National Institute of Economic Research [NIER]
Research Department (Model group)
2001-03-07

GROWTH ACCOUNTING AND THE BUSINESS CYCLE FOR THE PRIVATE BUSINESS SECTORS OF THE SWEDISH ECONOMY (1963 – 1999)

Bharat Barot
Petter Lundvik
National Institute of economic research
Box 3116 S-10362 Stockholm

The views expressed are those of the authors and do not necessarily reflect those of the National Institute. We would like to thank Karl Gustav Hansson and Michael Wolf from Statistics Sweden for helping us with the national accounts. Alfred Kanis from Stockholm's University and Hans-Martin Krolzig from Nuffield College for comments and constructive suggestions. In particular I would like to thank Michael Andersson other colleagues at NIER. Any results, opinions and errors are those of the authors alone.

Contents

Abstract

This paper is concerned with the nature of economic growth in the nine sectors of private business in the Swedish economy for the sample period 1963-1999. The results of the study indicate that there is substantial heterogeneity (across both sectors and time) in rates of value-added, hours worked, labour productivity and Total Factor Productivity (TFP) during the sample period. The decline in value-added in the private business sector, when measured with constant prices during the sample period is associated with significant changes in the relative size of individual sectors.

The growth accounting exercise for six different sub periods reveals a decline in TFP after (1960-1969) i.e. the end of the postwar "golden era" due to two oil shocks from 1973-1979.
In the 1980s TFP accelerated but only to slowdown again at the beginning of the 1990s. After the first half of 1990s, TFP increased for the manufacturing, wholesale and retail trade, banking, goods and service producing sectors and the private business sector. While TFP has accelerated during the second half of the 1990s due to the recovery from the recession of the early 1990s, it is unclear to what extent this change is primarily cyclical or structural. Separating cycle from trend is always difficult in the midst of an expansion, and it is particularly challenging now because the current expansion is tending to conform to cyclical norms.

For the sake of comparison with the real business cycle literature we use the standard practice of taking logs and Hodrick-Prescott filtering the data. Cross correlations of detrended output, hours, investment and TFP at different leads and lags indicate that TFP leads investment, and hours worked and TFP and GDP for all the sectors is procyclical. Hence the decomposition of TFP into trend and cyclical component gives reasonable results.

Chow tests with a dynamic specification of TFP growth rates for the private business sectors of the economy indicates structural breaks for agriculture and construction in 1973, 1980, 1986 1987, and 1988 for electricity and construction in 1992, and for the banking real estate and other businesses, manufacturing, and community services in 1993. Granger causality tests indicate that TFP in the banking and real estate sector Granger causes TFP in the agriculture, manufacturing, and transport sectors. Simple cross correlations indicate that TFP, hours worked and the share going to capital are procyclical while capital stocks and the share going to labour are countercyclical.

KEYWORDS: *growth accounting, labour productivity, Total Factor Prodictivity, growth dynamics , granger causality, stability, crosses correlations*.

1 Introduction

There has been a debate about the economic causes and consequences of technological progress over the last decade. The so called sectors of the *new economy* are concentrated in the field of information technologies and telecommunication and the links between technology and productivity have been scrutinised by a number of recent OECD studies

The term ”*new economy*” has been used extensively to describe the working of the US economy, and in particular the part of its economy that is linked to information and communications technology. It reflects a view that something has changed and that the economy now works differently than it did in the recent past. The so-called *new economy* has been characterized in the following ways: (1) The new economy leads to a rise in the trend rate of economic growth. Hence the increase in trend growth would come from higher productivity growth, which would be due to more efficient business practices as a result of greater information and communcation technology (ICT) use. In addition, falling prices in certain parts of the economy would limit inflationary pressures and thus enable strong growth over prolonged periods. (2) The *new economy* dampens the business cycle[1]. Proponents of this view argue that ICT, in combination with globalisation, has led to a lower NAIRU (non-accelerating inflation rate of unemployment). This implies that the economy can expand for a longer period without inflationary pressures emerging. According to this view, ICT is putting downward pressures on prices, while greater global competition is keeping wages in check. (3) The sources of growth are different in the new economy. This view suggests that certain sources of growth are now more important than they were in the past and that certain parts of the economy benefit from increasing returns to scale, network effects and externalities.[2].

The internal adaptation of a society to growth potentials afforded by the stock of knowledge has been the chief concern of economic theory concerning the problems of growth. It is in this area that the discipline of economic analysis has made its greatest contribution. The magnitude of technological change can be assessed either by estimating the increase in output attributable to modern input or by measuring the growth in the use of modern input themselves.

Is growth ultimately attributable to the accumulation of capital or to the accumulation of knowledge (technological progress) ? It is commonly argued that while both of these forces contribute positively to growth in the short run, only the rate of technological progress matters in the long run. Hence capital accumulation at best plays a positive role, supporting, the levels of output, not its rate of growth. Although the growth rate of an economy's output will ultimately be the same as that of the capital stock, the ultimate driving force determining both growth rates is technological progress. Why does the source of growth matter? The neoclassical growth model, with its main assumption of diminishing returns in physical capital provides the answer. If this assumption is correct - and the large empirical growth literature tends to support it - capital accumulation cannot sustain long - term growth while Total Factor Productivity[3] (TFP) can, see (Senhadji 1999).

---

[1] The new economic paradigm by no means implies the end of the business cycles.
[2] See forth coming OECD report for details. A new economy?- The role of innovation and information technology in recent OECD economic growth. See DST\IND\STP\ICCP(2000) 1\REV1
[3] Often even called Multifactor Productivity Growth.

A number of economic hypothesis can often be advanced for the changing fortunes of the different sectors of the Swedish economy during the period of the study (including for example, oil price crisis 1974 and 1979, macroeconomic policy, changes in the exchange rate 1992, deregulation of the financial market 1985 and the Tax Reform of the year 1991).

Neverthless, these hypotheses often pay insufficient regard to the interesting variation in economic performance across different sectors of the private business sectors. A first step in the formulation of testing such hypotheses must be a detailed understanding of the nature of economic growth at a disaggregated level between the different sectors of the Swedish economy. It is just such an understanding that the present study seeks to facilitate. We deliberately step back from framing economic hypothesis in order to characterize the raw data that such hypotheses must explain. Hence this study remains mainly *data based*[4] but also *theory based* (on the endogenous growth theory[5]) on the interepretation of the empirical results obtained from the study.

Through national income accounts concepts, economies affect the measurement of data variables, and theory models influence the choice of the data to examine and the classes of models and functional forms to use, as well as suggesting what parameterisation is of interest. Conversely, a major objective of a study in economics may be to test the validity of some theoretical propositions. See Hendry (1993).

1.1 Aim and scope of the paper

International studies on growth accounting were presented in studies by Solow (1957), Kendick (1961), Denison (1962), Jorgenson and Griliches (1967). Griliches (1997) study is seminal because it provides an overview of the intellectual history with particular emphasis on the development of the Solow residual.

A considerable literature already exists on output and productivity growth across industries. Recent examples include Jorgenson (1988) for the United States, Cameron (1997) and Bean and Crafts (1996), Oulton and O'Mahony (1994) for the United Kingdom; and Bernard and Jones (1996a,b) for cross-country studies.

In the Swedish context a few studies regarding growth accounting are included in the Expert report no.3 to the produktivitetsdelegationen (1991). They include four interesting papers respectively by Bentzel, Walfridson and Hjalmarsson, Hansen and finally Anxo and Sterner. These were followed by the Bergman and Hultz study (1993) on the analysis of TFP that scrutnizes the manufacturing sector. Other studies in this area are Swedberg (1999) which gives an overview of the empirical work in this area and finally a recent set of studies included in Swedish economic policy review (2000). NIER publishes estimates and forecasts of TFP for the industrial and business sectors of the economy in almost every report published.

---

4 Data-driven approaches imply that models are developed just to describe the data. However in this study we merge inference from data with guidelines from economic theory.

5 An important step in the theory of economic growth has been the development of models that endogenise the process of technological progress. These models not only have the potential for accommodating the stylised facts of growth but also provide more realistic mechanisms for technological progress. See Mankiw (1995), Romer (1986). Romer was very much a catalyst for much of the endogenous growth theory as he suggested a mechanism to counteract diminishing returns to capital.

1.2 The main objectives of the study

Given that much of the theoretical and empirical attention in the 1999's has been on the performance of *countries*, with a respectable amount of work devoted to the performance of *firms*, it is not surprising that *industry* level studies have been slightly neglected. This paper analyses the productivity performance of nine business sectors of the Swedish economy and conducts the traditional growth accounting exercise. The business sectors of the Swedish economy that are under scrutinization (with sector notation numbers within parenthesis) are: Agriculture hunting, forestry and fishing (1000)[6], Mining and quarrying (2000), Manufacturing (3000), Electricity, gas and water (4000), Construction (5000), Wholesale and retail trade, restaurants and hotels (6000), Transport, storage and communcation (7000), Finance, insurance, real estate and business services (8000) and finally Community, social and personal services (9000). We decompose TFP, hours worked, investment and output using the standard practice of taking logs and Hodrick-Prescott (HP) filtering data for the business sectors of the Swedish economy. We then calculate the standard deviation of all relevant variables as well as cross correlation of the detrended data set at varying leads and lags.

