22. ECONOMIC GROWTH IN SWEDEN, NEW MEASUREMENTS

By Tomas Skytesvall* and Hans-Olof Hagén**
*National Accounts, Statistics Sweden; **Economic Analysis, Statistics Sweden

Introduction

Almost 50 years ago Robert Solow\(^{324}\) started up a new era in growth measurement by publishing his article on economic growth and technological development in the US economy. He used the technique of Growth Accounting to break down growth in US labour productivity into components. His results indicated that almost all growth in the US economy was due to technological developments and very little to capital deepening. This inspired Zwi Griliches and Dave W. Jorgensen\(^{325}\) to try to improve the capital measurements. Another important contribution was made by Denison\(^{326}\) who tried to incorporate a measurement of the improvement in labour quality. This period of rapid development of the neoclassical growth theory and use of the Growth Accounting technique lost momentum due to researchers’ increasing interest in short term questions, a lack of adequate data and the fact that growth was treated as exogenous in the neoclassical word, so these theories could not explain growth in itself.

Solow did however later argue, for instance, that increased capital-intensive investment embodies new machinery and new ideas as well as increased learning for even further economic progress. But Kaldor\(^{327}\) is the first theorist after the Second World War, who thought growth to be endogenous. Before the War it was of course Schumpeter who indeed saw growth as an exogenous process with creative destruction as one major concept. Kaldor regarded learning as a function of the rate of investments. Arrow went on and viewed learning as a function of cumulative investments. But this area stagnated nevertheless after the 1960s.

This changed drastically when Romer\(^{328}\) published his breakthrough article 1986, where he finally incorporated endogenous growth in the model. This started up a new field of growth literature, which was called “new” or “endogenous” growth theory. But still the neoclassical growth theories have their supporters. Even if these theories cannot explain the driving forces


\(^{327}\) N. Kaldor “A New Model of Economic Growth”, with, 1962, RES

behind different growth rates, they can still answer important questions, like if there is a tendency towards convergence (see among others Barro and Sala-i-Martin.\textsuperscript{329}) The technique of decomposing economic growth by Growth Accounting has been widely used during the last decade with many important contributions, not least by Dave W. Jorgensen\textsuperscript{330}, who is still very active in this field.

An important trigger has been the improved growth performance of the US economy. It ceased to lose ground to the European economies around 1995, as had been the case since the Second World War, and outperformed them thereafter. Now many articles have been published that have looked into the US economy in depth. The objective of these articles has been to get a better understanding of US transformation from the stagnating economy it was for many decades, into a growth economy. Some researchers have also compared US development to some European countries\textsuperscript{331}. Important work has also been done in Canada during the last 10 years; at Statistic Canada led by Professor John Baldwin\textsuperscript{332}, both on the Canadian development and its comparisons with the US. Bart van Ark\textsuperscript{333} at Groningen Growth and Development Centre the University of Groningen is another important researcher in this field. Another trigger of the increased use of the Growth Accounting technique was the interesting result Young\textsuperscript{334} came up with when he decomposed the economic growth of the “Tiger Economies” in East Asia. He found their very imposing growth in labour productivity was almost entirely due to a drastic increase in capital intensity.

This development in the research field together with the increasing importance of the European growth problem has also led the EU Commission together with Eurostat to act. They have commissioned a development and analysis of a comprehensive long time series for most European countries. This is being carried out by a broad consortium lead by Bart von Ark. Statistics Sweden is also now linked up to this ongoing work.

\textsuperscript{329} Barro, Robert J. and Sala-i-Martin, Xavier, Convergence», 1992, JPE
\textsuperscript{332} Dale W. Jorgenson and Khuong Vu Information and the world economy Presented at the EU-KLEMS meeting in Helsinki 2005.
\textsuperscript{333} Susanto Basu, John G. Fernvald, Nicholas Oulton, and Syaja Srinivasan. The Case of Missing Productivity Growth, or Does Information Technology Explain Why Productivity Accelerated in the United States but Not in the United Kingdom?
\textsuperscript{335} Bart van Ark, Robert Inklaar and Robert H. McGuckin (2002), ““Changing Gear”: Productivity, ICT and Services: Europe and the United States”, Research Memorandum GD-60, Groningen Growth and Development Centre, December
\textsuperscript{337} Young Alwyn, «The Tyranny of Numbers», National Bureau of Economic Research, Inc in its series NBER Working Papers number 4680
The OECD has always had economic growth on its agenda, and has recently created a productivity section on their website on growth accounting, with both methodological papers and a database. This work as well as the analytical work in this field is led by Paul Schreyer at the Statistics Directorate and Dirk Pilat at the Directorate for Science, Technology and Industry. In the Nordic countries Statistics Denmark has led the way and published multifactor productivity growth figures on a very detailed sector level, already in 2004335.

At Statistics Sweden this kind of work is still on an experimental level, but two studies made by external researchers have already been published in this field. The first one was the first time a separate series for ICT capital was constructed and used336 in Sweden. The second study also used a quality adjusted labour input337. The former chief economist of Statistics Sweden has also led a Nordic Ministerial work group, GAG, that has compared economic growth in recent years in the Nordic countries. This study is presented in another chapter in this book.

