industry in Germany for the period 1993–2000.

For RTC the Swedish labor productivity level increases throughout the period 1993–2000 relative to Germany when country specific deflators are used. When the US deflators are applied for Germany and the country-specific ones for Sweden, the result shows that Swedish relative labor productivity increased for the period 1993–1997. After 1998 there is a decline in the Swedish relative labor productivity level and in 2000 the higher productivity level in Sweden has almost disappeared. When the US deflators are applied on both countries, there is a similar decline in the Swedish relative labor productivity level after 1998. For the year 2000 the relative labor productivity level is only 93 percent of the German labor productivity level. On the other hand, if country specific deflators are used for both countries the productivity level increases throughout the period 1993–2000.[28]

The results presented in *table 8* show that the use of different deflators for the ICT-producing industries has a large influence on the relative labor productivity level between Sweden and Germany. Nonetheless, the results in *table 8* strongly suggest that the labor productivity level for the Swedish RTC (ISIC 32) industry relative to Germany has decreased since 1998. This does not imply that the productivity growth rate for this industry has been slow in Sweden since 1998, but rather that the Swedish RTC industry has lagged in labor productivity relative to Germany since 1998.

4.2 A detailed investigation of the Radio television and communication equipment industry

During the period 1993–2000 labor productivity growth in the Swedish RTC industry was 47 percent per year. *Figures 4–6* illustrate the development of the RTC industry in Germany, Sweden and the US. *Figure 4* shows that gross output in the Swedish RTC industry as a share of gross output in manufacturing, increased from 4 percent in 1993 to

[28] To compare labor productivity growth rates for Germany and Sweden with country specific value added deflators is very problematic, since Sweden uses other types of quality adjustments than Germany (see section 3.1.2).

12 percent in 2000. The corresponding figures for Germany and the US were approximately 2 and 6 percent 1993–2001. As illustrated by *figure 5* the value added in the Swedish RTC industry as a share of value added in manufacturing also increased considerably during the 1990s. However, the corresponding share for the US RTC industry was higher in 1993–2000. *Figure 6* shows that the number of persons engaged in the Swedish RTC industry as a share of total manufacturing increased from around 4 percent in 1993 to 6 percent in 2000. The number of persons engaged in RTC related service industries such as data-consulting and data-services also increased considerably during the 1990s (Johansson 2004).

Figures 4–6 show that the Swedish RTC industry became increasingly important for the Swedish economy during the 1990s. It is therefore crucial that the productivity development in the Swedish RTC industry is correctly measured. *Table 8* showed that the use of different deflators for the RTC industry can have enormous effects on productivity growth measures. By using US deflators also for the German and Swedish ICT-producing industries one implicitly assumes that the structure of the ICT-producing industries is the same in all three countries and that the price fluctuations of output and intermediate input prices are identical. In this section, I investigate what happens with the deflators for the Swedish and the US RTC industry when these assumptions are relaxed.

When comparing ICT deflators across countries it is crucial to understand how the value added in different countries is deflated. Both the Swedish and the US National Accounts are based on double deflation to arrive at a value added in fixed prices (see section 3.1.2). Double deflation implies that the values of gross output and intermediate input are deflated separately with an output price index and an intermediate input price index, respectively. These two series are then used to arrive at value added in fixed prices. More specifically, value added in fixed prices can be defined as an average of the price change in gross output $(\frac{\partial \ln P_{Output}}{\partial \ln t})$ and the price change of intermediate inputs $(\frac{\partial \ln P_{Input}}{\partial \ln t})$. The price change of intermediate inputs is weighted by the share of intermediate inputs in gross outputs $(\frac{P_{Input} M}{P_{Output} Q})$ and the entire expression is multiplied by the inverted share of value-added in gross output ($\frac{P_{Output}Q}{P_{VA}VA}$) (OECD 2001a). The exact relation for the value added price deflator and intermediate input and output prices is shown in the following expression:

$$\frac{d\ln P_{VA}}{dt} = \frac{P_{Output}Q}{P_{VA}VA}\left[\frac{d\ln P_{Output}}{dt} - \frac{P_{Input}M}{P_{Output}Q}\frac{d\ln P_{Input}}{dt}\right] \tag{4.1}$$

Equation 4.1 shows that the price change in intermediate inputs has a large influence on the value added price deflator if the proportion of intermediate input as a share of total output is high.

Figure 7 shows the gross output and intermediate input price deflators for RTC in Sweden and the US. According to *figure 7* the US gross output and the intermediate input prices decreased more rapidly than the corresponding gross output and input prices for Sweden. The average price deflator for the Swedish intermediate inputs was zero, while the average price deflator for the US intermediate inputs was –0.05 for the period 1994–2001. For the output prices the average price deflator for Sweden was –0.10 and for the US –0.18. For which products have the price deflator for the intermediate input prices and for the output prices decreased more in the US compared to Sweden?

To answer this question I investigate the price deflators for RTC at a more disaggregated industry level. At the 3-digit ISIC industry level, RTC consists of the following three industries: Electronic valves and tubes[29] (ISIC 321), Telecommunication equipment (ISIC 322), Radio and television receivers (ISIC 323). *Figures 8–10* compare the gross output price deflator for these three industries in Sweden and the US for the period 1994–2001. For Sweden there exists two price indexes for the three industries. One price index is published by the Department of Prices and Consumption and the other is based on the National Accounts.[30] The difference between the two price indexes is that the price index

[29] By and large, Electronic valves and tubes (ISIC 321) consists of the production of semiconductors and microprocessors.
[30] The Department of Prices and Consumptions and the National Accounts are both Departments at Statistics Sweden.

published by the Department of Prices and Consumption is based on a product mix that is lagged two years, while the price index in the National Accounts is not.[31] Moreover, the output price index in the National Accounts is an industry index, which means that it includes both goods and services, while the index published by the Department of Prices and Consumption is a product index which only represents goods.

Figure 8 shows that the US gross output price deflator for Electronic valves and tubes (ISIC 321) was much more negative than the corresponding Swedish deflator throughout the period 1994–2001. *Figure 9* shows that the Swedish gross output price deflator for Telecommunication equipment (ISIC 322) differs considerably for the years 1997–2001 depending on which price index that is used. For the years 1997–2000 the difference is approximately 10 percent per year. According to the Department of National Accounts these differences are due to the fact that the Department of Prices and Consumption uses a product mix that is lagged two years. However, it is difficult to accept that this would explain the whole difference of approximately 10 percentage points per year 1997–2000 between the two output price indexes.[32] According to the price index published by the Department of Prices and Consumption the Swedish gross output prices for Telecommunication equipment (ISIC 322) has declined less than the corresponding US deflator 1997–2000. However, the price index in the National Accounts suggests that the Swedish price deflator has been approximately the same as the US deflator. *Figure 10* indicates that for the period 1994–2001 the Swedish gross output price deflator for Radio and television receivers (ISIC 323) has been more negative than the corresponding US deflator.

Intermediate input price deflators for Sweden are not available at the 3-digit ISIC industry level.[33] *Figure 11* shows the US intermediate input price deflators for Electronic valves and tubes (ISIC 321), Telecommunication equipment (ISIC 322) and Radio and

[31] On February 9th 2004 the Department of National Accounts at Statistics Sweden decided to release their output price indexes for the RTC industry at the 3-digit level. The output price indexes published by the Department of National Accounts had not been public at the 3-digit level and they were released after a close investigation of an earlier draft of this paper by officials at Statistics Sweden.
[32] One explanation to the large difference between the two indexes could be that the Swedish telecommunication company Ericsson decided to outsource the manufacturing of cell phones abroad during this period.
[33] Statistics Sweden does not publish input price deflators for the 3-digit ISIC level.

television receivers (ISIC 323) 1991–2001. For the period 1991–1995 the intermediate input price deflators for all three industries were close to zero. However, for the period 1996–2001 the price deflators have become more negative in all three industries. The decrease has been more rapid for Electronic valves and tubes (ISIC 321) and Telecommunication equipment (ISIC 322) compared to Radio and television receivers (ISIC 323).

One possible explanation to the larger decrease in the intermediate input and output price deflators in the US (see *figure 7*) is that the US systematically uses hedonic adjustments for semiconductors and microprocessors. This implies that the improved quality in semiconductors and microprocessors is considered when the price changes are estimated. Since the invention of the transistor in 1948 there has been an extraordinary increase in the capacity of semiconductors. According to "Moore's" law microprocessors are halved in price and double in capacity every 18 months. In Sweden hedonic price adjustments are not used to take the quality improvements of semiconductors and microprocessors into account. This could be the reason why the gross output Swedish price deflators for Electronic valves and tubes have not decreased as much as in the US (see *figure 8*).

Since semiconductors are important intermediate inputs in Telecommunication equipment (ISIC 322) and Radio and television receivers (ISIC 323), it is likely that the use of hedonic price adjustments for semiconductors also influences the input deflators for these industries. The fact that Sweden is not using hedonic adjustments for semiconductors and the lack of Swedish price data for intermediate inputs at the 3-digit ISIC level for RTC cause problems for accurately comparing price deflators between Sweden and the US.

Triplett (1996) has shown that if the output price decline in the semiconductor producing industry is underestimated this means that the intermediate input price decline in computers is also underestimated. Thus, if the output price decline in the semiconductor producing industry is overestimated, the intermediate input price decline in computers would be overestimated. This means that if all intermediate inputs where produced domestically, the measured productivity for the computer industry would be correct despite the incorrect measurement of prices in the semiconductor producing industry. Though, the measured productivity would be incorrect for less aggregated industries within the computer industry such as the semiconductor industry. If the findings by Triplett are applied on the RTC industry this means that if all semiconductors that are used in the RTC industry also were produced domestically by the RTC industry the productivity for the whole RTC industry would be unaffected if the price decline of semiconductors were underestimated. However, the reasoning by Triplett is only correct as long as all semiconductors are produced domestically.

Figure 12 shows the value of imports of Electronic valves and tubes as a share of the total value of production and imports. According to *figure 12* approximately 75 percent of the Electronic components that were used in Swedish RTC industry were imported in 1995–2001. Hence, Triplett's results do not hold for the Swedish RTC industry. If the estimated prices of semiconductors are incorrect, the effect on intermediate inputs is much larger since approximately 75 percent of the electronic components that are used as intermediate inputs in the RTC industry are imported. How would the Swedish value added price deflators change if hedonic price adjustments were made also for semiconductors in Sweden? In order to give an accurate answer to this question it would be necessary to have price data at a very detailed product level for Sweden and the US. This data is not available for Sweden due to secrecy. Nevertheless, *table 9* and *10* provide estimates of how value added deflators would change if hedonic price indexes also were used for semiconductors in Sweden.