The accounting exercise is viewed as a preliminary step for the analysis of fundamental determinants of growth. The final step involves the relations of factor growth rates, factor shares, and technological change (the residual) to elements such as government policies, household preferences, natural resources, initial level of physical and human capital etc. We refrain from this aspect in this study.

Hence the growth accounting exercise can be particularly useful if the fundamental determinants that matter for factor growth rates are substantially independent from those that matter for technological change.

The complementary objective interrelated to this study is to identify the sectors which can be incorporated into the new annual model *MICMAC* built by the model group in the research department at NIER. This will hopefully enable us to build the supply side to *MICMAC* and hence lead to the required dissaggregation of *MICMAC*.

The contribution of the present paper lies in the disaggregated data set containing annual information for the period 1963 – 1999, and in the application of several analytical tools to the growth accounting exercise results. In addition such an extensive growth accounting exercise has not been carried out for the private business sectors of the Swedish economy.

This study is organised in the following sections. Section 2 presents the framework of growth accounting and the Cobb-Douglas production function, which is so central to the decomposition of output growth into contribution from physical capital, labour and productivity. In Section 3 we present the data and outline some problems in measuring the output and productivity. In Annex A we report the data definations and sources of the data set. Section 4.1 presents the results with respect to the share of value added in total value added. Section 4.2 presents the growth dynamics with respect to value added that reflect the dynamics of growth for the private business sectors of the economy. In section 4.3, we present results with respect to the simplest measures of labour productivity, i.e. value added per hour

[6] The new notation for sector 1000 = 01-05, 2000 = 10-14, 3000 = 15-37, 4000 = 40-41, 5000 = 45, 6000 = 50-52 plus 55, 7000 = 6064, 8000 = 65-67 plus 70-74 plus 71-74, 8000 = 80-85 plus 90-95.

worked cross sectors of the economy. Two alternative measures of the rates of productivity growth are then considered: labour productivity and (TFP). With regard to the second of these measures, growth accounting techniques that follow Solow are used to decompose the rate of growth of value-added into the contributions of physical capital accumulation, increased labour input, and a residual**,** TFP growth. The same decomposition may then be used to evaluate the contribution of capital accumulation and TFP growth to labour productivity growth, so that the two measures of productivity growth, may be explicitly related to one another. We compare the results of our study with other Swedish and International empirical studies. Section 5, presents results of growth accounting exercises for the business sectors of the Swedish economy for the sub-sample periods 1963-1970, 1970-1980, 1980-1990, 1990-1999, 1994-1999 and 1963-1999, and discusses the productivity acceleration respective slowdown for TFP growth rate. Section 5.1 describes testing for structural breaks in the dynamic equation specified for TFP growth rate. In section 5.2 we test for Granger causality both for whether the TFP growth rate in one of the sectors Granger causes TFP in another sector and if TFP growth rate causes investment growth rate or vice versa. In section 6 we present the description of the business cycle with respect to cross correlation and the decomposition of the level of TFP into a trend and a cyclical component using a Hodrik Prescotts (HP) filter. Cross correlations and standard deviation of the cyclical components of TFP, value-added, hours worked, and investment for the private business sectors of the Swedish economy using leads and lags are also presented. Section 7 concludes the main results of this study.

2. Theoretical framework

A production function is a relation between the inputs in a production process and its output. This relation can be based on both micro and macro considerations as in the case of a production function relating to a firm and to an industrial sector, respectively. Assume the representative 'neoclassical' aggregate production function for the Swedish economy takes the following functional form[7]:

$$Y = Y(K, L) \qquad [1]$$

Thus the rate of growth of national output over time must be due, to the growth of inputs.

$$\textit{Let} \quad \dot{Y} = \frac{dY}{dt} \quad \dot{K} = \frac{dK}{dt} \quad \dot{L} = \frac{dL}{dt} \qquad [2]$$

Then differentiating the production function with respect to time, yields

$$\dot{Y} = Y_K \dot{K} + Y_K \dot{L} \qquad [3]$$

$$\textit{Hence} \quad \frac{\dot{Y}}{Y} = Y_K \frac{K}{Y}\frac{\dot{K}}{K} + Y_L \frac{L}{Y}\frac{\dot{L}}{L} \qquad [4]$$

[7] See Layard and Walters (1978).

Thus the rate of growth of output is a weighted average of the rate of growth of the inputs. The weights are the elasticities of output with respect to each input, which in competitive conditions are measured by their factor shares.

In the later 1950's there developed a "*growth accounting*" concept in which this formula was applied to explain the long-term growth of the U.S. economy.

The simplest concept of technical change is to suppose that it increases the output from given inputs without in any way affecting the way the inputs interact. Hence the production function for period t then becomes

$$Y_t = A(t)\,\mathrm{f}\,(K_t, L_t) \qquad [6]$$

$$\frac{\dot{Y}}{Y} = f(\mathrm{Kt}, \mathrm{Lt})\frac{\dot{A}}{Y} + Af_K\frac{K}{Y}\frac{\dot{K}}{K} + Af_L\frac{L}{Y}\frac{\dot{L}}{L} \qquad [7]$$

$$= \frac{\dot{A}}{A} + Y_K\frac{K}{Y}\frac{\dot{K}}{K} + Y_L\frac{L}{Y}\frac{\dot{L}}{L} \qquad [8]$$

The residual[8] is now simply the rate of growth of *A*, or, if you like, the rate of growth of the economy's efficiency parameter. It is called the growth in "*total factor productivity*". TFP growth is defined here as that portion of real output growth, which is not accounted for by increase in inputs of labour and capital, the two most fundamental factors of production. TFP growth is a measure of the gains in the efficiency of production, i.e. over the medium and longer term it can be taken as a measure of technological progress, but over the shorter periods it can also be affected by other factors as managerial efficiency, capacity utilisation, work habits and weather (Solow, 1957). Note that this decomposition, though informative, yields no conclusion about causality: for example, even if capital accumulation is ultimately induced by increases in TFP.

3 *Data*

The annual data used in this study covers the private business sector of the Swedish economy for the sample period 1963–1999, and has been collected from several Statistics Sweden. publications. The variables used in this study are the sum of total wages, employers contribution to social security, hoursworked, value added both at producer and factor prices. The variables are in current and constant prices. The measurement of capital K_t is based on a perpetual inventory stock calculation method. See Annex A for detailed data definations and sources.

[8] Measuring technology has always been one of the most perplexing problems facing empirical economics. One tradition, epitomised by Solow (1957), is to measure technology as a residual from a production function. The problem is that the residual, no matter how cleverly constructed, is rather like a statistical dust bin holding a lot of trash as well as a few nuggets of gold. See Bloom and Reenen WP 00/2.

There are problems in measuring output and productivity. Achieving a suitable measure of services output over time is complicated by two factors: The first factor is that market prices may not be observable for publicly provided services and the second factor, is that it may be difficult to identify precisely what constitutes the services activity and to account for quality changes. It is necessary to identify whether the output consists of the transaction performed or the outcome from the services. For example, should teaching output be measured by the numbers of teaching hours or by the results achieved by students. In the first case, productivity growth is zero by definition. In the second case productivity rises when students improve their marks, see OECD (1996).

4 Presentation of the results

4.1 Share of value-added in total value-added

The growth of the Swedish economy (1950–1999) and the accompanying structural changes are usually results of productivity increases in the economy that can be easily computed by the ratio of the share of value-added from the sectors 1000 to 9000 to the total value added in current prices. The results are presented in Table 1.

Table 1 Structural changes: according to the share of value added per sector in total value added in percentage changes at annual rate

Sectors	**Periods**				
	(1950 – 1959)	**(1960 –1969)**	**(1970-979)**	**(1980-1990)***	**(1990 –1999) ***
1000	11%	7%	5%	5%	3%
2000	2%	1%	1%	1%	1%
3000	34%	34%	34%	29%	35%
4000	2%	3%	3%	4%	3%
5000	11%	13%	11%	8%	7%
6000	12%	13%	16%	13%	11%
7000	8%	8%	9%	12%	11%
8000	15%	16%	15%	25%	26%
9000	4%	5%	6%	3%	3%
Sum	**100%**	**100%**	**100%**	**100%**	**100%**

Note: * denotes the new national accounts. The shares have been calculated in current prices as the ratio of each sector value added to the sum of value added by all the sectors.

The major shifts in the structure of the Swedish economy have been in both the Agriculture hunting forestry and fishing (1000) and banking, real estate and other business (8000). The share in total value added for the Agriculture sector has declined by more than 50%, while the decline in the mining sector is marginal, and relatively stable. There has been a marginal increase in manufacturing which is an important sector of the Swedish economy. The share of the sector electricity, gas and water (4000) has been fairly stable. The share of the construction (5000) sector has declined by 4%. Wholesale and retail trade, restaurants and hotels (6000), transport, storage and communication (7000) have been rather stable. The sector 8000 has increased dramatically from 15% to 26% in the last sub-periods of the study. This is one way to analyse structural changes in the Swedish economy.