All this work has inspired us to go on with our own experiments in the growth accounting field. This time we have tried to go beyond the value added and capital stock approach and try to use the KLEMS method. This means that growth of gross output is decomposed instead of growth in value added. In this attempt capital services will be used as measurement of capital input instead of capital stock. The capital service concept is an important improvement since a stock concept is changed into a more appropriate flow concept. An intuitive example of this is the difference between the rent of a building and the value of the building. It is of course more relevant to use the rent as a measurement of the input cost of building capital in explaining the production that has taken place in this building during a year since all other variables like worked hours, bought materials and services are flow concepts.

The variables that influence the cost of the capital service of a certain capital type are: the price of the investment goods, the alternative interest that can be earned, the depreciation rate due to the economical and physical reduction in its production capacity of using it a year, and finally the price development of the investment good during the same year. The price changes, which for most investments goods are positive, decrease the cost of the capital service. But since this is not the case with ICT goods we see a very marked difference in the importance of these goods when capital service is used instead of a capital stock as capital inputs. However, even more important is the difference in depreciation rate between ICT capital and other capital items. This means that the relative cost of ICT investments is markedly appreciated compared to other capital types, especially buildings, since the depreciation rate is much higher and its price developments are much lower. The other major difference is that we use the production, or gross output, as output measurement, which means that also intermediate input becomes an input variable. The intermediates are split into three categories; energy, other material input and service input. This makes it possible to study how outsourcing and energy conservation influences the production.

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The objective of this study is thus to improve the measurement of economic growth in the Swedish business sector by growth accounting experiments, where gross production is used as the output variable and capital service as capital input. However, the growth accounting methodology is just a technique to decompose the growth and it cannot answer the question of why the growth was high or low or what caused it. Nevertheless, it gives valuable data for further analysis of these important questions.

**Theory and model outline**

As mentioned above, we will take a KLEMS point of view in our productivity analysis. That is to say we will incorporate the effects of input of capital (K), labour (L) and intermediate input on production. The intermediate input is broken down into input of energy (E), materials (M) and services (S).

The production function expresses the relationship between the factor inputs and the output in the economy. Let gross output be a function of capital, labour and intermediate input. $A$ is an index of the level of technology in the economy.

$$Y = AK^\alpha L^\beta M^\gamma$$  \hspace{1cm} (1)

$A$ is commonly referred to as total factor productivity, TFP, or multi factor productivity. Changes in $A$ shift the production possibility curve making it possible to produce more without changing the factor inputs.

Growth accounting is a technique commonly used in productivity analysis. This method allows the growth in production and labour productivity to be decomposed into growth of the factor inputs and growth in total factor productivity, TFP. Studying the production function, estimates on growth in production and growth in factor inputs is normally not a problem to obtain. Using growth accounting, total factor productivity is that part of growth in output that cannot be explained by growth in the input factors. While having estimates on growth in output and input factors $\text{TFP}$ is estimated residually.

While using the production function stated above we assume standard neo-classical growth assumptions, constant returns to scale, perfect competition and profit-maximizing firms. All of this meaning that factor inputs will be rewarded by the size of their marginal productivity. Also we assume the growth in TFP be Hicks-neutral. Assuming constant returns to scale yields the coefficients to sum to one; $\alpha + \beta + \gamma = 1$.

Being focused on growth we need to reformulate equation (5). By taking the logarithm and the first difference of the production function we express all variables in terms of rates of growth and get:

$$\Delta \ln Y = \alpha \Delta \ln K + \beta \Delta \ln L + \gamma \Delta \ln M + \Delta \ln A$$  \hspace{1cm} (2)

$\Delta$ refers to the first difference, i.e. $\Delta x \equiv x_t - x_{t-1}$.

Studying the model one realizes that growth in gross output is possible only by raising the input of one of the input factors or by raising the level of technology in the economy, that
is, the total factor productivity, TFP. By expressing the production function in growth rates (log differences) the growth in Y is split up in the share weighted growth in capital, labour, intermediate consumption and TFP.

Using this model enables us to study the share weighted growth in GDP. In so doing we need estimates on the weights of the factor inputs. By taking the starting point in the firms profit maximization function, the quantities of capital services, labour and intermediate inputs are chosen so as to minimize total costs and maximize profits. Let $\Pi$ denote the profit, Y is production, $\omega L$ is the total cost of labour, $rK$ is the total cost of capital and $pM$ is the total cost of intermediate inputs.

$$\Pi = Y - \omega L - rK - pM$$

(3)

While maximizing $\Pi$ subject to $Y = AK^\alpha L^\beta M^\gamma$ it can be shown that

$$\alpha = \frac{rK}{Y},$$

(4)

$$\beta = \frac{\omega L}{Y},$$

(5)

$$\lambda = \frac{pM}{Y}.$$  (6)

We see that the weights of the factor inputs, $\alpha$, $\beta$ and $\gamma$, are represented by each factor’s share in total production.