Table 9 and *10* shows the recalculation of the Swedish value added deflators under the assumption that the Swedish intermediate input prices for Electronic valves and tubes (ISIC 321), Telecommunication equipment (ISIC 322) and Radio and television receivers (ISIC 323) are the same as for the corresponding industries in the US. The intuition behind this assumption is that price changes of all intermediate inputs except semiconductors would be the same in the US and Sweden. It is true that prices vary between different markets, however a large part of the intermediate inputs in the RTC industry is purchased globally at world market prices. Moreover, it is also assumed that the Swedish gross output price deflators for Electronic valves and tubes (ISIC 321) are equal to the corresponding industry in the US. The intuition behind this assumption is that if hedonic prices were implemented in Sweden for semiconductors and microprocessors the price decline in the semiconductor producing industry would equal that in the US. This is a plausible assumption since semiconductors are often priced and purchased at world market prices (Triplett 1996).

Neither Sweden nor the US use hedonic price indexes for estimating gross output price deflators for Telecommunication equipment (ISIC 322) and Radio and television receivers (ISIC 323). Therefore, the calculations in table *9* and *10* for these industries are based on domestic price indexes for Sweden. Gross output price deflators for Telecommunication equipment (ISIC 322) and Radio and television receivers (ISIC 323) in *table 9* are based on the price indexes by the Department of Prices and Consumption, while the price deflators in *table 10* are based on the price indexes in the National Accounts. Finally, the prices are weighted by the specific industry structure of the Swedish RTC industry (measured as shares of production in gross output and intermediate inputs at factor costs).

Not surprisingly, the results of the recalculated deflators presented in *table 9* and *10* differ widely from the results of the official value added deflators presented in *table 7*. The largest difference can be noticed for the period 1997–2000. The recalculated value added price deflators in *table 9* are even positive for the years 1997, 1998 and 2000. The recalculated value added deflators in *table 10* are all negative, but less negative than the value added deflators in *table 7*. The reason for the large difference between the deflators in *table 7, 9* and *10* is that the method to calculate the value added price deflator is very sensitive to the development of the intermediate input[34] price deflators. The reason why Sweden is much more sensitive to price changes in intermediate inputs than the US is because the intermediate input/gross output ratio for the Swedish RTC industry is much larger compared to the US.

Figure 13 shows the intermediate input/gross output ratio for the Swedish and the US RTC industry 1993–2001. During the period investigated the Swedish intermediate

[34] Semiconductors and microprocessors are important intermediate inputs in RTC.

input/gross output ratio has been constantly higher than the US. Since 1998 the Swedish ratio has increased dramatically and in 2001 intermediate inputs exceeded the total gross outputs. Hence, value added in current prices was negative. This development is due to the increased outsourcing by the Swedish telecommunication company Ericsson. In Sweden a very large part of the total output of RTC is produced by Ericsson. This implies that the bulk of intermediate input prices that are reported to Statistics Sweden are determined by the pricing of one single firm. Semiconductors are often purchased and priced on the world market. However, if semiconductors or other intermediate inputs are produced by Ericsson abroad and then imported and used in the Swedish RTC industry, there is a risk that the internal pricing by Ericsson would not reflect world market prices of semiconductors and other inputs. It is unclear to what extent Ericsson produces its own intermediate inputs abroad. However, if a large share of Ericsson's inputs are produced abroad by Ericsson and imported, there is a possibility that price changes of semiconductors and other inputs would be measured incorrectly. This would result in incorrect productivity estimates for RTC in Sweden.

The value added deflators presented in *table 9* and *10* have a great impact on how the productivity growth in the Swedish RTC industry is measured. *Figure 14* shows the labor productivity growth in the RTC industry 1994–2000 with the official value added price deflators (see *table 7*) and the recalculated deflators (see *table 9* and *10*). The results show that the productivity growth differs widely depending on which deflators that are being used. The price deflators based on the price indexes published by the Department for Prices and Consumption (see *table 10*) give the largest difference in productivity growth compared to the official deflators. However, the difference in productivity growth is also large when the deflators based on the price indexes in the National Accounts are used instead of the official deflators. The annual productivity growth becomes 20 percent instead of 35 percent 1997–2000 if the recalculated deflators based on the price indexes in the National Accounts are used instead of the official deflators.

The use of different deflators also has implications for the growth in total manufacturing. *Figure 15* shows the growth rate of total manufacturing with official and recalculated deflators. For the period 1997–2000 the growth rates of total manufacturing would be considerably smaller if the recalculated deflators are used. The effect on productivity growth in manufacturing is smaller if the recalculated deflators based on the price indexes in the National Accounts are used instead of the deflators based on the price indexes published by the Department of Prices and Consumption. However, in 1998 the productivity growth in manufacturing would be about one third lower with the recalculated value added deflators based on the price indexes in the National Accounts. The relative productivity development in Sweden is also affected by the use of different value added deflators. *Figure 16* shows the relative productivity with the recalculated deflators based on the price indexes published by the Department of Prices and Consumption for the period 1993–2000. The conclusion is that Sweden has only been growing at the same rate as in the US. The catching up effect in the end of the 1990s (see *table 1*) has been eroded.

5. Conclusions

I have used the industry-of-origin methodology to investigate the development of labor productivity levels in Swedish manufacturing relative to manufacturing in Germany and the US. The results show that Swedish manufacturing productivity caught up with levels in Germany and the US during the 1990s. In 1995 Sweden overtook Germany in terms of labor productivity level and continued to catch up with the US throughout the period 1995–2000. Moreover, Chemicals (ISIC 24) and Paper products (ISIC 21) had the highest relative labor productivity compared to Germany and the US in 1993–2000.

Evidence of the increasing importance of the RTC industry for total manufacturing in Sweden during the 1990s was also presented. For RTC, labor productivity increased substantially in Sweden relative to Germany and the US in 1993–1998. However, for the period 1998–2000 labor productivity of the Swedish RTC industry declined relative to Germany and the US. This suggests that the productivity growth of RTC was slower in Sweden than in the US and Germany 1998–2000.

The results of the labor productivity levels for Office accounting and computing machinery and RTC turn out to be very sensitive to the choice of value added price deflators. Value added price deflators are used by Statistical Offices to take price and quality changes into account. Moreover, value added price deflators differ widely among industries and countries. The Swedish value added price deflators for RTC was considerably more negative compared to the German and US deflators throughout the period 1993–2000.[35]

One explanation to why value added price deflators are more negative in Sweden than in the US is that the US Statistical Agencies systematically use hedonic adjustments for semiconductors and microprocessors, while Statistics Sweden is not. Hedonic price indexes take the improved quality in semiconductors and microprocessors into consideration when the price changes are estimated. Moreover, semiconductors and microprocessors are important inputs in the Swedish RTC industry. Calculations of the Swedish value added deflators based on the US price development for semiconductors and microprocessors, show that the productivity growth in the RTC industry becomes considerably lower. This suggest that the spectacular labor productivity growth exceeding 35 percent per year in 1996–2000 for the Swedish RTC industry is partly an artefact. Moreover, the results show that it is dangerous to draw conclusions from international productivity comparisons in industries characterized by rapidly changing technology.

The overestimation of labor productivity growth for Swedish RTC also has important effects for productivity growth in total manufacturing. If the recalculated value added deflators for RTC are used in order to calculate labor productivity growth rates for total manufacturing, the productivity performance is less impressive than what is suggested by official data. Using the revised estimates Sweden caught up with German and US labor productivity levels during the first half of the 1990s. However, for the period 1997–2000 the labor productivity level was lower than suggested by official data. From a policy perspective this is an important result, because it shows that the productivity growth miracle in Swedish manufacturing during the late 1990s is partly an artefact.

[35] Except for the year 1998.

6. References

Abramovitz, Moses (1986), “Catching Up, Forging Ahead, and Falling Behind”, *Journal of Economic History*, Vol. 46, No. 2, pp. 385–406.

Apel, Mikael and Lindström, Tomas (2003), “Informationsteknologins betydelse för den svenska produktivtetsutvecklingen – ännu en pusselbit”, *Ekonomisk Debatt*, Vol. 31, No. 5, pp. 29–37.

van Ark, Bart and Pilat, Dirk (1993), “Productivity Levels in Germany, Japan, and the United States: Differences and Causes”, *Brookings Papers on Economic Activity: Microeconomics 2*, Washington D.C.

van Ark, Bart (1996), “Issues in Measuring and International Comparison Issues of Productivity – An Overview”, OECD Expert Workshop on Productivity: International Comparison and Measurement Issues, OECD, Paris.

van Ark, Bart and Timmer, Marcel (2002), “Measuring Productivity Levels – A reader”, OECD Working Paper, Paris.

Council of Economic Advisers (2003), *Economic Report of the President*, United States Government Printing Office, Washington D.C.

Edquist, Harald and Henrekson, Magnus (2001), “Solowparadoxen och den nya ekonomin”, *Ekonomisk Debatt*, Vol. 29, No. 6, pp. 409-419.

Edquist, Harald and Henrekson, Magnus (2002), “Kommer IKT-revolutionen även att att lyfta europas ekonomier?” in Litan, Robert E. and Rivlin, Alice M. (2002), *Bortom dot.com-företagen*, SNS Förlag, Stockholm.

Europroms (2001), *European production and market statistics: EU-15 Prodcom/Combined Nomenclature*, Eurostat, Luxemburg.

Gerschenkron, Alexander (1962), *Economic Backwardness in Historical Perspective*, Harvard University Press, Cambridge (Massachusetts).

Groningen Growth and Development Centre (GGDC) (2003), *60-industry database,* Groningen. Available online: http://www.ggdc.net

IMF (2003), *PPI Manual*, Washington DC. Available online: http://www.imf.org

Hansson, Pär and Henrekson, Magnus (1994), “Catching up in industrialized countries: a disaggregated study”, *Journal of International Trade & Economic Development*, Vol. 3, No.2, pp. 129–145.

Inklaar, Robert, Stokes, Lucy, Stuivenwold, Edwin, Timmer, Marcel and Ypma, Gerard (2003a), “Chapter VII Data Sources and Methodology” in O’Mahony, Mary and van Ark, Bart (eds), *EU Productivity and Competitiveness: A Sectoral Perspective. Can Europe Resume the Catching-up Process?* European Commission, Luxemburg.

Inklaar, Robert, O'Mahony, Mary, Robinson, Catherine and Timmer, Marcel (2003b), "Chapter III Productivity and Competitiveness in the EU and the US" in O'Mahony, Mary and van Ark, Bart (eds), *EU Productivity and Competitiveness: A Sectoral Perspective. Can Europe Resume the Catching-up Process?* European Commission, Luxemburg.

Johansson, Dan (2004), "Is small beautiful? The case of Swedish IT industry" *Entrepreneurship & Regional Development*, forthcoming.

Lind, Daniel (2002), "Tillväxtens drivkrafter – Produktion och användande av informationsteknologi i svensk ekonomi", *Ekonomisk Debatt*, Vol. 30, No. 7, pp. 611-619.

Lind, Daniel (2003), "Svensk industriproduktivitet i ett internationellt perspektiv under fyra decennier – vad kan vi lära oss av 1990-talet?", *Ekonomisk Debatt*, Vol. 31, No. 5, pp. 39–48.