4.2 Growth rates in Value-added

In Table 2, we present the growth rates in value-added of the different private business sectors for the sub-periods 1950-1959, 1960-1969, 1970-1979, 1980-1989, 1990-1999 and finally 1994-1999. The growth rates in constant price gives us the growth dynamics for the private business sectors for the different sub-periods. As it is clear from Table 2, that there were considerable variations in rates of growth of value-added. By scrutinising the growth rates for the 1950s and 1960s sub-periods, we note that almost all of the sectors experienced positive growth rates with the exception of the agriculture sector. Electricity, gas and the manufacturing sector enjoyed the highest annul rates of growth (7.9% and 6.5% respectively), with agriculture and private community services experiencing the slowest (-0.5% and 1.1% respectively). The Swedish economy was in the golden age of growth during this period. During the 1970s there was deceleration in the growth rates in almost all the sectors of the economy. This was perhaps mainly due to the 1974 oil price crisis.

During the 1980s growth rates in value-added started accelerating once again because of stable oil prices. In the beginning of the 1990s the Swedish economy experienced the severest of recessions. Between 1991-1993 GDP fell by more than 5%, unemployment rose to 12% (including those enrolled in various market programs), asset prices fell dramatically and residential activity came virtually to a standstill. This aggregated picture of the economy is partly reflected in the disaggregated picture for the sectors. Since the mid 1994s the Swedish economy has once again enjoyed high growth rates, but they are not as high as in the golden age of the 1950s and 1960s.

Table 2 Growth rates in value added for the business sector (percentage changes at annual rate)

Periods	**Sectors**									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	**Agg**
1950-59	-0.5	4.6	3.7	6.2	3.8	3.5	3.3	4.1	1.4	**3.3**
1960-69	0.8	7.1	6.5	7.9	5.1	4.3	5.1	3.8	1.1	**4.6**
1970-79	-0.1	-0.5	1.9	6.5	0.7	2.1	4.1	2.4	1.6	**2.1**
1980-89*	2.1	-0.5	2.1	4.7	1.9	2.7	3.3	2.8	1.8	**2.5**
1990-99*	0.1	1.7	3.5	0.2	-1.5	3.1	1.5	2.3	2.7	**2.2**
1994-99*	0.7	3.5	7.2	0.3	0.5	5.3	4.5	2.6	5.3	**4.2**
1963-1999	**0.6**	**1.5**	**3.2**	**4.3**	**1.4**	**3.0**	**3.3**	**2.8**	**1.8**	**2.9**

Note :* denotes the new national accounts. The averages are the means of the percentage changes in value added (growth rates) for the sectors for the respective sub-periods. In the last column Agg denotes the private business sector (aggregation of all the nine sectors of private business sector of the economy).

4.3 Labour productivity growth

By combining rates of growth of value-added and rates of growth of hours worked, one obtains information about the first and simplest of our measures of productivity growth i.e. labour productivity defined by the rate of growth of value-added per hour worked (shown in Table 3). This measure of productivity growth has the advantage of imposing no theoretical restrictions on the data. However, it suffers the disadvantage of being the measure of the productivity of only one factor of production. In contrast the second measure of productivity, TFP[9], evaluates the efficiency with which all factors of production are employed.

As it is clear from Table 3, there are considerable variations in the rates of labour productivity across the private business sector of the Swedish economy. Despite the decline in the overall size of the agriculture and mining sectors and an increase in manufacturing and banking real estate and other business, the nine sectors experienced positive growth rates in labour productivity with the exception of community, social and personal service.

Table 3 Labour productivity growth (1960-1999). (Percentage changes at annual rates)

Periods	**Sectors**									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	AGG
	Y/L	*Y/L*	*Y/L*	*Y/L*	*Y/L*	*Y/L*	*Y/L*	*Y/L*	*Y/L*	*Y/L*
1960-69	7.9	10.3	7.5	7.4	5.1	4.5	4.5	0.6	0.7	**6.0**
1970-79	4.1	1.8	4.1	6.2	3.8	2.8	4.5	1.5	1.6	**3.9**
1980-89*	5.2	2.6	2.6	4.5	1.2	2.4	1.7	0.4	-0.2	**2.4**
1990-99*	2.7	5.2	4.4	1.4	1.4	3.4	1.4	2.1	-0.8	**2.9**
1994-99*	2.8	5.5	4.9	2.3	0.9	4.1	3.5	0.6	1.5	**2.9**
1960-1999	**4.9**	**4.8**	**4.6**	**4.8**	**2.8**	**3.3**	**3.0**	**0.4**	**3.7**	

Notes: Y/L denotes Labour productivity growth measured by the rate of growth of value added per hour worked. * Denotes the new national accounts. Agg denotes the private business sector.

Looking at Table 3 we once again see that during 1960s sub-sample period's labour productivity was high for all the sectors with the exception of banking, real estate and other businesses and community services. The average growth rate for the private business sector has been 6.0%. The mining and manufacturing sectors enjoyed the highest annul rates of labour productivity growth (10.3% and 7.5% respectively), with banking real-estate and other businesses and private community services experiencing the slowest (0.6% and 0.7% respectively).

Labour productivity has declined gradually both for the total private business sector and each individual sectors since the 1960s. During the 1970s there was a fall in labour productivity for both the individual and aggregated business sector of the Swedish economy. This "productivity slowdown" of the 1970s continued in the eighties for all the sectors with the exception of the agriculture and the mining sectors. The growth of labour productivity rebounded 1994-1999, as we see that the Swedish economy has been under a period of economic boom. For labour productivity, the recovery during the 1990s was so strong within the manufacturing sector that during 1994-1999 period, Sweden had recovered the productivity losses since 1980. Neverthless this does not apply to all other sectors. All sectors experienced a fall in hours worked, but again there were substantial variations across sectors. The value-added for most of the sectors was growing faster than hours worked.

According to the computations of labour productivity growth measured by the rate of growth of value added per hour worked has declined rapidly over the different sub-periods and is on the increase over the last sub-period (1990-1999), for mining, manufacturing, construction, wholesale retail and hotels, and the financial institutions, real estate and other businesses.

[9] For details on the link between labour productivity and Total factor productivity, see Cameron et al [1997].

Comparing our results with Lindbeck (2000) with respect to labour productivity for the manufacturing sector for the sub-sample periods (1960-1970), (1970-1980), (1980-1990), and (1990-1998) we get the following results.

Table 3.1 Comparison of labour productivity for the manufacturing sector (Percentage changes at annual rates)

Studies	Years			
	(1960-1970)	**(1970-1980)**	**(1980-1990)**	**(1990-1998)**
Lindbeck	6.7	3.4	2.5	5.0
Barot&Lundvik	7.5	3.8	2.5	4.5

Note: The results are in line with the only reservation that Barot and Lundvik use final figures from Statistics Sweden, while Lindbeck uses the data from the old national accounts.

In order to facilitate comparisons of our results the with OECD's Minilink model for labour productivity estimates for USA, Japan, European Union and OECD for the sub-sample periods (1961-1970), (1971-1980), (1981-1990 and finally (1991-1995), are presented in Table 3.2.

Table 3.2 Labour productivity in the private business sector (Percentage changes at annual rates)

Countries	Years			
	1961-1970	**1971-1980**	**1981-1990**	**1991-1995**
USA	2.6	0.9	1.1	0.6
Japan	9.2	3.7	2.9	0.7
European Union	5.4	3.1	2.2	1.5
OECD	4.8	2.3	1.8	1.0
Sweden*	5.7	3.9	2.4	2.9

Notes: OECD *Economic outlook* 60. * Indicates the calculations of this study.

Looking at Table 3.2 we once again see that during 1960s sub-sample period labour productivity was high for all the countries. There was a deceleration in it during the 1970s and 1980s and a rise in it merely for Sweden during the 1990s.

In order to assess the impact of labour and capital in output and productivity growth rates, proper account should be made of the role that each factor plays as input in the production process. In the case of labour input, the simple count of hours worked is only a crude approximation since workers show great differences in education, experience, sector of activity and other attributes that greatly affect their marginal productivity. In particular, a measure of labour input in efficiency units can be obtained by weighting types of labour by their marginal contribution to the production activity in which they are employed. Since these productivity measures are generally not observable, information on relative wages by characteristics is used to derive the required weights to aggregate types of labour. The resulting measure of labour input can be quite different from a simple aggregate of total hours to total persons (Dean et al., 1996). Hence the difference between the weighted and unweighted series yields an index for the compositional change of labour input, or its quality.

In this study we have used hours worked. With respect to labour productivity for the Swedish economy it is better to have another measure i.e. GDP per person of working age (15-64). See Lindbeck (2000) for details.

5 Results from Growth accounting

The main techniques to examine aggregate economic growth are growth accounting exercises and cross-country growth regressions. Growth accounting[10] exercise have a long tradition, seminal calculations were made as early as in the 1950s (e.g. Solow, 1957). Cross-country growth regressions are a more recent avenue of research significantly by the developments of databases by Summers and Heston (see Summers and Heston, 1991) and seminal work by Barro and Sala-Martin (1991).