Assuming perfect competition, there are no profits other than the remuneration to labour, capital and intermediate input. Hence the value of output can be expressed as:

$$Y = \omega L - rK - pM$$

(7)

Then we see that the weights are represented by each factor inputs share in total cost.

In the empirical analysis below we are using different types of capital. Splitting capital into these subcategories yields:

$$\alpha \Delta \ln K = \sum_j \alpha_j \Delta \ln K_j$$

(8)

where $\alpha_j$ represents each capital’s share in total capital costs:

$$\alpha_j = \alpha \frac{r_j K_j}{\sum_j r_j K_j}$$

(9)

Since we are interested in the effects of different types of labour the set of labour were divided into a number of categories. Assume in this case that A is the set of different labour types, and $L_a$ the quantity of labour of type $a \in A$. 
Here $l_{ait}$ is the share of category $a$ in total labour, and the $\beta_{ait}$-coefficients represent each types share in total labour cost:

$$\beta_{ait} = \beta_{it} \frac{\omega_{ait} L_{ait}}{\sum_a \omega_{ait} L_{ait}}$$  \hspace{1cm} (11)$$

**Labour Productivity**

Economic growth is our focus thus the effects of changes in factor inputs on changes in labour productivity are of interest. Therefore we introduce total worked hours $H_t$. When dividing both sides of the production function above with total worked hours we get:

$$\frac{Y_t}{H_t} = A_t \frac{K_t^\alpha L_t^\beta M_t^\gamma}{H_t^\alpha H_t^\beta H_t^\gamma}, \alpha + \beta + \gamma = 1$$  \hspace{1cm} (12)$$

Expressing the equation above in growth terms by taking the logarithmic first-difference we get:

$$\Delta Y_t - \Delta H_t = A_t \Delta \ln L_t - \Delta \ln H_t$$

$$+ \gamma (\Delta \ln M_t - \Delta \ln H_t) - \Delta \ln A$$  \hspace{1cm} (13)$$

In this case we identify four sources of the growth in labour productivity. First we have the change in capital per the change in hours worked, known as capital deepening. The second component is the improvement in labour quality which is defined as the difference between the growth rates of labour services and hours worked. The third part is the growth in intermediate consumption per hour worked. The fourth source is the growth in TFP.

**Data**

In the empirical analysis we will study the growth in TFP both on gross production and on value added. We use data from the national accounts on capital stocks, worked hours and intermediate input. The data on labour is derived from RAMS, register-based labour market statistics at Statistics Sweden and is presented in more detail below. We have data on all variables for the period 1994–2002. We also make an effort to estimate the TFP for the years 2003 and 2004. As so far as it has been possible we have used true values for the years 2003 and 2004. When that has not been possible (as in most cases besides preliminary data for value added and hours worked that we do have) we have extrapolated the following years with averages of the most recent preceding years. The section below will in more detail describe the data on the factor inputs.
Capital Services

As mentioned earlier we will in this empirical analysis use the flow of capital services streaming from capital rather than the value of the capital stock itself. By taking into account the heterogeneity of capital and that different types of capital have different marginal productivity, we get a more effective measure of the capital input in production.

The value of the flow of services from the stock is a better measure of the input in production than is the value of the stock itself. Over time there should be a substitution of capital towards capital with higher marginal productivity. For example as prices on ICT capital is falling industries tend to invest more in this cheaper and more productive capital.

For this study estimates of capital stocks were derived from national accounts, Statistics Sweden, to construct estimates of capital services. Official data on capital stocks is published by Statistics Sweden on Machinery and equipment, Dwellings, Other buildings and construction and Other capital formations which mostly consist of software. Using these stocks of capital, stocks of Machinery exclusive ICT, Transport equipment, Buildings and construction and ICT were estimated. The ICT stock was originally estimated for Lindström (2002). Following the recommendations of OECD an ICT stock was then estimated for the business-, goods-, manufacturing-, service- and ICT sector respectively for the period 1993 to 2000. For this study this time-series was prolonged to the year 2003 using data on investments for the same period and the perpetual-inventory method, PIM. While using these new stocks of capital, capital service measures for ICT capital and non-ICT capital were constructed.

Consider the capital stock \( K_t \). The capital stock is estimated by using the traditional PIM-method.

\[
K_t = K_{t-1} (1 - \delta_{t-1}) + I_t
\]

Here \( \delta \) is the value of depreciation in period \( t-1 \) and \( I \) is the value of investment in period \( t \).

The value of the stock is estimated at the beginning of the year. Assuming that new investments becomes available for production in the middle of the year we express capital services as

\[
C_t = \alpha(0.5K_t + 0.5K_{t+1})
\]

(footnote D. Jorgenson)

The capital service flow is assumed to be proportional to the average of the current and lagged capital stock where \( \alpha \) denotes the proportionality constant. The flow of capital services is then estimated by using asset specific user costs to weight the growth in each type of capital and to account for the substitution between them.

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**User Cost**

The flow of capital services is weighted with the user cost of each type of capital. The user costs are, under certain assumptions, equal to the marginal productivity of capital. User cost can be seen as the cost of borrowing capital and investing in a capital good, renting it out, and collecting a rent.