Lundgren, Kurt and Wiberg, Anders (2000), "Solowparadoxen eller den nya ekonomin?", *Ekonomisk Debatt*, Vol. 28, No. 8, pp. 747-757.

MathWorld (2004), "MathWorld – A Wolfram Web Resource", Wolfram Research. Available online: http://mathworld.wolfram.com

Monnikhof, Erik and van Ark, Bart (2002), "New Estimates of Labor productivity in the Manufacturing Sectors of Czech Republic, Hungary and Poland". Research Memorandum GD-50, Groningen Growth and Development Centre.

Newsweek (2000), "Shining Stockholm", February 7.

Nordhaus, William D. (1997) "Do Real-Output and Real-Wage Measures Capture Reality? The History of Lighting Suggests Not," in Bresnahan, Timothy F. and Gordon, Robert J. (eds), *The Economics of New Goods*, University of Chicago Press, Chicago.

OECD (2001a), *OECD Productivity Manual: A Guide to the Measurement of Industry-Level and Aggregate Productivity Growth*, Directorate for Science, Technology and Industry, Paris.

OECD (2001b), *STAN Database*, Paris

OECD (2002), "Measuring the Information Economy", OECD Working Paper, Paris.

OECD (2003), *Structural Statistics for industry and Services Database*, SourceOECD, Paris.

Scarpetta, Stefano, Bassanini, Andrea, Pilat, Dirk and Schreyer, Paul (2000), "Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level," Economics Depatement, Working Paper No. 248, OECD, Paris.

Statistics Sweden (2003a), *Industrins varuproduktion (IVP)*, Stockholm. Available online: http://www.scb.se

Statistics Sweden (2003b), *National accounts 1993–2001*, Stockholm. Available online: http://www.scb.se

Statistics Sweden (2003c), *Swedish Statistical Database; prices and consumption*, Stockholm. Available online: http://www.scb.se

Triplett (1996), "High-Tech Industry and Hedonic Price Indices", in OECD, *Industry Productivity; International Comparisons and Measurement Issues*, OECD, Paris.

United Nations Statistics Division (2000), International Standard Industrial Classification of All Economic Activities, Third Revision, (ISIC, Rev.3). Available [online]: http://esa.un.org/unsd/cr/family2.asp?Cl=2

Table 1 **Values of gross output (in thousands of SEK) and quantity (number of radio transmission apparatus) for the Swedish Radio transmission apparatus with reception apparatus product group in 1997**

	Code	*Gross output*	*Quantity*
Radio-telegraphic and radio-telephonic transmission apparatus, incorporating reception apparatus, for civil aircraft	CN 85252010	1307438	n.a.
Transmission apparatus, incorporating reception apparatus, for cellular networks "mobile telephones"	CN 85252091	31779377	12705376
Transmission apparatus for radio-telephony, radio-telegraphy, radio-broadcasting or television, incorporating reception apparatus	CN 85252099	48538126	n.a.
Radio transmission apparatus with reception apparatus	**Prodcom 32301170**	**81624940**	**n.a.**

Sources: Europroms (2001) and Statistics Sweden (2003a).

Notes: n.a. = not available. CN stands for combined nomenclature and is a classification code for industry products that is used by Statistics Sweden. The CN code is compatible with the Prodcom classification code.

Table 2 **Number of matches, coverage ratios and unit value ratios for the manufacturing industry in Sweden and Germany in 1997**

Industry	*ISIC*	*Number of matches*	*Percentage of output matched*		*Unit value ratios SEK/EUR*		
			Sweden	*Germany*	*Laspeyres*	*Paasche*	*Fisher*
Food products	15–16	188	79	64	10.19	9.38	9.78
Textile, clothing, leather and footwear	17–19	91	29	2	11.10	6.99	8.81
Wood and products of wood and cork	20	26	71	36	7.97	7.97	7.97
Paper products	21	49	54	48	9.34	7.23	8.22
Printing and publishing	22	14	39	37	12.58	10.16	11.31
Chemicals	24	78	14	16	10.89	6.20	9.59
Rubber and plastic products	25	24	23	11	9.28	9.92	9.59
Non-metallic mineral products	26	40	35	42	10.49	6.02	7.95
Basic metals	27	62	29	27	13.17	9.57	11.22
Fabricated metal products	28	33	11	10	7.76	5.30	6.41
Machinery and equipment	29	88	18	12	11.42	5.02	7.57
Office, accounting and computing machinery	30	4	14	6	7.22	4.71	5.83
Electrical machinery and computing	31	34	34	13	17.38	7.00	11.03
Radio, television and communication equipment	32	10	74	23	10.06	9.33	9.69
Medical precision and optical instruments	33	16	8	10	18.67	13.41	15.83
Motor vehicles, trailers and semi-trailers	34	15	15	17	10.49	11.80	11.12
Other transport equipment	35	6	12	8	12.76	10.37	11.50
Manufacturing, recycling n.e.c	36	24	28	37	7.67	6.70	7.16
Total Manufacturing		802	37	25	10.75	8.24	9.41

Source: Europroms (2001) and own calculations.

Note: For an exact definition of the Laspeyres, Paasche and Fisher index see MathWorld (2004).

Table 3 **Number of matches, coverage ratios and unit value ratios for the manufacturing industry in Germany and the US in 1997**

Industry	*ISIC*	*Number of matches*	*Percentage of output matched*		*Unit value ratios Dollar/EUR*		
			US	*Germany*	*Laspeyres*	*Paasche*	*Fisher*
Food products	15–16	132	65	62	1.09	1.36	1.22
Textile, clothing, leather and footwear	17–19	76	44	62	0.62	0.71	0.66
Wood and products of wood and cork	20	13	52	31	0.93	1.08	1.00
Paper products	21	18	61	48	1.14	1.22	1.18
Printing and publishing	22	1	0.2	1	2.12	2.12	2.12
Chemicals	24	59	13	18	1.10	1.04	1.07
Rubber and plastic products	25	4	7	23	0.98	1.11	1.04
Non-metallic mineral products	26	23	22	29	1.26	1.42	1.34
Basic metals	27	43	71	70	1.12	1.25	1.18
Fabricated metal product	28	11	7	4	1.24	1.35	1.30
Machinery and equipment	29	53	14	15	0.95	1.04	0.99
Office, accounting and computing machinery	30	6	38	44	1.09	1.24	1.16
Electrical machinery and computing	31	18	15	42	0.78	1.22	0.98
Radio, television and communication equipment	32	17	17	9	0.84	0.96	0.90
Medical precision and optical instruments	33	16	14	3	1.52	1.72	1.62
Motor vehicles, trailers and semi-trailers	34	5	39	29	0.87	0.90	0.88
Other transport equipment	35	1	6	3	1.88	1.88	1.88
Manufacturing, recycling n.e.c	36	20	24	16	1.01	1.14	1.08
Total Manufacturing		516	28	28	1.09	1.13	1.11

Source: Inklaar *et al*. (2003a).

Note: For an exact definition of the Laspeyres, Paasche and Fisher index see MathWorld (2004).

Table 4 **Labor productivity and relative labor productivity levels (value added in thousands of EUR per person engaged) for manufacturing in Germany, Sweden and the US 1997 (Germany = 100)**

Industry	*ISIC*	*Germany*		*Sweden*		*US*	
		Levels	Relative levels	Levels	Relative levels	Levels	Relative levels
Food products	15–16	36.6	100	52.3	143	56.5	154
Textile, clothing, leather and footwear	17–19	33.8	100	36.2	107	51.3	152
Wood and products of wood and cork	20	41.6	100	55.6	134	41.6	100
Paper products	21	53.8	100	79.8	148	45.6	85
Printing and publishing	22	46.0	100	43.0	94	21.7	47
Chemicals	24	71.3	100	112.9	158	66.6	93
Rubber and plastic products	25	48.3	100	46.6	97	46.4	96
Non-metallic mineral products	26	51.2	100	57.7	113	38.2	75
Basic metals	27	52.1	100	55.7	107	44.1	85
Fabricated metal products	28	41.9	100	61.8	147	32.2	77
Machinery and equipment	29	49.5	100	65.4	132	50.0	101
Office, accounting and computing machinery	30	68.4	100	98.7	144	59.0	86
Electrical machinery and computing	31	51.5	100	38.6	75	65.5	127
Radio, television and communication equipment	32	50.3	100	68.3	136	120.8	240
Medical precision and optical instruments	33	38.9	100	34.7	89	36.8	95
Motor vehicles, trailers and semi-trailers	34	59.9	100	48.3	81	109.2	182
Other transport equipment	35	50.5	100	37.9	75	33.4	66
Manufacturing, recycling n.e.c	36-37	37.0	100	25.7	69	64.1	173
Total manufacturing	15-37	48.5	100	53.8	111	62.4	129

Sources: GGDC (2003), Europroms (2001), Statistics Sweden (2003b) and own calculations.

Table 5 Labor productivity and relative labor productivity levels (value added in thousands of EUR per person engaged) for manufacturing in Germany, Sweden and the US 1993 (Germany = 100)

Industry	*ISIC*	*Germany*		*Sweden*		*US*	
		Levels	Relative levels	Levels	Relative levels	Levels	Relative levels
Food products	15–16	33.8	100	41.6	123	51.9	153
Textile, clothing, leather and footwear	17–19	31.5	100	32.0	102	48.4	154
Wood and products of wood and cork	20	33.8	100	41,7	123	35.4	105
Paper products	21	44.9	100	77.4	173	45.5	101
Printing and publishing	22	42.8	100	32.8	77	21.1	49
Chemicals	24	54.3	100	97.2	179	55.7	102
Rubber and plastic products	25	40.6	100	35.5	87	39.4	97
Non-metallic mineral products	26	45.5	100	53.7	118	38.2	84
Basic metals	27	35.1	100	40.2	114	33.8	96
Fabricated metal products	28	37.8	100	53.5	141	29.8	79
Machinery and equipment	29	39.8	100	51.4	129	40.4	102
Office, accounting and computing machinery	30	4.2	100	5.6	136	3.6	86
Electrical machinery and computing	31	53.3	100	34.8	65	69.6	131
Radio, television and communication equipment	32	8.3	100	5.9	70	18.6	223
Medical precision and optical instruments	33	43.5	100	35.1	81	44.5	102
Motor vehicles, trailers and semi-trailers	34	50.0	100	30.5	61	110.6	221
Other transport equipment	35	35.4	100	40.3	114	35.0	99
Manufacturing, recycling n.e.c	36-37	38.9	100	17.5	45	58.5	150
Total manufacturing	15-37	41.4	100	38.4	93	51.1	121

Sources: GGDC (2003), Europroms (2001), Statistics Sweden (2003b) and own calculations.

Note: Calculations for the ICT producing industries are based on the US ICT deflators.