The most straightforward approach is to apply time-series data for labour and capital to a Cobb-Douglas production function with constant returns to scale. Then the difference between growth of output implied by this calculation and the actual growth is the unexplained component. The Cobb-Douglas production function is convenient because the required parameters, the partial output elasticities of capital and labour (assuming perfect competition), are easily calculated by taking average income shares over the time period in question. A variant of this approach is to assume that the shares in output change over time, based on observation of long-term trends. A more sophisticated approach is to regress output against a production factor, typically with the addition of a time-trend. The estimated time-trend, plus the residual from the regression then represent the Solow residual (see OECD, 2000a).

In contemporary research on estimation of production functions, error correction methods (ECM) are often used. The Cobb-Douglas production function can either be estimated with the first difference of logs. One drawback of this procedure, however, is that it results in a loss of "long-run information" in the data. In light of these issues, the production function can be estimated in levels. One can also combine differences (short run dynamics) with levels (the long-run) using an ECM model.

The approach we adapt to approximate the Cobb-Douglas function is original because it accommodates time varying shares going to the factors of production. Our approach for the calculation of the Solow residual as a time series is outlined below.

Following Solow (1957), suppose that the value-added in an individual sector of the business sector j , where j = 1, …9, is produced with the following neoclassical production function,

$$Y_{j,t} ? A_{j,t} L_{j,t}^{? \, j,t} K_{j,t}^{1?? \, j,t} \qquad [10]$$

where Y_{jt} is value-added from sector j at time t, L_{jt} is hoursworked from sector j at time t, $K_{j\,t}$ is the stock of capital from sector j at time t, and finally $A_{j\,t}$ is TFP for sector j at time t. This equation may be expressed more conveniently in logarithmic form as:

[10] There is a dual approach to growth accounting, whereby the Solow residual is computed from growth rates of factor prices, rather than factor quantities. This idea goes back at least to Jorgenson & Griliches (1967). See Barro (1998) for details.

$$\ln (Y_{j,t}) = \ln (A_{j,t}) + ?_{j,t} \ln (L_{j,t}) + \ln (K_{j,t}) (1 - ?_{j,t}) \qquad [11]$$

The properties of the Cobb-Douglas production fuction are quite well known. ? and (1 - ?) measure the elasticities of output with respect to labour and capital. The sum of ? and (1 - ?) gives information about returns to scale, i.e. the response of output to a proportionate change in the inputs. If there are constant returns to scale doubling the inputs will double the output.

Differentiating totally both sides of equation [11] yields:

$$\hat{y}_{jt} \; ? \; \hat{a}_{jt} \; ? \; ?_{jt} \, \hat{l}_{jt} \; ? \; (1 \, ? \, ?_{jt}) \, \hat{k}_{jt} \qquad [12]$$

where $?_{jt}$ is the ratio of the total wage plus employers contribution to social security, to value added at factor values for sector j at time t, (i.e. the share going to labour) and (1- $?_{jt}$) is the share going to capital for sector j at time t. The lowercase variables with a "hat" correspond to the growth rate of the uppercase variables described in equation (10). Using equation [12], we calculate the growth rates for TFP for the private business sectors. We present the results of the growth accounting exercise in Tables 4.1 to Table 4.12 in Annex B, in percentages changes in annual rates.

From the decomposition of growth rates of the private business sectors of the Swedish economy for the different sub periods one notices that after a decade of high productivity growth in 1960's, we observe a significant slowdown of productivity growth in the 1970's following the first oil shock in 1973 for all the sectors of the private business sector with the exception of electricity and gas, wholesale / retail and restaurants, banking, real estate and other business sector. The private business, the goods and service producing sectors all display a dramatic decline respectively both in growth rates in value-added and TFP.

One of the most likely explanations of the slowdown of productivity growth is the oil price shock that we observed in the 1970s, especially 1974 and 1979. The increases in the price of imported raw materials lead to lower value added and GDP for any given quantity of capital and labour, so it's not surprising that sharp increases in oil prices were associated with the productivity decline. For the 1970s, most of the sectors with the exception of electricity & gas and construction sectors were below their averages.

One notices that in the 1980's when oil prices were stable or even declining, productivity growth picked up. Sweden experienced a period of boom in 1980, 1984, and 1987-1989. During the end of 1990s the Swedish economy was overheated due to a boom, and there was a shortage of labour. During the first half of 1990's the Swedish economy began to slide into recession. First, interest rates escalated due to a rising budget deficit, then the rising unemployment signalled greater uncertainty about the future, and brought a radical decline in GDP. However, since 1996 there has been acceleration in the sectors of the Swedish economy.

It is implausible that negative TFP growth estimates for agriculture, mining, wholesale retail and hotels and banking real estate and community services sectors reflect technological regress. There are a number of problems in measuring the capital stock (see, for example, Muellbauer 1991), and these negative estimates for TFP growth may reflect measurement error. However, as argued earlier, it is important to realise that TFP growth is essentially a residual. Once one recognises this fact, negative TFP growth estimates for certain time periods and industries actually become quite plausible.

In addition, the new national accounts were introduced in May 1999 and hence new data were produced for the years 1993-1999. These new data brings new grounds to argue that we had entered in a new era of sustained productivity growth; and hence one heard a lot of talk about a "New Economy" where a "New Paradigm" of high growth and low inflation holds. Taking a look at the period 1994-1999 and calculating the TFP growth rates for the private business sector to be 3.1%, goods producing sectors to be 5.0% and finally the aggregated service sector to be 2.4% respectively.

The International comparisons are affected by the on going transition from the 1968 System of National Accounts (SNA68) to the 1993 System of National Accounts (SNA93), developed under the auspices of the United Nations, and from the 1979 European System of National Accounts (ESA79) to the 1995 system (ESA95). According to Gust et. al (2000) the switch to the new accounting system raises both the level and growth rates of GDP relative to the old accounting system.

The slowdown in TFP growth in the 1970's and the speedup in the 1980s was widespread in the private business sector and affecting all the sectors with the exception of the electricity and gas sector. At an aggregated level, both the goods and service producing sectors were affected by the productivity slowdown. In addition, the whole business sectors TFP was substantially decreased. The data show that TFP growth at the aggregate level reflects TFP growth in the individual sectors rather than sectorial shifts towards fast growing sectors. This speed up in the second half of the 1990s has continued for all the sectors (including aggregated goods & services and the private business sector).

Our results on growth accounting for the period 1994-1998 indicate that TFP growth has recovered in the information-intensive service industries:-wholesale and retail, transportation, storage and communcation and finance, insurance, real estate and business services with TFP growth rates of 3.8%, 3.3% and 1%, respectively.

Turning to the growth rates in Sweden TFP during the 1990s, the whole private business sector has been growing at 1.8% much below the average growth rates we had in 1960s. The manufacturing sector is growing at a high TFP growth rate of (3.3%) together with the wholesale/retail sector is growing at (2.6%). The answer to the question whether Sweden's private business sectors will continue to grow at the high growth rates characterised of the mid 1990s will depend on several factors which are exogenous to Sweden.

The US economy has been the engine of world growth. The US economy grew at about 5 per cent in 2000, while the world economy grew by just over 4 per cent. This has provided the world with a comforting sense of economic security. Unfortunately now US is in danger of turning into a source of instability. A recession in the US economy would cause a sharp slowing in global growth, severely damaging growth everywhere. Cycles work with leads and lags and a global recession could affect Sweden i.e. if USA sneezes Sweden takes a new breath. While on the other hand the Swedish economy can keep on growing with high demand on exports, increased disposable income, low interest rates, strong consumer confidence and falling unemployment. Separating cycle from trend is always difficult in the midst of an expansion, and it is particularly challenging now because the current expansion is tending to conform to cyclical norms. For reasons why Sweden grew faster than all the European countries and why Sweden lags behind see Lindbeck (2000).

In the international debate concerning of the total productivity, there are essentially two views: According to Krugman (1997), the Asian economic "miracle" was not due to TFP growth but rather to intensive use of factors of production. This view was very controversial since it implied that very little TFP growth had taken place in Asia. According to the advocates of this view the Asian growth was not sustainable in the long run given the expected fall in the rate of employment and the expected reduction of investment rates. The second view was on the contrary that the Asian miracle was due to TFP implying that the growth rate would be sustainable.

Turning now to the role that ICT plays in the economy, directly as a producer of final consumption and investment goods, and indirectly via the utilisation of these investment goods in the production process, it should be observed that the contribution of the information and communcation technology to output and productivity growth can take three main forms: (i) acceleration of productivity growth in the ICT-producing sectors themselves and an increase of their weight in the economy; (ii) capital accumulation driven by rapid investment in ICT equipment; and (iii) ICT-using sectors enhancing their efficiency by harnessing new technology. We refrain from this aspect in this study.

The results of TFP estimates disaggregated for the private business sector are presented in Table 4.13, which facilitates comparisons with earlier Swedish studies. In order to have a fair comparison we use the old national accounts. The reason why the estimates of TFP growth rates are not identical is mainly due to utilization because of different capital stocks.

Table 4.13 Swedish TFP historical comparisons. (Percentage change at annual rates).