The estimation of the user cost can be made more or less complex regarding tax regulations. In this study we are relaxing all effects of taxes.

The components of user cost are the rate of alternative investments, depreciation and the change in the price on investment goods. There are different options of choosing the rate of return. In this study we use the endogenous internal rate of return derived from the national accounts. By relating gross operating surplus to the capital stock, the rate of return was derived. This was done for each of the sector aggregates in the study. The rate of depreciation is estimated per sector and type of capital. Changes in prices on investment goods were derived from implicit price indices on investments in the national accounts.

In a very simple form the user costs were estimated as:

\[ \mu_t = r_t + \delta_t - \Delta p_{t,j-1} \]  

where \( \mu \) is the user cost, \( r \) is the rate of return, \( \delta \) is the rate of appreciation and \( \Delta p \) is the rate of price change in new investment goods.

The estimated user costs are then used to calculate the weights by which the flows of services are aggregated. The weights are defined, for a capital good \( C_k \) as:

\[ v_{k,j,t} = \frac{\mu_{k,j,t} C_{k,j,t}}{\sum_k \mu_{k,j,t} C_{k,j,t}} \]  

where \( v \) is the weight for the capital good \( C_k \).
characteristics. For each of the subgroups we calculated the average incomes from both the employed and the self-employed.

If the labour market functions well, the average income for each subgroup is the market’s valuation of the different categories as labour inputs. This is in accordance with a long tradition represented by Jorgensen\footnote{Jorgensen, Dale W., Frank M. Galup and Barbara M. Fraumeni. 1987. "Productivity and the U.S. Economic Growth," Cambridge, Harvard University Press.} and Bureau of Labour Statistics\footnote{Bureau of Labor Statistics. 1993. Labour composition and U.S. Productivity Growth, 1948–90, Bureau of Labor Statistics Bulletin 2426, Washington, D.C. , U.S. Department of Labour.} both of which have somewhat different approaches for the US labour market. This has been further developed on US and Canadian data by Gu and Maynard\footnote{Gu, Wulong and J-P Maynard. 2001. “The Changing Quality of Canadian Work Force, 1961–95”, in Jorgenson and Lee (eds) Industry-level Productivity and International Competitiveness between Canada and the United States, Industry Canada}. The income means are then treated as the market valuation of different categories of labour in respective workplaces. In most workplaces there are of course only a small number of these categories represented. But with help of the average prices it is possible to calculate a synthetic labour cost or labour composition indicator for the whole workplace. It is necessary to go via the workplace level since this is the unit that has an industry definition, not the individuals. They get an industry connection by their workplace. The workplaces can then be aggregated to industries on different aggregation levels.

Instead of creating an average for the whole time period we want to take account of the changes that take place in the valuation of different types of labour over the years. To take account of the changes over the years in relative prices is rather uncommon in the literature, but has been used by the researchers mentioned earlier at Statistic Canada\footnote{Gu, Wulong, Mustaapha Kaci, Jean-Pierre Maynard and Mary-Anne Sillamaa in the chapter of “The Changing Composition of the Canadian Workforce and its Impact on Productivity Growth” in the “Productivity Growth” edited by John R. Baldwin and Tarek M. Harchaoui. Statistics Canada 2002. Catalogue no. 15-204-XIE}. To be able to follow the changes in the labour market over the years in a meaningful way, it is necessary to deflate these mean incomes for different categories with the general wage increase; otherwise the labour composition indicator, which is based on the mean incomes, includes both inflation and real wage increases.

For this purpose the structure from one year, that is, the relative size of each category, is combined with the earnings for each category the following year. This is then aggregated to a fictive average earning of that year which is divided with the factual mean earnings of the last year. The increase in average earnings is then treated as a common price index that is used to deflate the incomes of each subgroup. The resulting changes of the deflated prices of a subgroup over the years is then only reflecting the market’s relative appreciation, or its depreciation, of the value of this group as labour input compared with all other subgroups.

The characteristics that have been used are the traditional ones; age, education and ethnicity with one exception, i.e. gender is not included. The choice of the different categories for each variable is based on how they are valued on the market. The education variable is split into two dimensions: orientation, and levels. There are five different levels but only two

\begin{thebibliography}{99}
\end{thebibliography}
fields: 1) the technical and natural science orientation and 2) all other orientations together.

The levels starts with primary (level 1 and 2) and lower secondary, and end with post graduate education (level 6). Concerning age, the workforce is split in as many as six categories, but of these the first and the sixth are very infrequent on the Swedish labour market. These categories are namely those who are 16–20 years of age, and those who have reach the age of 67. The ethnicity variable is based on the countries where people are born. Those with an origin outside of Sweden are divided in four groups.

The reason why the gender variable is excluded is because most of the differences of yearly earnings between men and women are more of an indicator of the differences of working hours than of anything else. We do not have any data on worked hours for individuals, but we know that there are many more women than men who are working shorter hours. Since the quantitative labour input is measured in hours, the sector difference is already incorporated in that variable, and if the gender is included it is measured twice. The rest of the differences between the two sexes are considered to be a reflection of discrimination and not a difference in labour quality. All these variables and their different categories give us in theory as many as 600 cells in total, but some of them are of course empty. And in a small or medium sized workplace only a handful is represented.