Table 6 Labor productivity and relative labor productivity levels (value added in thousands of Euros per person engaged) for manufacturing in Germany, Sweden and the US 2000 (Germany = 100)

Industry	*ISIC*	*Germany*		*Sweden*		*US*	
		Levels	Relative levels	Levels	Relative levels	Levels	Relative levels
Food products	15–16	37.8	100	54.4	144	48.3	128
Textile, clothing, leather and footwear	17–19	36.4	100	39.5	108	55.1	151
Wood and products of wood and cork	20	41.8	100	66.3	160	43.8	105
Paper products	21	56.9	100	90.8	159	40.6	71
Printing and publishing	22	50.7	100	44.0	87	23.4	46
Chemicals	24	75.8	100	139.9	185	70.1	93
Rubber and plastic products	25	47.9	100	50.7	106	46.6	97
Non-metallic mineral products	26	53.0	100	65.4	123	35.8	68
Basic metals	27	52.7	100	59.4	113	54.2	103
Fabricated metal products	28	43.5	100	68.0	156	31.8	73
Machinery and equipment	29	50.0	100	72.6	145	50.3	100
Office, accounting and computing machinery	30	219.1	100	319.8	146	188.9	86
Electrical machinery and computing	31	56.1	100	44.7	80	66.7	119
Radio, television and communication equipment	32	160.5	100	150.0	93	355.8	222
Medical precision and optical instruments	33	37.4	100	27.5	74	35.0	94
Motor vehicles, trailers and semi-trailers	34	48.5	100	72.8	150	126.0	260
Other transport equipment	35	52.8	100	39.8	75	35.8	68
Manufacturing, recycling n.e.c	36-37	38.2	100	32.4	85	68.7	180
Total manufacturing	15-37	50.4	100	67.5	136	72.6	147

Sources: GGDC (2003), Europroms (2001), Statistics Sweden (2003b) and own calculations.

Note: Calculations for the ICT producing industries are based on the US ICT deflators.

Table 7 **Value added deflators for the ICT producing industries (ISIC 30–33) 1994–2001**

	1994	1995	1996	1997	1998	1999	2000	2001
Germany								
Office, accounting and computing machinery	–0.17	-0.05	–0.01	–0.06	–0.06	–0.09	–0.13	
Electric machinery and computing	–0.002	–0.001	0.02	–0.01	0.004	0.01	–0.02	
Radio, television and communication equipment	–0.02	–0.01	–0.004	–0.003	–0.04	–0.04	–0.07	
Medical, precision and optical instruments	0.01	0.02	0.03	0.03	0.01	0.03	–0.008	
Sweden								
Office, accounting and computing machinery	0.04	0.02	0.06	–0.01	0.02	0.01	–0.004	0.21
Electric machinery and computing	0.05	0.07	0.12	0.008	–0.03	–0.07	–0.05	0.021
Radio, television and communication equipment	–0.41	–0.51	–0.40	–0.30	–0.39	–0.39	–0.51	
Medical, precision and optical instruments	0.06	0.02	0.05	0.007	–0.03	–0.03	–0.09	0.06
US								
Office, accounting and computing machinery	–0.23	–0.29	–0.50	–0.56	–0.56	–0.51	–0.23	–0.31
Electric machinery and computing	0.006	0.01	0.03	0.02	0.03	0.01	–0.01	0.02
Radio, television and communication equipment	–0.14	–0.41	–0.35	–0.26	–0.41	–0.35	–0.41	–0.35
Medical, precision and optical instruments	0.04	0.07	0.14	0.08	0.13	0.07	0.06	0.11

Sources: GGDC (2003), Statistics Sweden (2003b) and own calculations.

Note: n.a. = not available.

Table 8 Relative productivity level in Sweden and Germany with different ICT deflators (Germany=100) 1993–2000

Sweden = Swedish deflators *Germany = German deflators*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Office, accounting and computing machinery	207	166	160	173	144	149	130	110
Electric machinery and computing	83	84	88	82	75	87	86	91
Radio, television and communication equipment	7	14	35	78	136	182	219	228
Medical, precision and optical instruments	86	84	85	79	89	100	99	84
Sweden = Swedish deflators *Germany = US deflators*								
Office, accounting and computing machinery	1842	1370	954	533	144	106	67	52
Electric machinery and computing	78	80	84	80	75	89	88	94
Radio, television and communication equipment	29	49	79	113	136	136	129	104
Medical, precision and optical instruments	67	68	72	74	89	112	115	110
Sweden = US deflators *Germany = US deflators*								
Office, accounting and computing machinery	136	137	144	200	144	155	151	146
Electric machinery and computing	65	69	78	81	75	84	77	80
Radio, television and communication equipment	70	73	95	121	136	137	126	93
Medical, precision and optical instruments	81	84	85	81	89	97	90	74

Sources: GGDC (2003), Europroms (2001), Statistics Sweden (2003b) and own calculations.

Table 9 Recalculation of the Swedish value added price deflators for the Radio, television and communication industry (ISIC 32)

	1994	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Gross output price deflator (1)							
Electronic valves and tubes (US)	–0.12	–0.33	–0.33	–0.23	–0.39	–0.28	–0.32
Telecommunication equipment (SWE)‡	–0.06	–0.10	–0.12	–0.00	–0.01	–0.05	–0.01
Radio and television receivers (SWE) ‡	–0.03	–0.06	–0.12	–0.04	–0.09	–0.13	–0.15
Shares of gross output, measured as production at factor costs (2)							
Electronic valves and tubes	0.07	0.05	0.04	0.04	0.07	0.05	0.05†
Telecommunication equipment	0.89	0.91	0.90	0.92	0.89	0.90	0.90†
Radio and television receivers	0.04	0.04	0.06	0.05	0.04	0.05	0.05†
Gross output price deflator (3) = (1)*(2)							
Radio, television and communication equipment industry (ISIC 32)	–0.06	–0.11	–0.13	–0.01	–0.03	–0.06	–0.03
Intermediate input price deflator (4)							
Electronic valves and tubes (US)	0.01	0.01	–0.07	–0.06	–0.10	–0.05	–0.03
Telecommunication equipment (US)	0.00	0.00	–0.08	–0.07	–0.12	–0.05	–0.05
Radio and television receivers (US)	0.02	0.02	–0.02	–0.02	–0.03	–0.01	–0.00
Shares of intermediate input, measured as production at factor costs (5)							
Electronic valves and tubes	0.05	0.03	0.02	0.04	0.05	0.05	0.05†
Telecommunication equipment	0.90	0.93	0.92	0.90	0.91	0.91	0.91†
Radio and television receivers	0.04	0.04	0.06	0.06	0.04	0.04	0.04†
Intermediate input price deflator (6) = (4)*(5)							
Radio, television and communication industry equipment (ISIC 32)	–0.002	0.001	–0.08	–0.07	–0.11	–0.05	–0.04
Gross output/value added (7) ‡‡	3.51	3.90	4.04	3.93	3.92	4.38	5.98
Intermediate input/gross output (8) ‡‡	0.71	0.74	0.75	0.75	0.74	0.77	0.83
New value added deflators †† (9) = (7)*[(3)–(8)*(6)]	–0.21	–0.44	–0.30	0.15	0.19	–0.11	0.02

Sources: GGDC unpublished data, Statistics Sweden (2003b), Statistics Sweden (2003c) and OECD (2003).

Notes: ‡Gross output deflators for Telecommunication equipment and Radio and television receivers are based on producer price indexes published by the Department of Prices and Consumption. ‡‡Results for gross output/value added and intermediate input/gross output are average for period t and t–1. †Shares of gross outputs and intermediate inputs for the year 2000 are assumed to be the same as for 1999. This is due to the lack of data for the year 2000. ††The new value added deflators is derived from the formula in equation 4.1.

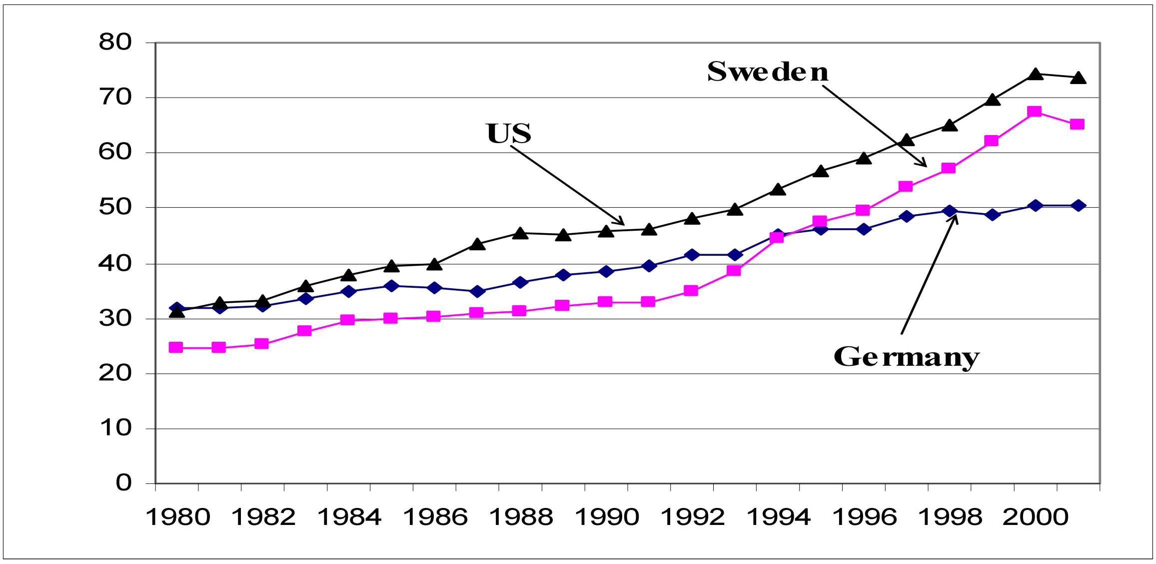
Table 10 Recalculation of the Swedish value added price deflators for the Radio, television and communication industry (ISIC 32)

	1994	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Gross output price deflator (1)							
Electronic valves and tubes (US)	–0.12	–0.33	–0.33	–0.23	–0.39	–0.28	–0.32
Telecommunication equipment (SWE)‡	–0.10	–0.13	–0.15	–0.08	–0.09	–0.09	–0.08
Radio and television receivers (SWE)‡	–0.02	–0.05	–0.11	–0.04	–0.09	–0.12	–0.14
Shares of gross output, measured as production at factor costs (2)							
Electronic valves and tubes	0.07	0.05	0.04	0.04	0.07	0.05	0.05†
Telecommunication equipment	0.89	0.91	0.90	0.92	0.89	0.90	0.90†
Radio and television receivers	0.04	0.04	0.06	0.05	0.04	0.05	0.05†
Gross output price deflator (3) = (1)*(2)							
Radio, television and communication equipment industry (ISIC 32)	–0.10	–0.14	–0.16	–0.08	–0.11	–0.11	–0.10
Intermediate input price deflator (4)							
Electronic valves and tubes (US)	0.01	0.01	–0.07	–0.06	–0.10	–0.05	–0.03
Telecommunication equipment (US)	0.00	0.00	–0.08	–0.07	–0.12	–0.05	–0.05
Radio and television receivers (US)	0.02	0.02	–0.02	–0.02	–0.03	–0.01	–0.00
Shares of intermediate input, measured as production at factor costs (5)							
Electronic valves and tubes	0.05	0.03	0.02	0.04	0.05	0.05	0.05†
Telecommunication equipment	0.90	0.93	0.92	0.90	0.91	0.91	0.91†
Radio and television receivers	0.04	0.04	0.06	0.06	0.04	0.04	0.04†
Intermediate input price deflator (6) = (4)*(5)							
Radio, television and communication equipment industry (ISIC 32)	–0.002	0.001	–0.08	–0.07	–0.11	–0.05	–0.04
Gross output/value added (7)‡‡	3.51	3.90	4.04	3.93	3.92	4.38	5.98
Intermediate input/gross output (8)‡‡	0.71	0.74	0.75	0.75	0.74	0.77	0.83
New value added deflators†† (9) = (7)*[(3)–(8)*(6)]	–0.34	–0.53	–0.41	–0.12	–0.10	–0.29	–0.38

Sources: GGDC unpublished data, Statistics Sweden (2003b), Statistics Sweden (2003c) and OECD (2003).