Sectors	**Years**										
	(1970-1975)			(1975-1980)			(1980-1985)			(1985-1990)	
	BL	**BH**	**SCB**	**BL**	**BH**	**SCB**	**BL**	**BH**	**SCB**	**BL**	**SCB**
1000	5.9	6.1	6.1	-0.2	2.4	2.4	2.6	2.8	1.4	1.7	1.4
2000	3.1	-2.0	-3.1	1.2	1.5	1.4	3.1	-0.2	3.3	3.2	3.3
3000	4.2	3.1	2.9	1.5	1.0	0.6	3.2	2.2	3.0	0.6	0.3
4000	0.8	3.4	2.8	1.1	1.9	0.7	5.5	5.0	4.8	2.8	0.0
5000	3.7	4.1	4.2	0.7	1.5	0.7	0.7	1.1	2.5	0.6	1.3
6000	1.2	3.2	3.3	0.9	1.6	-1.4	1.4	2.2	1.3.	1.9	1.0
7000	4.7	-	4.2	3.1	-	-2.1	1.4	-	-	2.6	4.7
8000	-1.9	-	-0.7	-0.1	-	0.9	2.3	-	0.9	1.2	-0.6
9000	0.5	-	5.1	0.8	-	0.9	-2.0	-	1.0	-3.3	-2.8

Notes: BL denotes Barot and Lundvik, BH denotes Bengt Hansson (1991) and finally SCB is Statistics Sweden (1991).

In order to facilitate comparisons of TFP for the private business sector with international results, we present them in Table 5.3. Looking at Table 5.3 we see once again that Sweden performed well during the 1960s. In the 1970s TFP declined by 50% but never to rise again at the same growth rate as in the 1960s.

Table 4.14 TFP in the private business sector. (Percentage change at annual rates).

Studies	Years			
	1961-1970	**1971-1980**	**1981-1990**	**1991-1995**
USA	2.5	0.6	0.8	0.4
Japan	6.1	1.8	1.8	-0.3
European Union	3.3	1.7	1.4	0.9
OECD	3.3	1.3	1.2	0.5
Sweden	3.1*	1.5	1.3	1.7

Notes: Our estimates for the period (1961-1970) begin in 1963. See OECD *Economic Outlook*.

The exercises we have performed with this growth-accounting framework have some limitations. First, they capture only the proximate sources of output growth: namely the accumulation of capital and labour, plus TFP. In particular, this framework does not model the underlying technical improvements that have driven the accumulation of growth. In addition the growth accounting framework is static by its nature, failing to capture the dynamic features of capital accumulation.

5.1 Chow test and structural breaks

In order to identify structural breaks in TFP growth rate we recursively run equations with a dynamic specification (i.e. including lags) of TFP growth rates. A sudden break in the time pattern of recursive least squares estimates of a parameter may suggest a point at which the parameter value has changed. Using a recursive Chow test may test the significance of such a break. The results are presented in the Table 5.1.

Table 5.1 Recursive Chow tests on structural breaks

Sectors	Years of structural breaks
1000	1973*, 1974*
2000	(-)
3000	1993*
4000	1986*, 1987*, 1988*
5000	1972 *, 1976 *, 1977 *, 1978 *, 1979 *, 1980 *
6000	1992 *,
7000	1974 *,
8000	1992 *,1993 *
9000	1993 *, 1994 *,
Goods	(-)
Services	1992 *, 1993 *, 1994 *
Business	1993 *

Notes: *Indicates significance at 5% level using an F-test. Business denotes the whole private business sector, while Goods and Services are the goods and service producing sectors respectively. (-) denotes no structural breaks were found.

The results indicate structural breaks for the agriculture, construction and transport sectors due to the 1973-oil price crisis. The second oil price crisis was in 1979 and this particular structural break is indicated merely for the construction sector. During the 1980s, there are structural breaks for construction, electricity and gas sectors. In context of the severe recession in the Swedish economy during 1990s the results indicate structural breaks for the following sectors: manufacturing, wholesale and retail financial institutions & real-estate and other business and finally for the community social and personal services. Chow test indicates structural breaks for the private business sector (1993) and for the aggregated service sector for the years 1992, 1993, and 1994.

5.2 Granger causality

Causality in econometrics is a somewhat different concept to that in everyday philosophical use. It refers more to the ability to predict. ***X*** is said to be a Granger cause of ***Y*** if ***Y*** can be predicted with greater accuracy by using past values of ***X*** rather than not using such past values, all other information been identical. In order to test whether ***Y*** Granger causes ***X*** we run the regression below:

$$Y_t = ?_0 + ?_1 y_{t-1} + ?_2 y_{t-2} + ?_3 y_{t-3} + ?_1 X_{t-1} + ?_2 X_{t-2} + ?_3 X_{t-3} + ?_t$$

The dependent variable is the first-difference of the logarithm of the Solow residual, the independent variables are generally first-differences of the logs.

Our null hypothesis is that $?_1 = ?_2 = ?_3 = 0$.

Our alternative hypothesis is $?_1 ? ?_2 ? ?_3 ? 0$. The hypothesis is tested using a Wald test.

We first test explicitly whether certain sector changes in TFP growth rates precede other sector growth rates. For this we perform Granger causality tests. Table 5.1 presents the results. The results indicate that an increase in growth rate in TFP in sector 8000 does cause changes in TFP growth rates in the agriculture, manufacturing, transport sectors. The results can be interpreted analogously for the other sectors.

Table 5.1 Granger-Causality tests for ? TFP between sectors (1963 - 1999)

Dependent Variable			**$?^2$test value**
? TFP1000(Agriculture)	?	? TFP8000	$?^2(3) = 8.2$, P[0.04]
? TFP2000 (Mining)	?	? TFP3000	$?^2(3) = 6.9$, P[0.07]
? TFP3000(Manufacturing)	?	? TFP8000	$?^2(3) = 16.2$, P[0.00]
	?	? TFP7000	$?^2(3) = 18.2$, P[0.00]
? TFP4000 (Electricity)	?	? TFP9000	$?^2(3) = 8.9$, P[0.02]
? TFP5000 (Construction)	(-)		
? TFP6000 (Wholesale)	?	? TFP4000	$?^2(3) = 10.8$, P[0.01]
		? TFP7000	$?^2(3) = 8.7$, P[0.03]
? TFP7000 (Transport)	?	? TFP8000	$?^2(3) = 8.2$, P[0.04]
		? TFP5000	$?^2(3) = 10.4$, P[0.02]
? TFP8000 (Banks)	(-)		
? TFP9000 Community	(-)		

Notes: * Indicates significance at 5%. Wald test has been used to test the null hypothesis.
? Indicates causes in the Granger sense. The Wald test used for linear restrictions is $?^2$ distributed with three linear restrictions imposed. (-) denotes no Granger causality.The figures in brackets are the probabilities.

To test explicitly whether certain sector growth rates in TFP precedes changes in gross investment rate, we perform a Granger causality tests as before. Table 5.2 presents the results. We conclude from the results that the changes in investment in the agriculture and banking, real-estate and other businesses Granger causes the change in TFP growth rates, while for the mining and the manufacturing sectors the TFP growth rates Granger causes the change in gross investment. The results that TFP growth rates cause the changes in investment are in accord with the endogenous growth theory.

Table 5.2 Granger-Causality tests for ? in TFP Granger causes ? Investment and vice-versa

Dependent Variable			?^{2}**test value**
? TFP1000(Agriculture)	?	? INV1000 *	?^{2}(3) 8.95, P[0.03]
? TFP2000 (Mining)	?	? INV2000	?^{2}(3)11.5, P [0.01]
? TFP3000(Manufacturing)	?	? INV3000 *	?^{2}(3) 7.0, P[0.07]
? TFP4000 (Electricity)	(-)		
? TFP5000 (Construction)	(-)		
? TFP6000 (Wholesale)	(-)		
? TFP7000 (Transport)	(-)		
? TFP8000 (Banks)	?	? INV8000	?^{2}(3) 11.8, P[0.01]
? TFP9000 Community	(-)		

Notes: * Indicates significance at 5%. Walled test has been used to test the null hypothesis.
? Indicates causes in the Granger sense. (-) denotes no Granger causality.

6 Description of the business cycle

The reason why macroeconomists care about fluctuations in TFP is first and foremost, because that productivity yields information about the aggregate production of goods and services in the Swedish economy. Secondly, productivity analysis may provide information about the firm and sector behaviour e.g., the mark-up and its cyclicality, the prevalence of increasing returns to scale, and the factors determining the level of utilisation. At an aggregate level, the appropriate measure of output in national expenditure on goods and services i.e. GDP, which is the sum of consumption, investment, government purchases, and net exports. GDP and value-added measure the quantity of goods available to consume today or invest for tomorrow. See Basu (2000) for details.