Regional differences in wage levels also exist on the Swedish labour market, but these differences are not mainly due to differences in competence but rather to the size and character of the local labour market. The same is true for industries. In general there could be a tendency for an expanding sector to pay more for the same skill since it needs to attract more people. Sector differences can also be a reflection of regional differences. This is not only due to chance, but also to conscious choices. Industries that are maturing are driven out from growth areas due to high wages and high rents. These factors are the reason for not including regions and sectors among our variables.

We have also limited the calculation to the private business sector since we are just studying this sector. It is also known that the public sector is paying less for the same competence. We have chosen broad education categories for the education orientations, since if they are narrower they tend to become more sector-specific.

The development of the quality measurement has been decomposed into 1) the change in the relative importance of each category and 2) the change of its quality or price. The effects of the weights are of course positive if a high quality group increases its importance as well as if a low quality group decreases it. The total effect for each group is the sum of the price and the relative size effects. All the effects are the total effect and not the partial effect. This means that the sum of all bars in the four figures in graph 22–1 all equal 0.38.

The relative income of those who are on the education level 6, postgraduates is twice the average income and there relative size has almost doubled during the period 1993–2002. But there are still not very many at this level, and their relative salaries have deteriorated somewhat. Much more important for the increase in total quality of the workforce is therefore the increase of the relative share of graduates, most of those on level 5, even if they too have undergone a decrease of there relative incomes. The decrease of those without a high school exam (or completion of upper secondary school), levels 1 and 2, from 31 to 21 per cent of the workforce is also of substantial importance. The decrease of all but one educational group is probably
partly due to the change of the relative size of the different age groups, and to a much smaller extent the increase of immigrants from outside of the western hemisphere. But the substantial increase of graduates and postgraduates have made those groups a less scarce resource and thus lowered their marginal productivity, since they are now used in areas other than where their education is most important. The change of educational orientation has also improved the quality of the labour force since those who are favoured by the market, i.e. those with an educational orientation towards natural science and technical fields have increased their share of the workforce somewhat from 30 to 33 per cent. However, the high bars in graph 22–1 b for the relative incomes are mainly due to the increase in educational levels in both groups.

**Total contribution to the increase in labour quality by: educational level, educational orientation, age and ethnicity.**

The impact is separated into the effects due to the change in the relative size of different groups and their relative quality or wage levels. The total effect is the sum of these two effects, positive or negative.

**G 22–1**

![Graph a) Educational level](image)

- Level 6
- Part of level 5
- Level 4
- Part of 5
- Level 3
- Level 1,2

![Graph b) Educational orientation](image)

- General
- Tech+Na Sci

![Graph c) Age groups](image)

- 16–20
- 21–30
- 31–45
- 46–60
- 61–66
- 67–

![Graph d) Ethnicity](image)

- Sweden
- EU 15, EFTA, US, Can, Aus
- EU 10, rest of OECD
- Other countries
- Africa
The same is true for figure c and d. The only two age groups which are above the average incomes are those aged 31–45 and those aged 45–60. This means that both the two most important changes in relative size are due to the movement in opposite directions of the two low income groups with younger people.

The negative effect is due to that the group with the youngest ones has increased in relative size and the positive ones to that the group with those who are a little older; 21–30 years of age, has decreased. The dominant effect in the last part of the figure, d), is due to the effects of higher educational standards and a more growth-oriented direction among those who were born in Western Europe or in other Anglo-Saxon nations. But there is also a small negative effect of an increase in the proportion of the labour force that comes from other countries with on average a lower educational level.

With the method we have used where the change in relative prices are into taken account instead of using a mean for all the years, the increase in the labour quality is reduced. The two methods give similar estimates for most years, (see graph 22–2) but it reduces the effect for the whole period from 0.5 to 0.35 per cent per year. This is due to the fact that the relative price has decreased for those groups with longer educations.

The increase in labour quality with constant and variable weights

![Graph showing the increase in labour quality with constant and variable weights](image)

**Intermediate Input**

The intermediate input is divided into three categories, energy, materials and services. Input of energy consists of products in ISIC 10–12, 23 and 40. Material input consists of products in ISIC 01–05, 13–14, 15–37 exclusive 23, 41 and 45. Services are the total input of products in ISIC 50–95.

The growth in input per category is calculated as the percentage change in volume consumed. The relative effect of each category on the growth in total input is estimated as the
weighted growth of the three parts. The weight’s is calculated as the relative value of the three categories to the value of the total input in current prices. Consider \( Z_{i,j,d} \) as the value of input of each category. Then the weight for each type of intermediate input is estimated as

\[
u_{i,j,d} = \frac{Z_{i,j,d}}{\sum_i Z_{i,j,d}}, \quad i = \text{energy, material, services}
\]

The average growth in intermediate input during the period 1994 – 2002 is higher in the goods sector than in the service sector. Except for energy input the growth is even higher in the manufacturing sector. But the overall strongest figures is derived in the ICT sector with growth rates three times as high as in the total business sector.