Notes: ‡Gross output deflators for Telecommunication equipment and Radio and television receivers are based on producer price indexes in the National Accounts. ‡‡Results for gross output/value added and intermediate input/gross output are average for period t and t–1. †Shares of gross outputs and intermediate inputs for the year 2000 are assumed to be the same as for 1999. This is due to the lack of data for the year 2000. ††The new value added deflators is derived from the formula in equation 4.1.

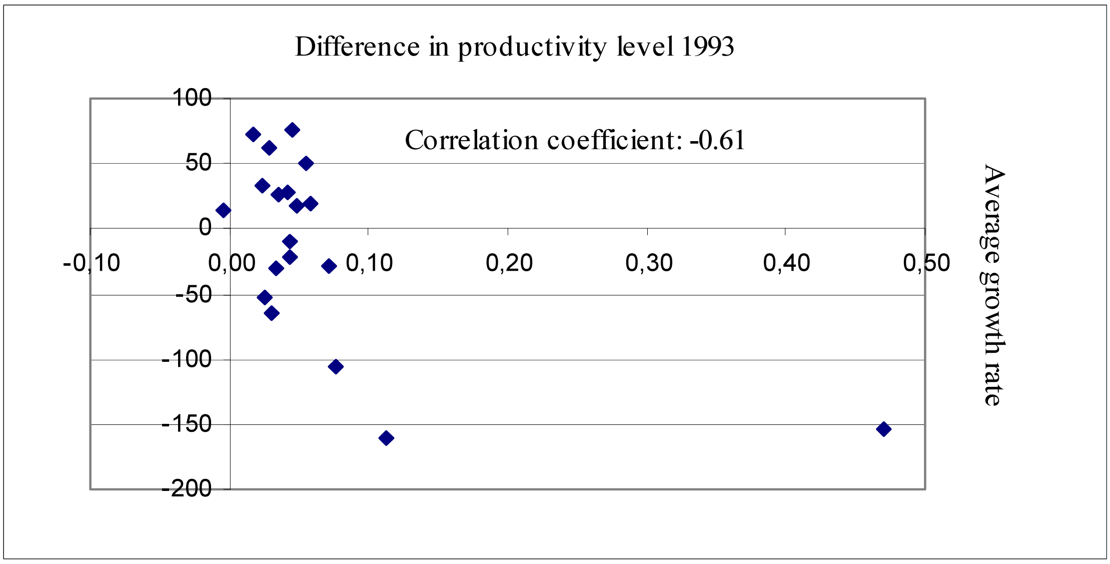
Figure 1 **Labor productivity levels in manufacturing, value added (in thousands of Euros) per person engaged in Germany, Sweden and the US 1980-2001**



Sources: GGDC (2003), Europroms (2001), OECD (2001b), Statistics Sweden (2003b) and own calculations.

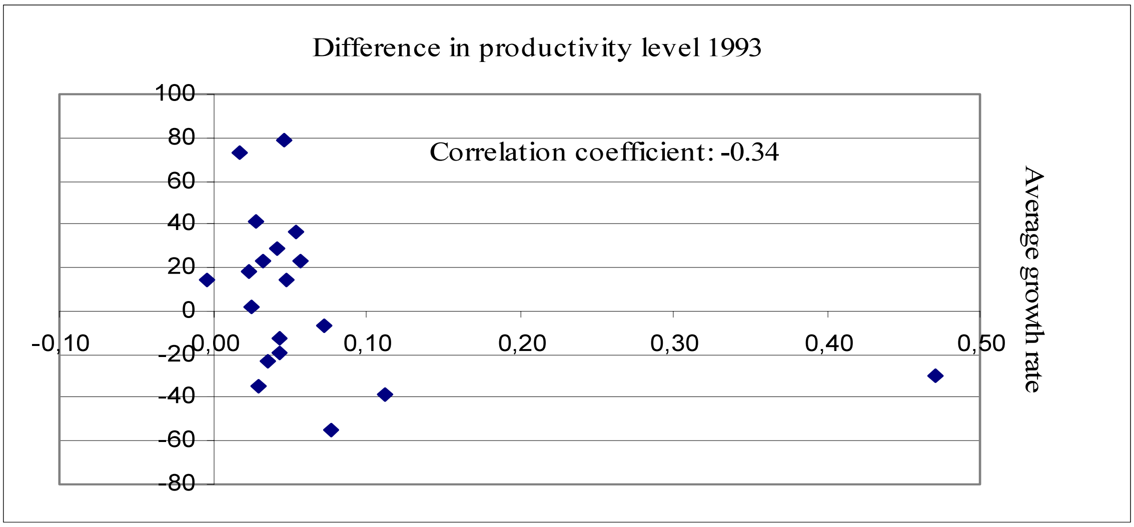
Note: Calculations are based on official value added deflators. The calculations for Germany before 1991 are based on figures for West Germany.

Figure 2 **Scatter diagram of the difference in productivity level between Sweden and the US in 1993 and the average Swedish labor productivity growth rate 1993–2000**



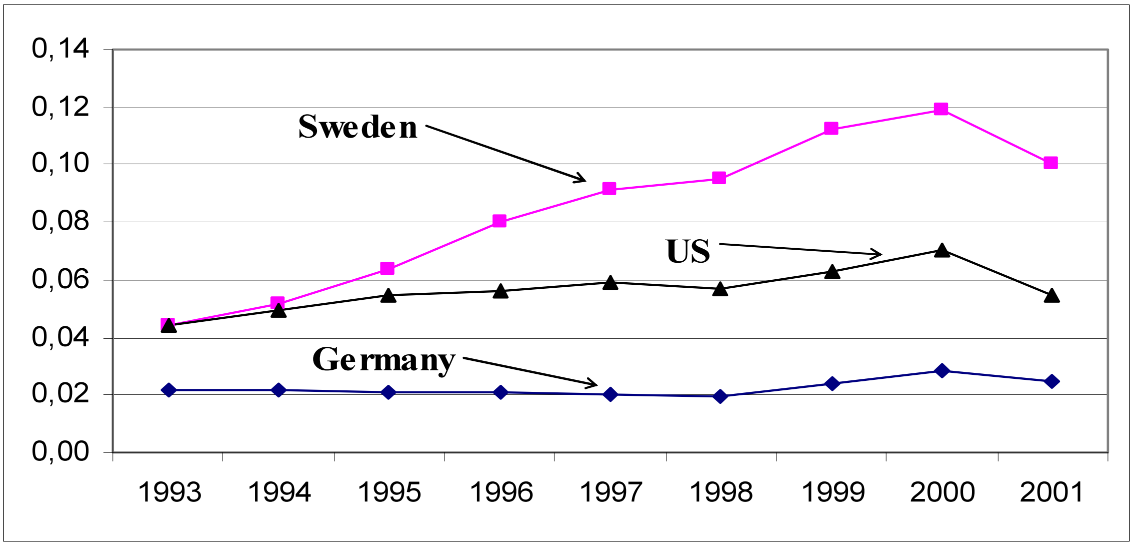
Sources: GGDC (2003), Europroms (2001), Statistics Sweden (2003b) and own calculations.

Figure 3 **Scatter diagram of the difference in productivity level between Sweden and Germany in 1993 and the average Swedish labor productivity growth rate 1993–2000**



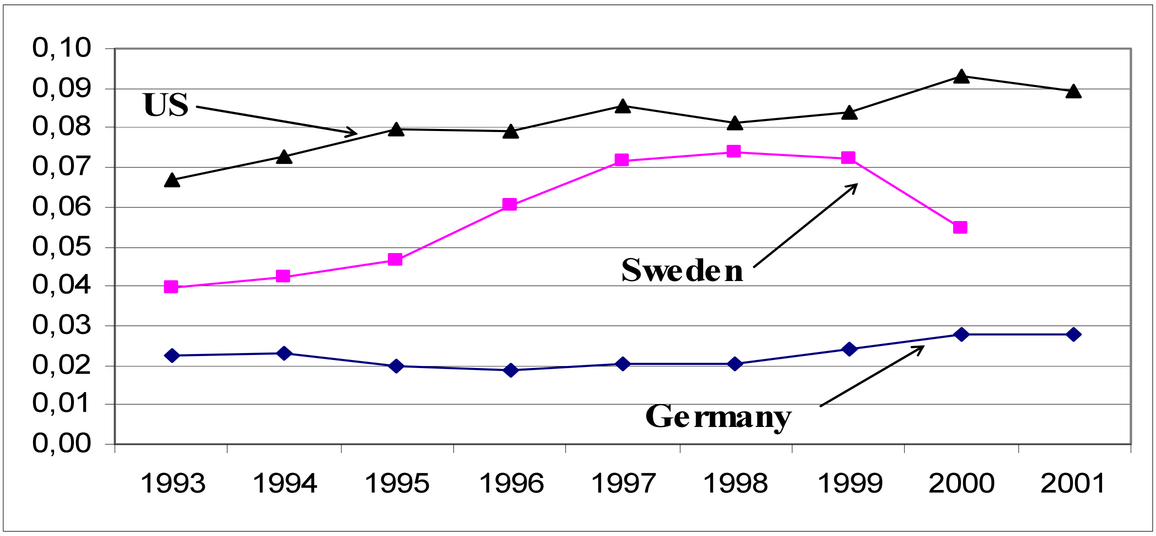
Sources: GGDC (2003), Europroms (2001), Statistics Sweden (2003b) and own calculations.