Lucas (1977) defined the business cycle as the co-movements between the deviations from the trends. Following Lucas, we define a business cycle in aggregated time series to be *procyclical* (*countercyclical*) if the cross correlations of time series are *positive* contra *negative*. In our production data set we present descriptive results on simple cross correlations between the growth rates of our basic variables value added and hours worked, value added and capital stocks, value added and the growth in TFP, value added and ? and (1-?). In addition it might be of interest to separate the direction from the magnitude of change. The correlation analysis takes both elements into account, but it may deny the existence of a significant relation between two series which move consistently in the comovements

We conclude in Table 5.3 our descriptive results of contemporary cross correlations between growth rates from the production data set that the growth rate in GDP and TFP has positive cross correlations indicating that these variables are procyclical for all the business sectors of the economy. Hours worked and GDP has also positive correlations and are procyclical (with the exception of Electricity and gas). GDP and the capital stocks are procyclical with the exception of the following sectors: the agriculture, mining, and manufacturing sector. GDP and the share going to capital are procyclical for all the sectors while the share going to labour is countracyclical.

Table 5.3 Contemporaneous correlations for growth rates for the business sector (1963 - 1999)

Sectors	*GDP & HH*	*GDP& KK*	*GDP & TFP*	*GDP & ?*	*GDP & (1-?)*
1000	0.32	-0.04	0.97	-0.65	0.65
2000	0.53	-0.09	0.94	-0.32	0.07
3000	0.72	-0.10	0.87	-0.44	0.39
4000	-0.14	0.55	0.96	-0.09	0.12
5000	0.72	0.36	0.63	-0.19	0.18
6000	0.66	0.10	0.81	-0.13	0.08
7000	0.47	0.26	0.96	-0.24	0.23
8000	0.17	0.10	0.64	-0.14	0.11
9000	0.21	-0.29	0.87	-0.23	0.10

Notes: HH = Hours worked, KK = Capital stocks, TFP = Total factor productivity, ? = is the share going to labour, (1 - ?) is the share going to capital.

6.1 The Hodrik Prescotts Filter (HP)

The decomposition of TFP into cyclical and trend components has important implications for macroeconomic analysis. Historical decompositions give us the possibilities of dating the business cycle (peaks and troughs), while so called real time decompositions make it possible to judge the current phase of the cycle, increasing the reliability of economic predictions.

The decomposition and the distinction between transitory and permanent components in TFP is useful when judging the success of structural reform programmes or assessing the sustainability of current productivity levels. In fact the measurement of trend productivity and output could possibly be used to calculate output gaps which contribute to the understanding of the fiscal stance and, when interpreted as deviations from potential, are expected to determine many important macroeconomic variables, such as wage and price inflation, and hence providing an important input for conducting research in monetary policy.

There exist various different methods to extract cyclical components in the time series. We follow the standard practice of taking logs and HP filtering the data. HP filter is an exponential smoothing procedure. HP filter helps to decompose an observed shock into a supply (permanent) component and a demand (temporary) component - the identifying differences being that the supply shocks have lasting, permanent effects, while demand shocks have only transitory effects.

The choice of HP filter to detrend the data have been subject to criticism. (See Cogley and Nason (1992), Harvey and Jaeger (1993), and King and Rebelo (1993). Following the real business cycle (RBC) literature we follow the standard practice of taking logs and HP filtering the data. By doing so, we follow the majority of the (RBC), and quote standard deviations and cross-correlations of the cyclical components.

The HP[11] filter is derived by minimising the sum of squared deviations of output from its trend subject to a smoothness constraint that penalizes deviations in the trend.

$$? _t = ? \ (y_t - y_{p, t})^2 + ? \ \ ? \ (?^2 y_t)^2$$

(1) (2)

(1) = Global distance, (2) = Fluctuations (Cycle)

$?^2$ = Double difference,

Y = Ouput, p = Trend,

? = Smoothness parameter, that is 1600 for quarterly data and 400 for annual

See Appendix 2 Figures 10 to Figures18 for the decomposition of level of TFP into Trend and cycle.

We calculate the cross correlation of detrended output, hours, and investment with TFP at different leads and lags. In the first set of results, we calculate the detrended cycles for the private business sectors of the Swedish economy using the manufacturing sector as the reference sector at different leads and lags. The manufacturing sector has traditionally been regarded as very cyclical. A sector is said to confirm to the reference cycle if the direction of its changes is largely the same as the direction of the changes in the reference cycle. We calculate cross correlations with leads at time *t-1* up to *t-4* and lags from *t+1* to *t+4*. The results with respect to cross correlations between the cyclical components of TFP between sectors indicate that the agriculture, mining, wholesale and retail sectors are simultaneous with the manufacturing sector (the reference cycle). While the cycle in the electricity & gas, construction, transport, banking real estate and other businesses are leading the cycle. The cross correlations of leads and lags are presented in Table 6.1.

Table 6.1 Correlations of the cyclical components of levels of TFP with leads and lags using manufacturing sector as the reference sector

		Leads					Lags		
Sector	***t-4***	***t-3***	***t-2***	***t-1***	***t***	***t+1***	***t+2***	***t+3***	***t+4***
1000	-0.28	-0.27	-0.14	0.21	0.56	0.44	0.14	-0.19	-0.28
2000	-0.13	-0.13	-0.02	0.40	0.77	0.57	0.22	-0.05	-0.13
3000	-0.29	-0.32	0.00	0.61	1.00	0.61	0.00	-0.32	-0.29
4000	0.25	0.31	0.40	0.28	0.08	-0.15	-0.44	-0.60	-0.56
5000	-0.31	-0.27	-0.12	0.01	-0.02	-0.19	-0.17	-0.02	0.17
6000	-0.29	-0.26	-0.07	0.40	0.66	0.45	0.11	-0.07	-0.07
7000	-0.14	-0.00	0.25	0.47	0.34	-0.03	-0.24	-0.19	-0.06
8000	0.20	0.44	0.69	0.62	0.30	-0.09	-0.34	-0.51	-0.56
9000	0.37	0.37	0.35	0.17	0.01	0.12	0.00	-0.16	-0.27

We proceed to calculate cross correlations with different leads and lags between levels of TFP and gross investment. The basic issue is that if TFP growth induces subsequent investment

[11] See Koskinen et al. (1997).

and more than investment induces subsequent TFP growth. The calculations of cross correlations at different leads and lags are presented in Table 6.2.

Table 6.2 Correlations for cyclical components of level of TFP and gross investment between sectors

		Leads				Lags			
Sectors	***t-4***	***t-3***	***t-2***	***t-1***	***t***	***t+1***	***t+2***	***t+3***	***t+4***
1000	-0.23	-0.50	-0.64	-0.52	-0.22	0.05	0.25	0.37	0.31
2000	-0.21	-0.54	-0.61	-0.31	0.27	0.63	0.57	0.20	-0.04
3000	-0.19	-0.49	-0.55	-0.27	0.25	0.58	0.54	0.22	0.01
4000	0.37	0.39	0.31	0.14	0.02	0.01	0.01	-0.26	-0.44
5000	0.29	-0.18	-0.52	-0.54	-0.32	-0.00	0.28	0.49	0.50
6000	-0.05	-0.27	-0.49	-0.50	-0.20	0.24	0.49	0.57	0.54
7000	-0.15	-0.16	-0.22	-0.26	-0.04	0.07	0.05	0.11	0.28
8000	0.20	-0.05	-0.32	-0.46	-0.40	-0.15	0.14	0.42	0.63
9000	-0.01	-0.30	-0.37	-0.39	-0.30	-0.04	-0.23	0.39	0.44

The results indicate that TFP leads investment for the agriculture, mining, electricity & gas, wholesale and retail and transport. For the construction, banking, real estate other business and community services TFP lags investment.

The results with cross correlations between TFP and hours worked indicates that TFP leads hours worked for the agriculture, mining, wholesale & retail and hotels banking real-estate & other businesses and finally community services. While for the electric gas and construction sectors TFP lags hour's worked. The cross correlations at different leads and lags are presented in Table 6.3.

Table 6.3 Correlations for cyclical components of level of TFP and hoursworked between sectors

				Leads		Lags			
Sectors	***t-4***	***t-3***	***t-2***	***t-1***	***t***	***t+1***	***t+2***	***t+3***	***t+4***
1000	-0.36	-0.37	-0.33	0.02	0.38	0.27	0.13	0.01	0.06
2000	-0.33	-0.30	-0.44	-0.29	0.28	0.52	0.49	0.18	0.01
3000	-0.15	-0.37	-0.58	-0.43	0.09	0.58	0.67	0.44	0.28
4000	0.02	0.07	-0.07	0.03	-0.01	0.15	0.23	0.01	-0.07
5000	0.37	0.32	0.02	-0.25	-0.34	-0.39	-0.34	-0.25	-0.25
6000	-0.01	-0.22	-0.35	-0.41	-0.09	0.13	0.18	0.38	0.54
7000	0.22	0.13	-0.02	-0.23	-0.33	-0.23	-0.08	-0.13	-0.18
8000	-0.14	-0.18	-0.23	-0.26	-0.29	-0.09	0.21	0.48	0.66
9000	-0.19	-0.22	-0.36	-0.48	-0.56	-0.34	-0.07	0.11	0.26

The cross correlations with respect to TFP and GDP at different leads and lags indicate that TFP leads GDP for the agriculture, mining, manufacturing, & wholesale and retail and restaurants while for the Electricity & gas, construction, transport, banking real estate and other businesses TFP lags GDP.The results are presented in Table 6.4 below.