### Results

Intermediaries are as could be expected very important for the growth in gross production. The intermediaries can be split into three main components: energy, other materials and services. Together they account for a little more than half of the growth. Of these components, other materials are a little more important than services while energy is almost negligible. This means that the service society is not here yet. ICT capital services and non-ICT capital services are of almost equal importance, but the ICT capital service has a small edge.
ICT capital service is thus during this time period more important than the input of all other capital service but together. This is a dramatic difference compared with the capital stock concept. The input of labour services is almost half as important as the capital service. Even if the quality has increased somewhat the quantity has not increased very much. And together they still cannot really match the total factor productivity, even if they are of the same magnitude. The intermediaries have as a whole developed quite parallel with gross output and consequently also with the value added. The service input has increased by a few per cent and the energy component has dropped substantially, or by around 20 per cent. But since the material input has had higher weights, especially in the beginning, its impact has been a little bigger.

### T22–3 The growth in production and value added 1993-2004 decomposed

<table>
<thead>
<tr>
<th></th>
<th>1993-2004</th>
<th>Value added 1993-2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth in output</td>
<td>3.91</td>
<td>Growth in output</td>
</tr>
<tr>
<td>ICT capital service</td>
<td>0.31</td>
<td>ICT capital service</td>
</tr>
<tr>
<td>Non ICT capital service</td>
<td>0.26</td>
<td>Non ICT capital service</td>
</tr>
<tr>
<td>Labour services</td>
<td>0.28</td>
<td>Labour services</td>
</tr>
<tr>
<td>Intermediate consumption</td>
<td>2.16</td>
<td>TFP</td>
</tr>
<tr>
<td>Energy input</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Material input</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Service input</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>TFP</td>
<td>0.89</td>
<td></td>
</tr>
</tbody>
</table>

A decomposition of the growth of the value added gives us a total factor productivity which grows by a full 2 percentage points per year. This factor therefore accounts for a little more than half of the growth. This means that a little less than half of the growth can be explained by the increase in the inputs of the labour services, the ICT-capital services and the non-ICT capital services. Their relative importance is of course the same as above, but in absolute terms much higher.

In this calculation the capital input is measured as capital services which, as shown above, have increased twice as fast as the capital stock. This will of course increase the importance of the capital as an input factor and thus in parallel diminish the unexplained part of the growth, the total factor productivity. One of the short cuts we have taken in this, our first attempt to calculate the capital service input, has been to not take into account the tax effects. This will of course bias our estimate downwards. That means that if this will be included in our next effort, the measurement of the capital input will thus be increased.

In our measurement of labour quality we have lifted the common restriction on the weights so that they are not constant during our estimation period. That choice has led to a less rapid development of the labour quality measurement. This is due to the decrease of the relative price of some of the more attractive subgroups.
The growth pattern over the years is for most variables influenced by cyclical as well as trend components. The cyclical pattern is very distinct for inputs of materials as well as for services, as could be expected. The cycle is defined here as the development of the gross production of the business sector. This is however not true for input of energy. Perhaps this is due to the fact that most of the energy input is used in just a handful of industries and that the developments of these industries are not synced with the general production fluctuations.

In this rather short time period there is also quite a distinctive trend in the total input of intermediates, caused by services. The relative weight of material inputs in total production has no trend, and the same is true for the energy input. This is true at least up to 2002, which is our last observation; now this can have changed. In contrast the importance of services has increased 20 to 25 per cent relative to the production. This is almost entirely due to the increase in their relative price, even if there also has been a slight increase in volume terms. If this was true it could be interpreted as an indication that the service society is not approaching very fast. It is just a question of increased relative price due to slow growth in productivity. However, a reservation for the lack of good price measurement for the majority of the service industries during most of this period, and for some for the whole period, must be made. So probably the volume development of services is underestimated and the price increase overestimated.

The constancy of the weight of energy input is a result of the strong trends with higher prices and lower volumes. This means that it has been possible for the enterprises to diminish their energy intensity as a response to increasing relative prices. This has not been possible for the services, so this can be seen as a clear sign of the increasing importance of services.

The input of labour services has, like the intermediate input, a strong cyclical pattern, but no trend. As in the energy case, these are two balancing factors with distinctive trends that
are hidden behind. The labour quality has a strong positive trend but quantitatively the trend is biased downwards.

The development of capital input has however a quite different pattern. There is an expansion of capital input from 1993 up to 2000 and then a contraction to 2003, our last observation. This is mainly caused by the ICT investment which has accounted for more than half of the capital service input during the whole period, but the proportion between non-ICT and ICT inputs has varied a lot. The increase in the ICT service input was much higher 2000–2001 and clearly lower 2002–2003, the years after the ICT crisis. This crisis has apparently not meant a decrease in the ICT capital input but a very distinctive slow down in the expansion rate. The expansion of the non-ICT capital service has been very stable but there was an acceleration during the first couple of years and a deceleration during the very last years.