Figure 4 **Gross output in the Radio, television and communication equipment as a share of gross output in total manufacturing (current prices) 1993–2001**



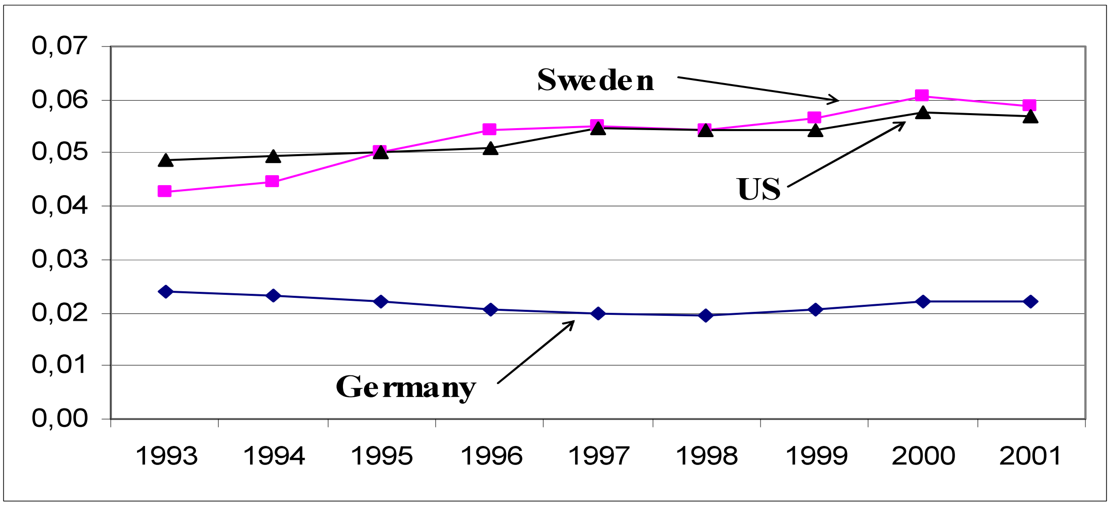
Sources: OECD (2001b) and Statistics Sweden (2003b).

Figure 5 **Value added in Radio, television and communication equipment as a share of the value added in total manufacturing (current prices) 1993–2001**



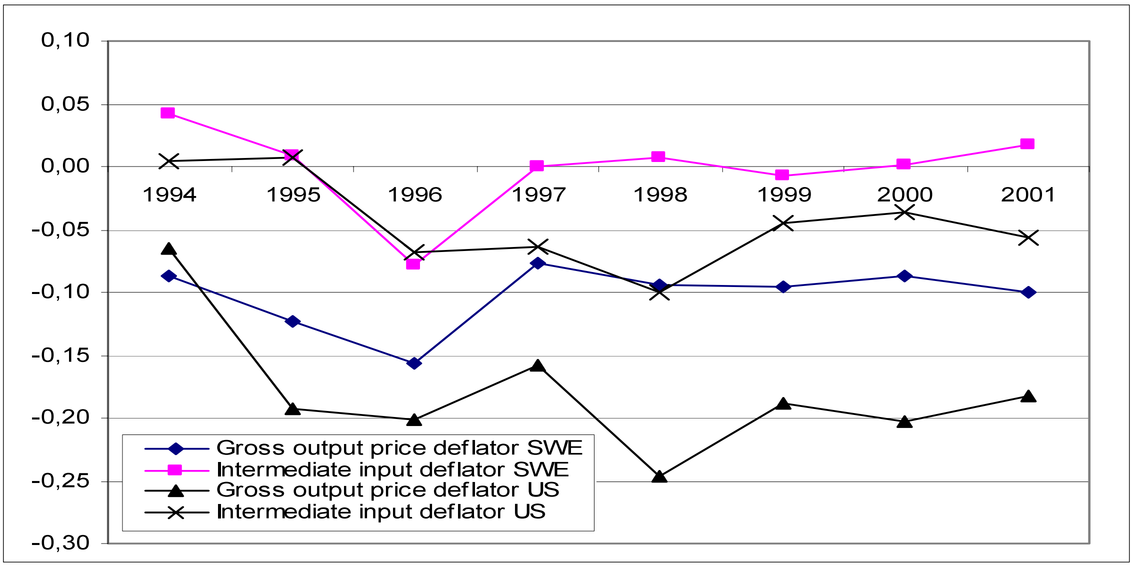
Sources: GGDC (2003) and Statistics Sweden (2003b).

Figure 6 **Persons engaged in Radio, television and communication equipment as a share of the persons engaged in total manufacturing (current prices) 1993–2001**



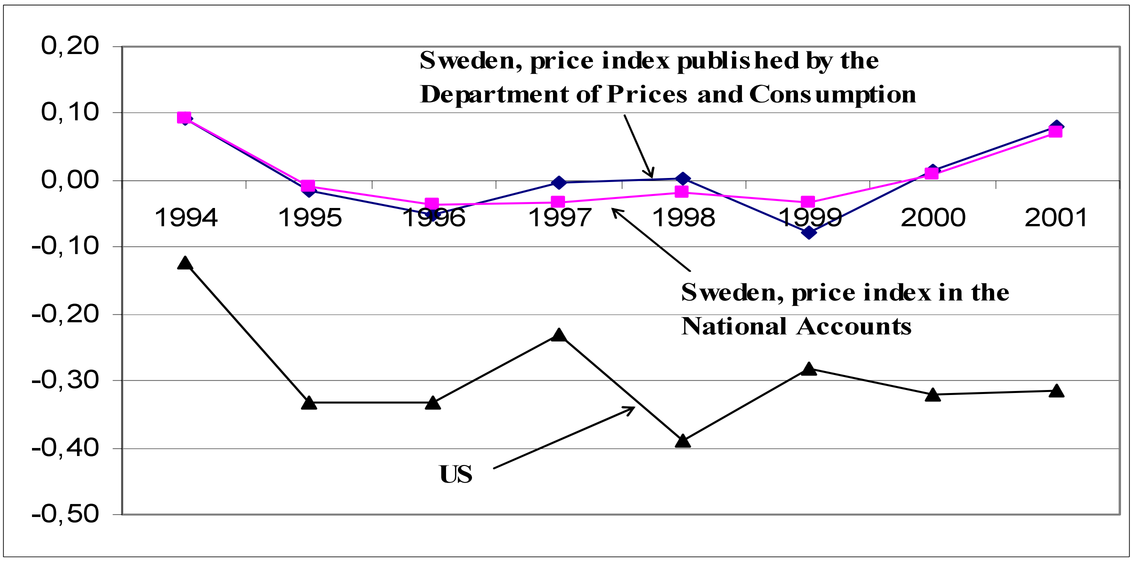
Sources: GGDC (2003) and Statistics Sweden (2003b).

Figure 7 **Gross output and input price deflators for the Radio, television and communication equipment industry (ISIC 32) 1994–2001**



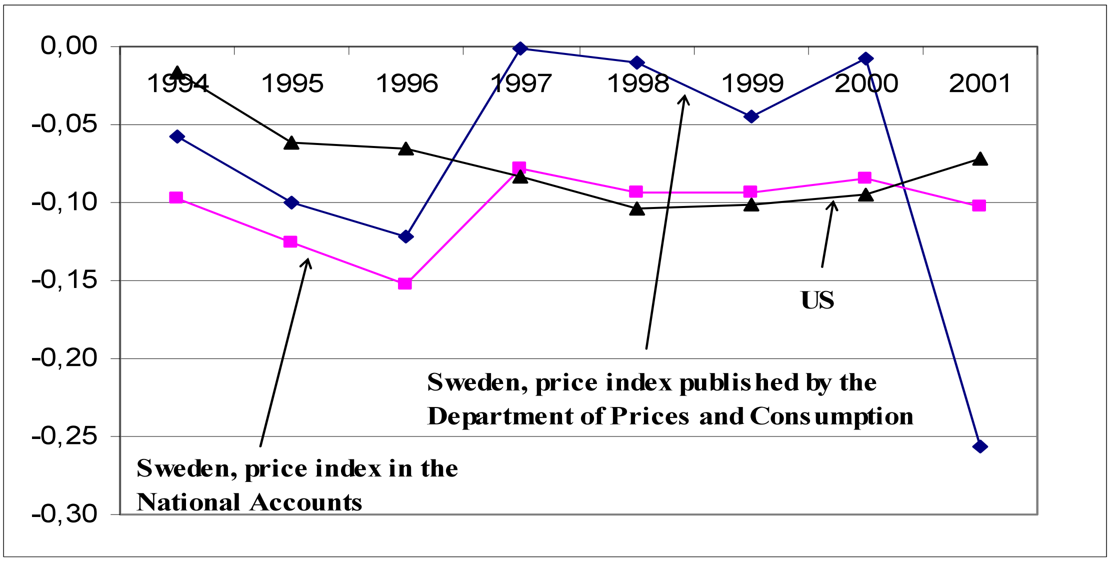
Sources: GGDC unpublished data and Statistics Sweden (2003b).

Figure 8 **Gross output price deflators for the Electronic valves and tubes (ISIC 321) industry 1994–2001 (percent)**



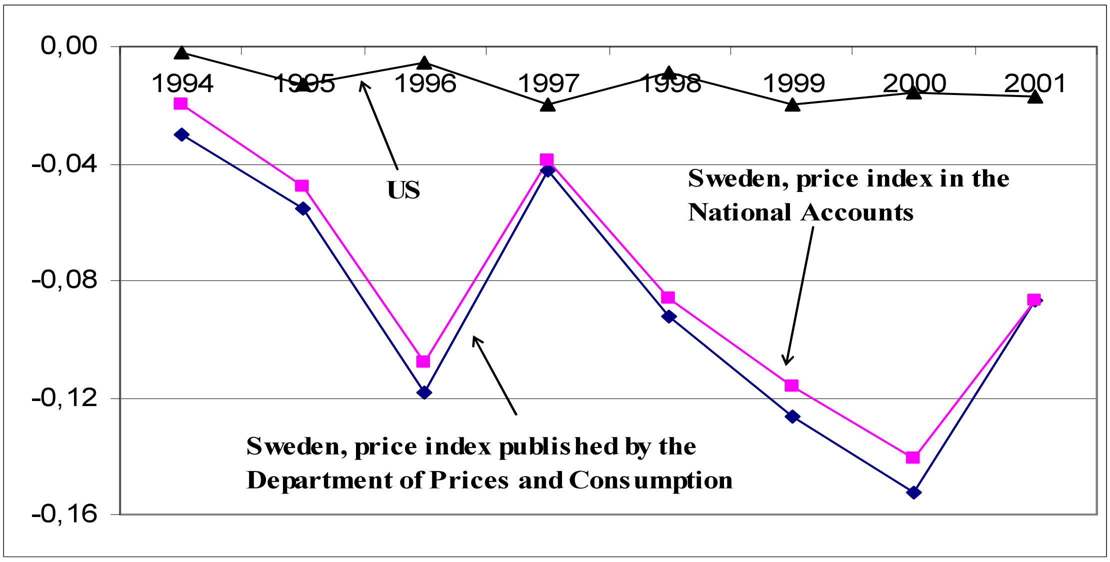
Sources: GGDC unpublished data and Statistics Sweden (2003c).