Table 6.4 Correlations for cyclical components of level of TFP and GDP between sectors

	Leads					Lags			
Sector	***t-4***	***t-3***	***t-2***	***t-1***	***t***	***t+1***	***t+2***	***t+3***	***t+4***
1000	0.08	0.23	0.08	0.16	0.53	0.09	-0.13	-0.30	-0.44
2000	-0.16	0.09	0.10	0.19	0.50	0.54	0.46	0.25	0.20
3000	-0.34	-0.46	-0.49	-0.11	0.46	0.73	0.55	0.26	0.17
4000	-0.25	-0.18	-0.16	-0.14	-0.16	-0.35	-0.34	-0.01	0.37
5000	0.36	0.24	0.05	-0.05	-0.04	-0.20	-0.28	-0.24	-0.29
6000	-0.24	-0.31	-0.35	-0.18	0.18	0.46	0.56	0.56	0.47
7000	-0.02	-0.12	-0.25	-0.21	-0.01	0.01	-0.01	-0.12	-0.14
8000	-0.18	-0.30	-0.26	-0.24	-0.12	-0.10	-0.02	0.09	0.25
9000	0.27	0.28	0.19	0.20	0.22	0.06	-0.20	-0.28	-0.25

A simple measure of volatility is the standard deviation. We calculate standard deviations for the cyclical components of GDP,TFP, hours worked, and finally investment. Looking at Table 6.5, the cyclical components of GDP indicates that the mining, manufacturing, construction, transport and electricity and gas are sectors with relative high standard deviations and hence volatile. With respect to hours-worked mining, manufacturing, and construction are the most volatile sectors. Finally the cyclical components of investment indicate that the most volatile of sectors are transport, electricity and gas, construction, followed closely by manufacturing. .

Table 6.5 Standard deviation

	Variables			
Sectors	***GDP***	***TFP***	***HH***	***INV***
1000	0.05	0.5	0.03	0.15
2000	0.12	2.08	0.04	0.16
3000	0.06	1.01	0.04	0.17
4000	0.06	0.5	0.02	0.21
5000	0.05	0.8	0.06	0.19
6000	0.04	0.7	0.02	0.15
7000	0.06	0.6	0.03	0.35
8000	0.02	0.5	0.03	0.16
9000	0.04	1.3	0.03	0.11

From Table 6.5, we emphasise on the following business cycle facts with respect to the Swedish business cycle:

(1) The cyclical volatility of hours worked is approximately of the same magnitude as the volatility in value-added for some sectors, suggesting that 'an understanding of aggregate labour market fluctuations is a prerequisite for understanding how business cycles propagate over time', see Kydland (1994).

(2) Gross investment displays the most volatility over the business cycle.

(3) TFP for the private business sector is more volatile than value-added.

7 Conclusions

This paper has been concerned with a detailed analysis of the nature of growth in the private business sector of the Swedish economy for the years 1963-1999. The decline in both constant price value-added and hours worked in all the sectors of the private business sectors was found to conceal considerable heterogeneity across sectors.

Looking at the structural changes in the Swedish economy for the period 1950-1999 from the perspective of the share of value-added of each private business sector to the total value-added for all of the private business sectors of the Swedish economy, we conclude that there has been a shift in the structure of the Swedish economy. The share of value-added from the agriculture sector has declined from 11% to 3%, while the share of financial institutions (banks), real-estate and other businesses has increased from 15% to 26%. The construction sector indicates a fall from 11% to 7%. The decline has been substantial during the 1980s and 1990s.

By combining the rates of growth of value-added and rates of growth of hours worked, one obtains information about the simplest of measures of productivity growth i.e. labour productivity. Results indicate that there have been considerable variations in the rate of growth of value-added and hours worked across the private business sectors of the Swedish economy. Our empirical results are in line and do not contradict the domestic nor the international results.

The results from the growth accounting exercises indicate that after a high decade of productivity growth in 1960s we observe a significant slowdown in the 1970s for almost all the sectors of the Swedish economy. One of the explanations is the oil price shock we observed in the 1970s. One notices that in the 1980s when oil prices were stable or even declining, productivity growth increased.

Our recursive Chow tests on structural breaks on the TFP growth rates indicates structural breaks in 1972,1973, 1974 for the agriculture, then construction, and the transport sectors respectively. The Chow tests indicates structural breaks for the electricity and gas sector for the years 1986, 1987, and in the year1988, for the construction sector.

For the first half of 1990s there are structural breaks for growth rates in TFP for the following sectors: manufacturing, wholesale and retail, banking real-estate and other businesses and community social and personal services. The Chow test indicates structural breaks both in the aggregated private business sector and services during the year 1993 and 1992, 1993, and 1994 respectively.

Granger causality tests indicate that that the TFP growth rate in the manufacturing sector Granger causes TFP growth rate in the Mining sector, while the TFP growth rate in the banking real-estate and other businesses Granger causes TFP growth rate in Agriculture, Manufacturing and the Transport sector. Granger causality tests with respect to growth rates in TFP and investment indicate that investment in the agriculture and banking, real-estate and other businesses Granger cause TFP growth rates for the agriculture and banking sectors while TFP growth rates Granger causes manufacturing and mining investments.

Filtering the production data set using the HP decomposition and calculating cross correlations at different leads and lags for the cyclical components of the production data set indicates that with respect to detrended cycles using the manufacturing sector as the reference cycle that, the agriculture, mining, wholesale and retail sectors are simultaneous with the reference cycle. While the remaining sectors are counter cyclical . The results with respect to the cycles both in TFP and investment indicate that TFP both leads and lags investment for the agriculture, mining, electricity & gas, wholesale and retail and transport. While for the remaining sectors TFP lags the cycle. The results specific to TFP and hours worked indicate that TFP cycle leads hours worked for the agriculture, mining, wholesale and retail and banking, real estate and other businesses. While for the remaining sectors it's on the contrary.

The cyclical volatility of hours worked is approximately of the same magnitude at the volatility in value-added. Gross investment displays the most volatility over the business cycle. *MICMAC* can be disaggregated into two sectors, the goods and the service producing sectors.

Annex A Data definitions and sources

(1) ***Value added at constant prices (PPV1000-PPV9000)***

Value added: denotes value added at different constant prices, basic values. Value added can be defined as the difference between total revenue of a sector and the cost of material, services and components purchased. Thus it measures the value the sector has added to these purchased materials services and components by its process of production. The gross domestic product by kind of economic activity, basic values, industries inclusive domestic services for the years 1950 - 1974 have been collected from Statistics Sweden pages 52-53. The value-added figures for the year 1950-1963 are in 1959 prices, while the figures for the period 1963-1974 are in 1968 prices collected from the same source, published by National Central Bureau of Statistics Sweden Nr N 1975:98, Appendix 4 The value-added figures for the period 1970-1985 in 1980 prices have been collected from Table 4:4 in million Swedish crowns .The figures for the same variable been collected from Production and Factor income Appendix 4 Nationalräkenskaper Årsrapport (National Accounts), 1970-1985 N10 SM 8601. The same figures for the period 1980-1986 have been collected fromN 10 SM 9701 in 1991 prices. The figures are according to the old nationalAccounts. The new figures for the years 1980-1999 have been delivered by Statistics Sweden.Value added at current prices for the period 1950-1999, (PPL1000 – PPL9000) has been collected from the same sources mentioned above from Statistics Sweden.

(2) ***Hoursworked (HH1000 – HH9000) 1960 - 1999****:*

Hours worked denotes the data for the nine respective sectors of the Swedish economy. Employment here means the total labour input, measured in hours. The number of hours worked measures consequently, apart from possible estimation errors, all work regardless of whether it has been carried out as over-time, full time or part-time, by permanently or temporarily employed persons, by entrepreneurs, by persons partially or completely able to work etc. The data for hours worked in millions for the period 1960-1974 has been collected from Statistics Sweden, National Accounts Nr N 1975:98 Appendix 5, and pages 52-57. Data for the period 1963-1980 for the same variable for the period 1963-1980 is from Statistics Sweden, Statistical Reports N 1981: 2.5, Appendix 5, pages 56-61.The data for the period 1980-1996 has been collected from National accounts 1980-1996, N 10 SM 9701, Tables 2:3 pages 74-74-85. The hours worked are reported in 10000 of hours worked. Hours worked for the period 1993-1999 are from National accounts 2000-11-20 and are reported in 10000 hours from pages 18-27.

(3) ***The wagesum (WW1000-WW9000)***

is the sum of total wages for sectors 1000 – 9000 is in current prices. The total wages is defined as the compensation of employees by functional sector divided into wages and salaries and employers contributions to social security, private pension etc by kind of economic activity, industries and households.The figures for the year 1950 - 1974 have been collected from Statistiska meddelanden Nr. N 1975:98 Appendix 4 Production and factor income Table 4 AA pages (86-113). The figures for 1970-1980 are from Statistical Reports N

1981:2.5 Appendix 5. The data for the period 1980-1996 for the variables wagesum and employers contribution to social security is from Statistics Sweden, National accounts number N 10 SM 9701 from Tabel 2:2 pages 56-73. The statistics for the same variables for the period 1993-1998 is from the new yearly National accounts (1993-1998) 2000-11-20, pages 5-18.