There is still around one per cent of the yearly growth in production and two per cent in value added that is not accounted for, the total factor productivity. This is thought to be due to increased knowledge of different kinds together with new combinations and use of older knowledge. There should be a clear cyclical pattern in total factor productivity due to difference in capital utilisation and labour hoarding in different phases in the business cycle. This can also be found in our data, but the most interesting part is of course the other part, the level and the trend. The level is quite high internationally and probably distinctively much better than it could have been during the two previous decades, if it was measured. There is no trend even if the level that was achieved during the first two years after the big economic crisis 1991–93 has not been reached since.

The Sector Differences

When looking into the different sectors we see the largest contribution on average to growth in output from intermediate input in all sectors. Intermediate input is the factor with the highest weight in the model. Every percentage point of growth in intermediate input contributes with at least half a percentage point in output growth in all sectors.

The sector where the largest contribution to growth in output stems from capital input is the service sector. The contribution from non-ICT capital is larger than the contribution from ICT capital in the goods and the manufacturing sector. In the service sector and in the ICT sector the contribution from ICT capital is larger. The difference between non-ICT capital and ICT capital is in general small except in the ICT sector. In the ICT sector the effect of ICT capital is twice the effect of non-ICT capital.

Relative to the growth in output, the largest impact of labour services is seen in the service sector. However, the contribution from labour services is in general small. In both the goods and the service sector, the contribution of labour services is less than half of the capital services.

In all four sectors, half, or almost half, of the growth in production is explained by intermediate input. All sectors except the service sectors show a larger contribution from materials than from services. The contribution from material input to the growth in the goods sector is more than double the contribution from service input. Contrary to this is the service sector, where the contribution of service input is four times the input of materials.

When comparing the input of energy, both the service sector and the manufacturing sector display lower figures than the goods sector. This is explained by the fact that industries included
in goods but excluded in manufacturing have had higher weights for the energy input. These sectors include, above all, the electricity, gas and water works sector but also the construction industry, mining and quarrying and agriculture, forestry and fishing sectors. Overall, the contributions from energy input are very low on average and in many cases close to zero.

Total factor productivity plays an important role for the growth in gross production in all sectors except the service sector. In the business sector the contribution from TFP is, as mentioned earlier, 0.89 percentage points on average. This should be compared with the goods sector where the contribution from TFP is 1.38 percentage points on average and the manufacturing industry is at 1.74 percentage points. In the service sector the contribution from TFP is only one tenth of the growth in production. The largest contribution of TFP is seen in the ICT sector where TFP explains more than a third of the growth in production. On average the size of the ICT sector is about ten per cent of the total business sector. According to this, more than half of the growth in TFP in the total business sector at 0.89 per cent, stems from the ICT sector.

### T 22–4 Contribution to the growth in gross production by different factors

#### Goods sector

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<td>0.36</td>
<td>0.31</td>
<td>0.25</td>
<td>0.19</td>
<td>0.14</td>
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<td>0.09</td>
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<td>0.23</td>
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<td>3.44</td>
<td>3.11</td>
<td>5.06</td>
<td>0.34</td>
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<td>1.09</td>
<td>4.38</td>
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<td>1.62</td>
<td>1.17</td>
<td>2.26</td>
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### T 22–5 Contribution to the growth in gross production by different factors

#### Manufacturing Industry

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<td>6.50</td>
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<td>-0.76</td>
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<td>2.57</td>
<td>8.98</td>
<td>5.89</td>
<td>5.87</td>
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<td>0.68</td>
<td>0.63</td>
<td>0.57</td>
<td>0.50</td>
<td>0.39</td>
<td>0.29</td>
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<tr>
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<td>0.46</td>
<td>0.34</td>
<td>0.26</td>
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<td>0.09</td>
<td>0.06</td>
<td>-0.00</td>
<td>0.06</td>
<td>0.22</td>
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<td>0.19</td>
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<td>-0.02</td>
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<tr>
<td>Labour services</td>
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<td>Intermediate consumption</td>
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<td>0.03</td>
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<td>1.57</td>
<td>5.48</td>
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<td>3.58</td>
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<tr>
<td>E</td>
<td>-0.06</td>
<td>0.05</td>
<td>0.26</td>
<td>0.14</td>
<td>-0.00</td>
<td>-0.04</td>
<td>0.25</td>
<td>-0.08</td>
<td>-0.20</td>
<td>0.02</td>
<td>0.06</td>
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<td>0.04</td>
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<tr>
<td>M</td>
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<td>5.06</td>
<td>0.04</td>
<td>2.89</td>
<td>2.00</td>
<td>2.17</td>
<td>4.49</td>
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<td>1.09</td>
<td>3.80</td>
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<td>S</td>
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<td>1.60</td>
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<td>0.46</td>
<td>1.62</td>
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<tr>
<td>TFP</td>
<td>3.63</td>
<td>2.14</td>
<td>0.31</td>
<td>1.96</td>
<td>1.51</td>
<td>2.25</td>
<td>1.81</td>
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<td>1.53</td>
<td>3.12</td>
<td>1.61</td>
<td>1.74</td>
</tr>
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</table>
Turning to the growth in value added the average contributions of factor inputs to the growth are displayed in graph 22–5. The weight of the intermediate input relative to capital and labour differs between the service industry and the other industries, with manufacturing having the largest share of 69 per cent, followed by the ICT sector and the goods sector at 66 and 64 per cent respectively. The service sector has a substantially smaller share of intermediate inputs, only 44 per cent. This gives the total business sector a share of intermediate input of 55 per cent. Eliminating the effects of growth in intermediates by decomposing the value added instead of the gross production results in a similar picture as described earlier. However, all the factor inputs increase proportionally as does TFP. The magnitude of this difference is proportionate to the share of the intermediate input in each sector. The higher estimate of TFP for value added relative to TFP for gross production is thus largest in the manufacturing industry. However, the overall largest contribution of TFP, by far, is recorded in the ICT sector.
sector where the growth rises from 5.03 to 13.8 percentage points. The growth in TFP in the ICT sector is more than double the growth in the second ranked sector.