Figure 9 Gross output price deflators for the Telecommunication equipment (ISIC 322) industry 1994–2001 (percent)



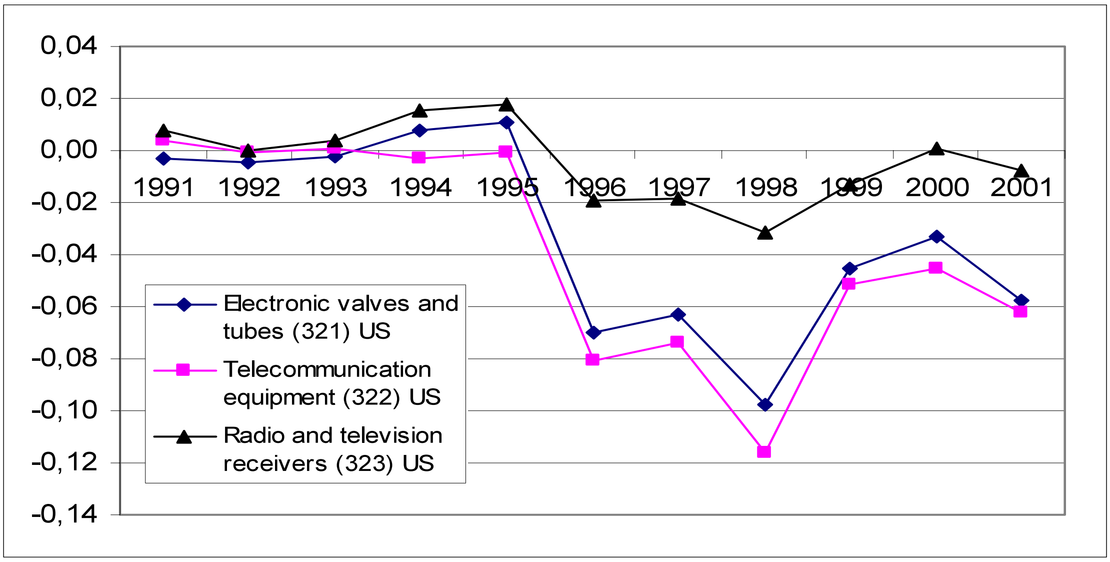
Sources: GGDC unpublished data and Statistics Sweden (2003c).

Figure 10 Gross output price deflators for the Radio and television receivers (ISIC 323) industry 1994–2001 (percent)



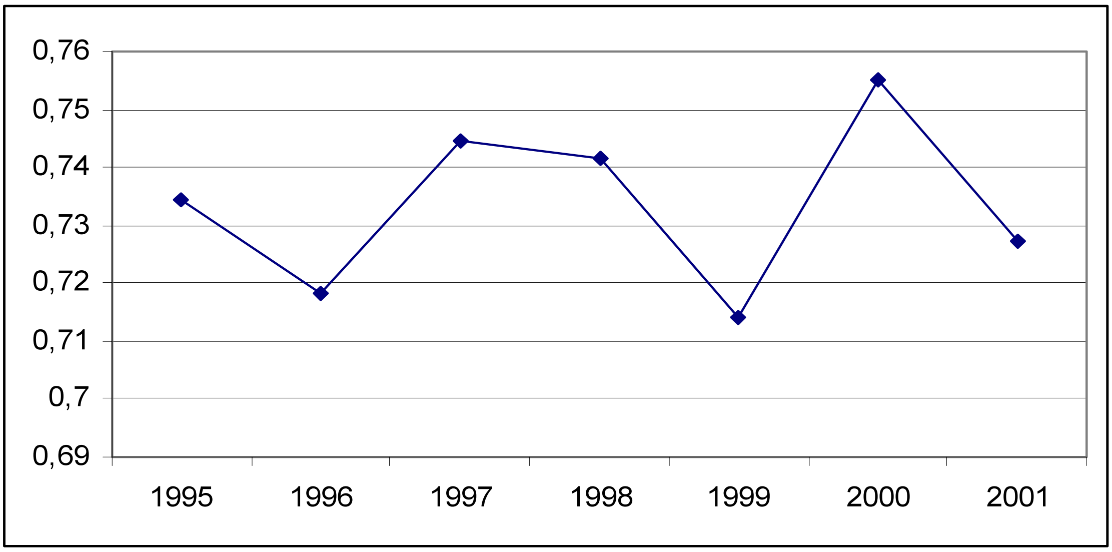
Sources: GGDC unpublished data and Statistics Sweden (2003c).

Figure 11 Input price deflators for Electronic valves and tubes (ISIC 321), Telecommunication equipment (ISIC 322) and Radio and television receivers (ISIC 323) in the US 1991–2001



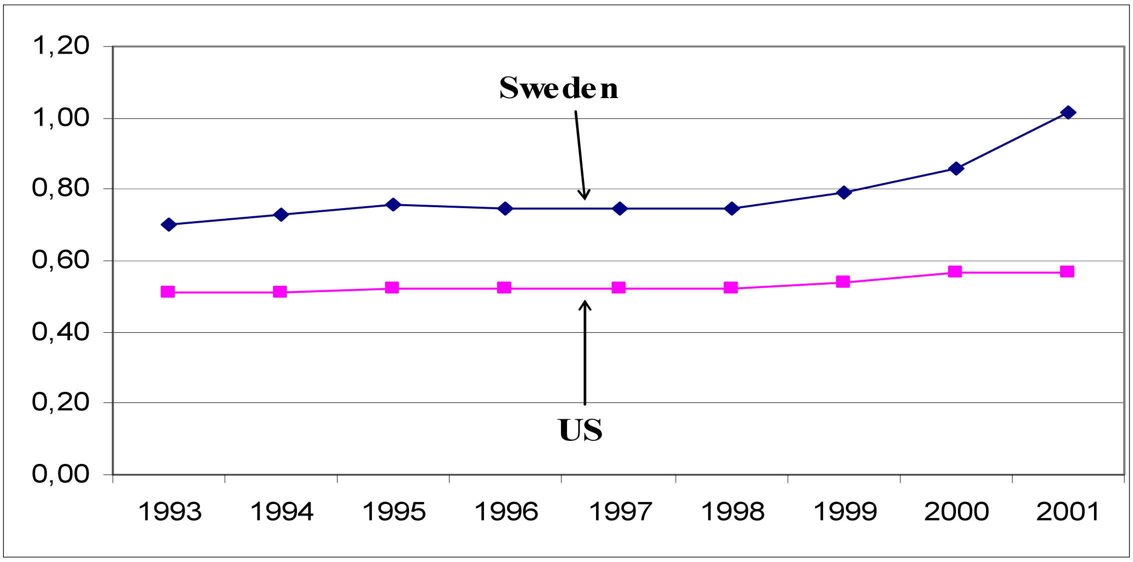
Source: GGDC unpublished data.

Figure 12 Imports of Electronic valves and tubes (ISIC 321) as a share of total production and imports of Electronic valves and tubes in Sweden 1995–2001 (in current prices)



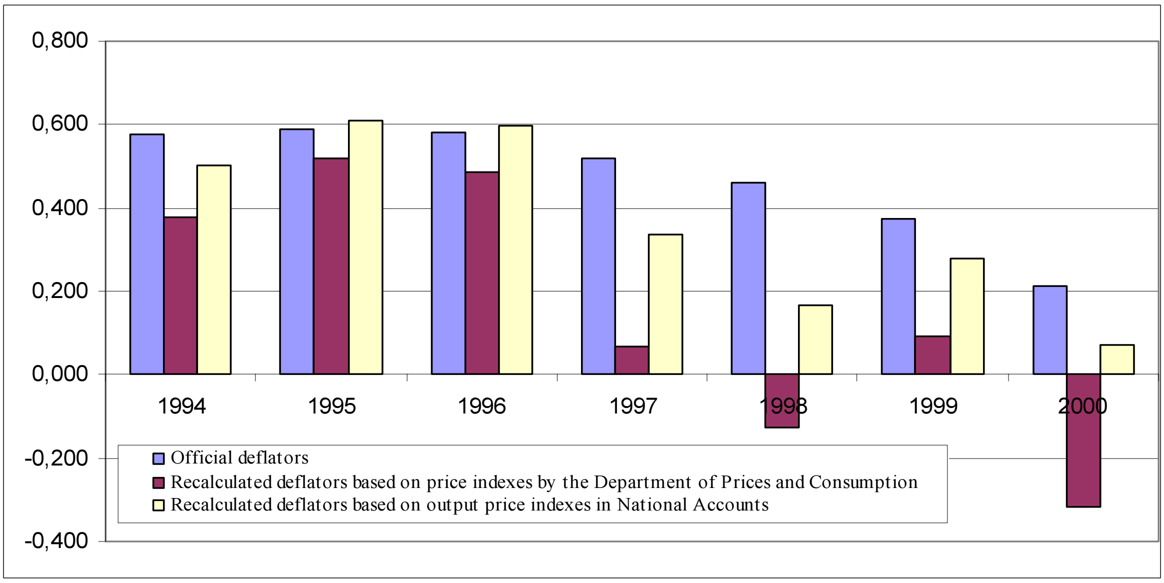
Source: Statistic Sweden (2003b)

Figure 13 Intermediate input/gross output ratio for the Swedish and US Radio, television and communication equipment industry 1993–2001 (in current prices)



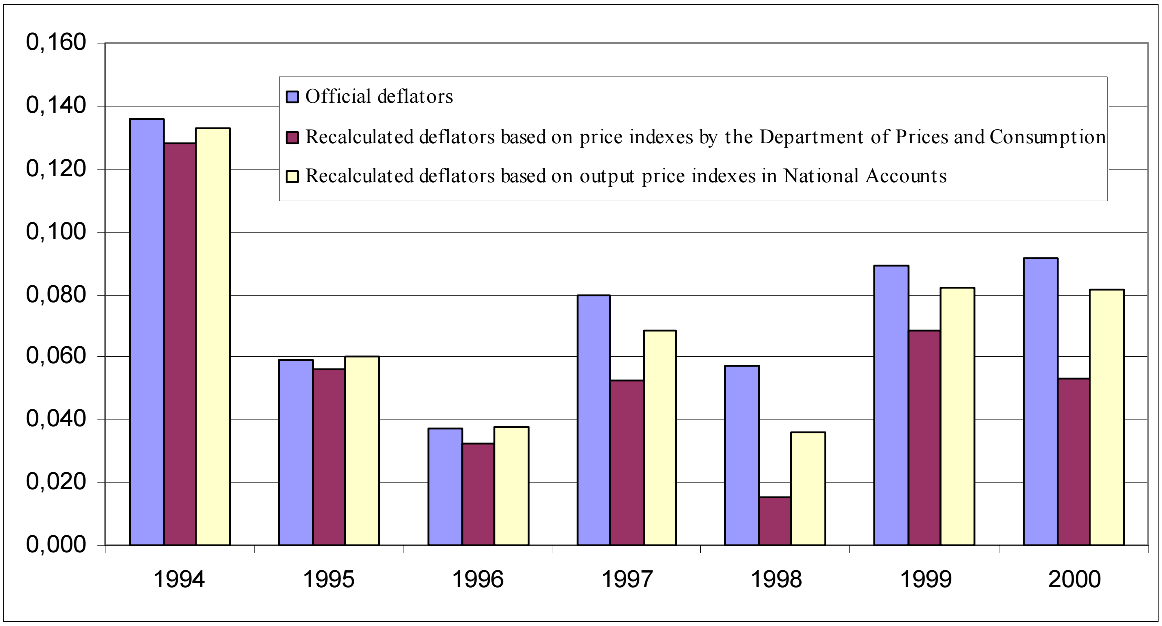
Sources: Statistics Sweden (2003b) and OECD (2003).