![Graph 22–4]

**Average contribution by factors to the growth in value added 1994–2004**

**Effects on Labour Productivity**

Table 22–8 shows the growth rates in gross production and the growth rates in average labour productivity, ALP, in the total business sector. The growth rate in ALP is calculated by subtracting the growth rate of hours worked from the growth rate of output. Further, the growth rate of ALP is decomposed in the table by the contributions from capital deepening, labour quality, intermediate input per hour worked and TFP.

This decomposition shows that intermediate input per hour worked is the largest contributor to the growth in labour productivity by 1.72 per cent. The contribution from capital deepening by 0.38 percentage points is almost a tenth of the growth in total output. The main part of that stems from ICT capital which contributes almost three times that of non-ICT capital. Substitution towards labour with higher marginal productivity has contributed by 0.09 per cent per year. Average TFP growth rate is 0.89 per cent. The highest TFP rates appear in the beginning of the period, 1994 and 1995. Also in the last part of the period, 2002 to 2004, the TFP growth is higher than average. This period recognising firms reducing their working staff and trimming their organizations.

Graph 22–5 presents an overview of the decomposition of average labour productivity, ALP, for all the sectors. Overall, contributions from TFP and intermediate input of materials and services explain the main part, on average, of the growth in ALP for just about all sectors. The contribution from capital deepening is larger than the contribution from labour quality.
Contribution to the growth in labour productivity by the Business sector by different factors

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<td>4.75</td>
<td>5.62</td>
<td>6.57</td>
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<td>4.40</td>
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<tr>
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<td>3.68</td>
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<td>0.33</td>
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<tr>
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<td>0.44</td>
<td>0.58</td>
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<td>-0.18</td>
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<td>0.17</td>
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<td>0.36</td>
<td>0.10</td>
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<td>0.96</td>
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<td>1.03</td>
<td>1.24</td>
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Average contribution by factors to the growth in labour productivity 1994–2002

Conclusions

As has already been underlined, the objective of this study is to improve the measurement of economic growth in the Swedish business sector by growth accounting experiments. But it is important to remember that the growth accounting methodology is just a technique to decompose the growth and that it cannot answer the question of why the growth was high or low or what caused it. Nevertheless, it gives valuable data for further analysis of these important questions.
In this experiment we have focused on three methodological concepts. We have decomposed the gross output of the business sector instead of the value added, used capital service instead of capital stock as capital input and allowed for variable weights for different categories of the labour service input.

The analyses of input of intermediates give us the insight that they are very important for the growth in gross production, and their importance has grown over the years. This is caused by the service input that has increased slightly in volume but more strongly in price terms. The increase in relative price for the intermediate input of energy has in contrast been balanced by a very substantial decrease in its relative volume. This is true for the service sector as well as for the goods sector, and that sector’s dominant part, the manufacturing industry. This means that the material input into the manufacturing sector has neither increased during the period 1993–2002 in value terms, nor in volume terms.

The change of measuring the input of capital from capital stock to capital services has increased the importance of capital inputs, since capital services have increased twice as fast as the capital stock. This is primarily due to the ICT investments that have increased dramatically in importance during this period, accounting for just over half of the capital services for the whole period. Both high depreciation rates and low or negative price increases lie behind the high cost of ICT capital services. But also the capital service input of the non-ICT machinery has increased quite substantially. And it is of course the capital services of buildings and interiors that has balanced this by almost dramatically decreased importance. All these developments have also lead to an almost continuous capital deepening during our studied time period.

Instead of using constant value weight for the different categories of labour and allowing for changing weights over time, the growth of the input of labour services has been lower. This is due to that most categories of qualified labour have decreased their relative prices, caused by a considerable increase in their supply.

The OECD is publishing TFP measurement of many of the OECD-countries on their website. These TFP measurements are in value added terms for the whole economy including the public sector. A very rough translation of our results into value added for the whole economy, that is GDP, give on average very similar results to the OECD data. But the time profile differs somewhat since the OECD-figures have a marked higher growth rate the last years and lower the first years. In the OECD material the Swedish TFP performance is above average, but not in any way extreme.
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