Figure 14 Labor productivity growth rates in the Radio television and communication equipment industry with official and recalculated deflators



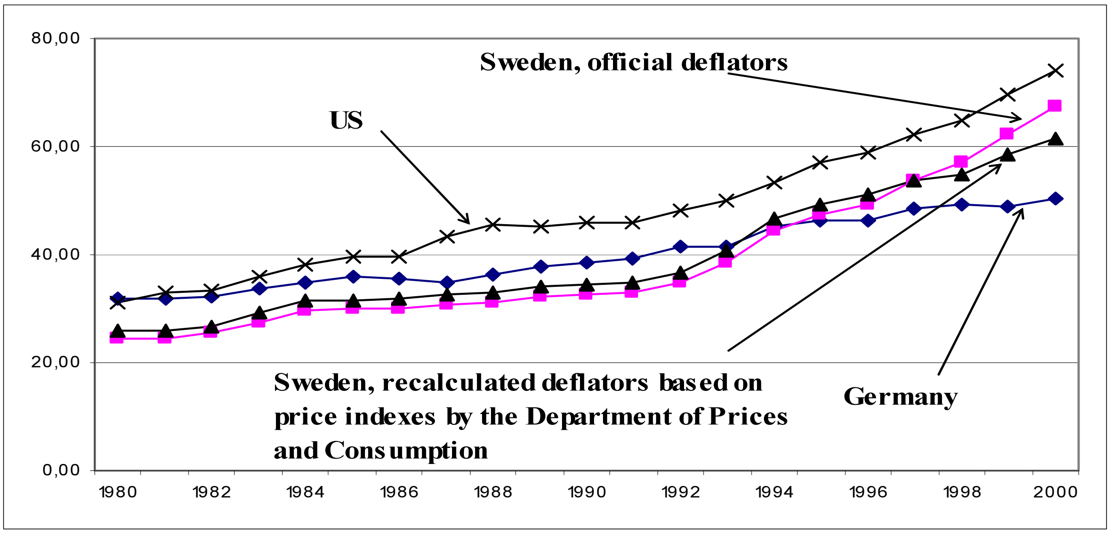
Sources: GGDC unpublished data and OECD (2003), Statistics Sweden (2003b) and Statistics Sweden (2003c).

Figure 15 Labor productivity growth rates in the total manufacturing industry with official and recalculated deflators



Sources: GGDC unpublished data and OECD (2003), Statistics Sweden (2003b) and Statistics Sweden (2003c).

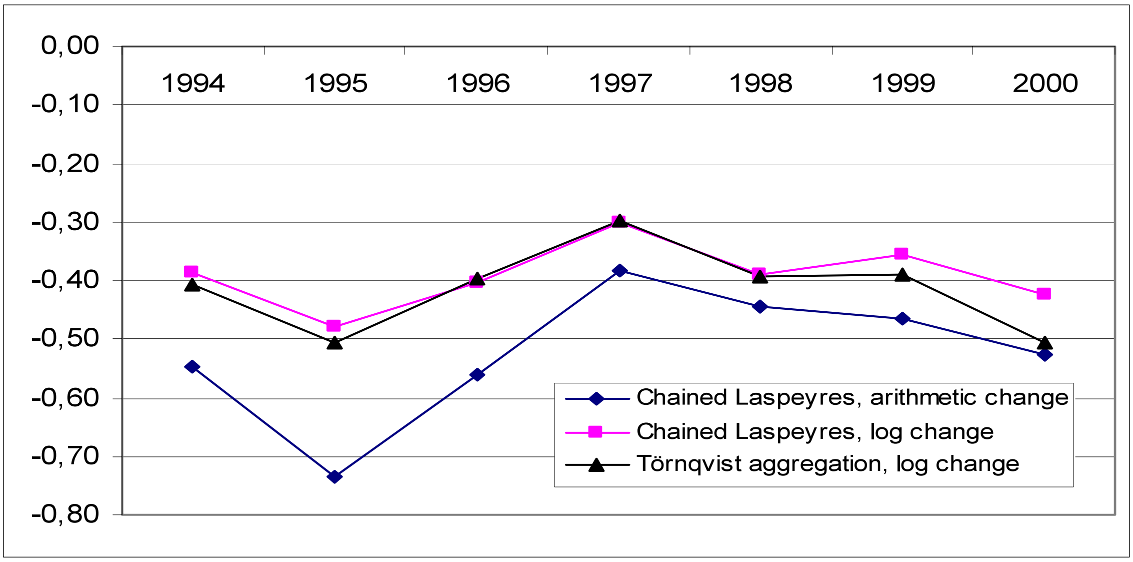
Figure 16 Labor productivity levels in the manufacturing industry, value added (in thousands of EUR) per person engaged in Germany, Sweden and the US 1980-2000



Sources: GGDC (2003), Europroms (2001), OECD (2001b), Statistics Sweden (2003b) and own calculations.

Note: Recalculated deflators are used for the period 1994–2000.

Figure 17 Value added price deflators for the Swedish Radio, television and communication equipment industry (ISIC 32) for different types of index formulas



Sources: Statistics Sweden (2003b) and own calculations.

Note: See Appendix 2 for further details.

7. Appendix

7.1 Appendix 1: Unit value ratios

The UVR-based method was first introduced in the late 1950s, but has been further refined by the ICOP (International Comparisons of Output and Productivity) group at the University of Groningen under the direction of Angus Maddison and Bart van Ark (van Ark and Timmer 2002).

Industry UVRs are based on two alternative indexes: the Laspeyres index that is using the quantity weights of the base country and the Paasche index that uses the quantity weight of the other country. As a first step, unit values (*uv*) are derived by dividing ex-factory output values (*o*) by produced quantities (*q*) for each product *i* in each economy:

$$uv_i = \frac{o_i}{q_i} \qquad (7.1)$$

The unit value can be thought of as an average price, averaged throughout the year for all producers and across a group of nearly similar products. In a bilateral comparison broadly defined products with similar characteristics are matched. For each matched product, the ratio of the unit values in both countries is taken. This unit value ratio (UVR) is given by:

$$UVR_i^{xu} = \frac{uv_i^A}{uv_i^B} \qquad (7.2)$$

where, A and B are the countries being compared, B being the base country. The product UVR indicates the relative producer price of the matched product in the two countries.

The product UVRs are used to derive an aggregate UVR for manufacturing branches and total manufacturing. The most simple aggregation method is to weight each product UVR by its share in total manufacturing gross output.

$$UVR_j^{BA} = \sum_{i=1}^{I_j} w_{ij} UVR_{ij}^{BA} \qquad (7.3)$$

with i= 1,…, I_j the matched products in industry j; $w_{ij} = o_{ij} / o_j$ the output share of the i^{th} commodity in industry j; and $o_j = \sum_{i=1}^{I_j} o_{ij}$ the total matched value of output in industry j. In bilateral comparisons the weights of the base country (B) or the other country (A) can be used, which provide a Laspeyres and a Paasche type UVR respectively.[36] As the quantity weights are consistent with those that are used to derive the unit values, the weights and units are consistent. The same procedure is repeated for the final aggregation step from industry level to the level of total manufacturing.

[36] In this paper, calculations are based on the average of the Laspeyres and Paasche indexes, i.e. the Fisher index.

In a comparison between two different countries, it is not possible to match all products in an industry. This is due to missing data of gross output value and quantity, difficulties in finding corresponding products and the existence of country specific products. The composition of production tends to differ much more across countries than the composition of expenditure (van Ark and Timmer 2002).

7.2 Appendix 2: ICT deflators

Even though the Swedish and the US National Accounts are based on double deflation there are still differences in the way value added is measured. One important difference is that the US uses a Törnqvist price index to derive a Törnqvist value added volume index while Sweden uses a chained Paasche price index to derive a chained Laspeyres volume index, where the year t–1 is used as the base year.

A Törnqvist volume index is a weighted geometric average of the quantity relatives using arithmetic averages of the value shares in the two periods as weights.

$$Q_T = \prod_{i=1}^{n} (q_i^t / q_i^0)^{\frac{(s_i^t + s_i^0)}{2}} \tag{7.5}$$

where s_i^0 denotes the share of the value of product *i* in the total output of goods and services in period 0: that is, $p_i^0 q_i^0 / \sum p_i^0 q_i^0$.

A Laspeyres volume index is a weighted arithmetic average of quantity relatives using the values of the earlier period as weights.

$$Q_L = \frac{\sum_{i=1}^{n} p_i^0 q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^0} \equiv \sum_{i=1}^{n} (q_i^t / q_i^o) s_i^0 \tag{7.6}$$

where s_i^0 denotes the share of the value of product *i* in the total output of goods and services in period 0: that is, $p_i^0 q_i^0 / \sum p_i^0 q_i^0$.

The rational for using a certain index formula is based on theoretical arguments that will not be discussed in this paper.[37] However, from the definitions above there appear to be two major differences between the chained Laspeyres index and the Törnqvist index. One difference is that the Laspeyres index is based on the arithmetic average, while the Törnqvist index is based on the geometric average. Moreover, the Törnqvist price index uses the average of the two periods *t* and *t–1* as weights while the Laspeyres index only uses the period *t–1* as weights.

The logarithm of the Törnqvist index can be expressed in the following way:

$$\ln Q_T = \sum_{i=1}^{n} \frac{1}{2}(s_i^t + s_i^0)\ln\left[\frac{q_i^t}{q_i^0}\right] \qquad (7.8)$$

In order to approximate the Swedish data based on the Laspeyres index to the Törnqvist index, I use the logarithmic change of the values derived by the Laspeyres volume index. This gives the log change between two years instead of the arithmetic change. Moreover, I also use the average of the Swedish value added and intermediate input weights for the period *t–1* and *t*. Since I do not have access to the weights of every product for the intermediate input and output it is not possible to change the weights for each product. Nonetheless, for the total gross output/value added ratio as well as for the intermediate input/gross output ratio it is possible to use the average weights of the two years *t-1* and *t* (see section 4.2).

Figure 17 shows the different results from calculating the value added deflator for the Radio, television and communication equipment by using arithmetic mean and weights with year *t–1* as the base year, log change and weights with the year *t–1* as a base, and log change with the average of the years *t* and *t–1* as base years. Since the latter is the closest approximation to the Törnqvist price index it will be used for all calculations of value added price deflators. Moreover, one of the reasons that the value added price deflators based on arithmetic mean differs widely from those based on logarithmic

[37] For a thorough discussion of the theoretical reasons to use certain index formula, see IMF (2003).

change is that there are extremely high growth rates of production value and intermediate input 1993–2000. If the growth rates had been lower than 10 percent per year the difference would have been negligible.