(4) ***The capital stocks (KK10000 – KK9000)***.

The measurement of capital K_t is based on a perpetual inventory stock calculation method.The gross stock at the beginning of period t is a weighted sum of past investments. Generally, estimates of the physical capital stock are considered unreliable because of lack of information about the initial physical capital stock and the rate of depreciation. Hansson (1989) bases the construction of capital stocks that have been used in this study on an application of the Hulten-Wykoff studies. The figures for the respective sectors of the private business sectors for the period 1963-1987 in 1980 prices have been collected from Hansson . The stocks have been extended using the same method for the period 1980-2000 in 1995 prices. The two different series have been spliced .

Annex B Growth accounting

Table 4.1 Growth Accounting Agriculture Sector (1000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	1.12	3.09	-3.23	1.26	0.41
1970-1979	-0.08	-0.51	-1.30	1.73	0.32
1980-1989	2.07	2.17	-0.80	0.70	0.27
1990-1999	0.08	1.34	-0.59	-0.66	0.25
1994-1999	0.71	2.01	-0.38	-0.92	0.23
1963-1994	0.58	1.22	-1.34	0.70	0.30

Table 4.2 Growth Accounting Mining Sector (2000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	7.29	5.11	-1.73	3.67	0.38
1970-1979	-0.53	-0.16	-1.96	1.59	0.56
1980-1989	-0.51	2.75	-2.56	-0.71	0.73
1990-1999	1.71	2.71	-1.44	0.44	0.58
1994-1999	3.53	2.56	0.11	0.85	0.52
1963-1999	1.45	2.41	-1.94	0.98	0.58

Table 4.3 Growth Accounting Manufacturing sector (3000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	6.26	4.83	-1.21	2.63	0.71
1970-1979	1.90	1.96	-1.69	1.63	0.77
1980-1989	2.12	2.13	-0.42	0.41	0.73
1990-1999	3.47	3.34	-0.87	1.00	0.67
1994-1999	7.17	4.57	1.23	1.37	0.63
1963-1999	3.17	2.91	-1.02	1.28	0.72

Table 4.4 Growth Accounting Electricity and gas (4000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	7.09	4.25	0.15	2.69	0.25
1970-1979	6.53	4.42	0.10	2.02	0.26
1980-1989	4.68	4.13	0.03	0.52	0.16
1990-1999	0.24	0.30	0.05	-0.11	0.16
1994-1999	0.36	0.57	0.02	-0.24	0.16
1963-1999	4.34	3.14	0.08	1.12	0.21

Table 4.5 Growth Accounting Construction sector (5000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	5.23	0.90	0.96	3.37	0.72
1970-1979	0.73	1.97	-2.07	0.83	0.71
1980-1989	1.90	0.46	0.56	0.89	0.82
1990-1990	-1.46	0.19	-1.94	0.29	0.79
1994-1999	0.50	1.05	0.00	-0.56	0.78
1963-1999	1.37	1.13	-0.88	1.12	0.76

Table 4.6 Growth Accounting Wholesale retail and trade (6000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	4.43	-0.01	-0.30	4.74	0.72
1970-1979	2.07	0.89	-0.51	1.69	0.74
1980-1989	2.71	1.01	0.54	1.16	0.78
1990-1999	3.05	2.55	-0.36	0.85	0.75
1994-1999	5.31	3.78	0.87	0.65	0.72
1963-1999	2.96	1.26	-0.12	1.82	0.76

Table 4.7 Growth Accounting Transport sector (7000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	4.81	3.06	-0.14	1.89	0.70
1970-1979	4.11	2.45	-0.24	1.90	0.66
1980-1989	3.26	2.03	0.67	0.56	0.66
1990-1999	1.50	0.60	-0.27	1.17	0.61
1994-1999	4.51	3.28	-0.08	1.32	0.60
1963-1999	3.27	1.93	0.02	1.32	0.66

Table 4.8 Growth Accounting Banking realestate & other businesssector (8000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	3.96	-0.22	1.01	3.96	0.25
1970-1979	2.43	-0.21	0.79	1.85	0.33
1980-1989	2.83	0.91	1.04	0.87	0.28
1990-1999	2.34	0.96	0.78	0.60	0.32
1994-1999	2.58	1.03	1.38	0.17	0.34
1963-1999	2.77	0.38	0.93	1.45	0.30

Table 4.9 Growth Accounting Community services sector (9000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	0.20	-10.08	0.07	10.21	0.65
1970-1979	1.62	-5.54	0.08	7.08	0.80
1980-1989	1.78	-1.66	1.22	2.22	0.54
1990-1999	2.67	-2.76	2.42	3.01	0.63
1994-1999	5.34	-0.74	2.80	3.28	0.65
1963-1999	1.77	-4.39	1.04	5.12	0.66

Table 4.10 Growth Accounting Goods producing sectors (1000-5000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	5.45	4.79	-1.29	1.95	0.49
1970-1979	1.65	1.43	-1.38	1.60	0.52
1980-1989	2.21	1.91	-0.37	0.67	0.54
1990-1999	2.12	2.47	-0.82	0.47	0.49
1994-1999	4.99	4.02	0.47	0.50	0.46
1963-1999	2.57	2.41	-0.93	1.09	0.51

Table 4.11 Growth Accounting Services producing sectors (6000-9000)

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	3.86	1.90	-0.08	2.04	0.60
1970-1979	2.54	1.31	-0.25	1.49	0.63
1980-1989	2.80	0.88	0.58	1.34	0.56
1990-1999	2.31	1.24	0.16	0.91	0.58
1994-1999	3.68	2.37	0.87	0.44	0.57
1963-1999	2.77	1.27	0.12	1.38	0.59

Table 4.12 Growth Accounting (1000-9000) The private business sector

Decade	*GDP*	*TFP*	*? *HH*	*(1-?)*KK*	*?*
1964-1969	4.57	3.45	0.93	2.05	0.54
1970-1979	2.14	1.54	-0.99	1.59	0.57
1980-1989	2.53	1.44	0.04	1.05	0.55
1990-1999	2.22	1.83	-0.37	0.76	0.59
1994-1999	4.20	3.06	0.65	0.48	0.51
1963-1999	2.70	1.95	-0.54	1.29	0.55

Appendix 1 Total factor productivity

Figure 1 Agriculture sector

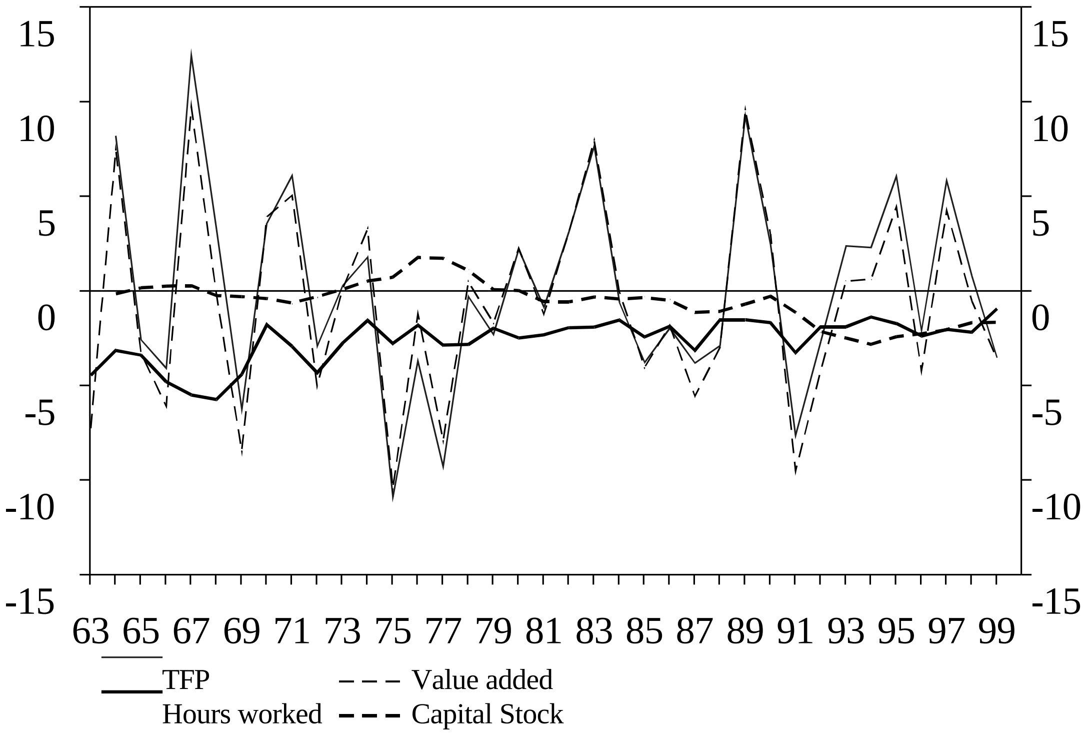


Figure 2 Mining sector

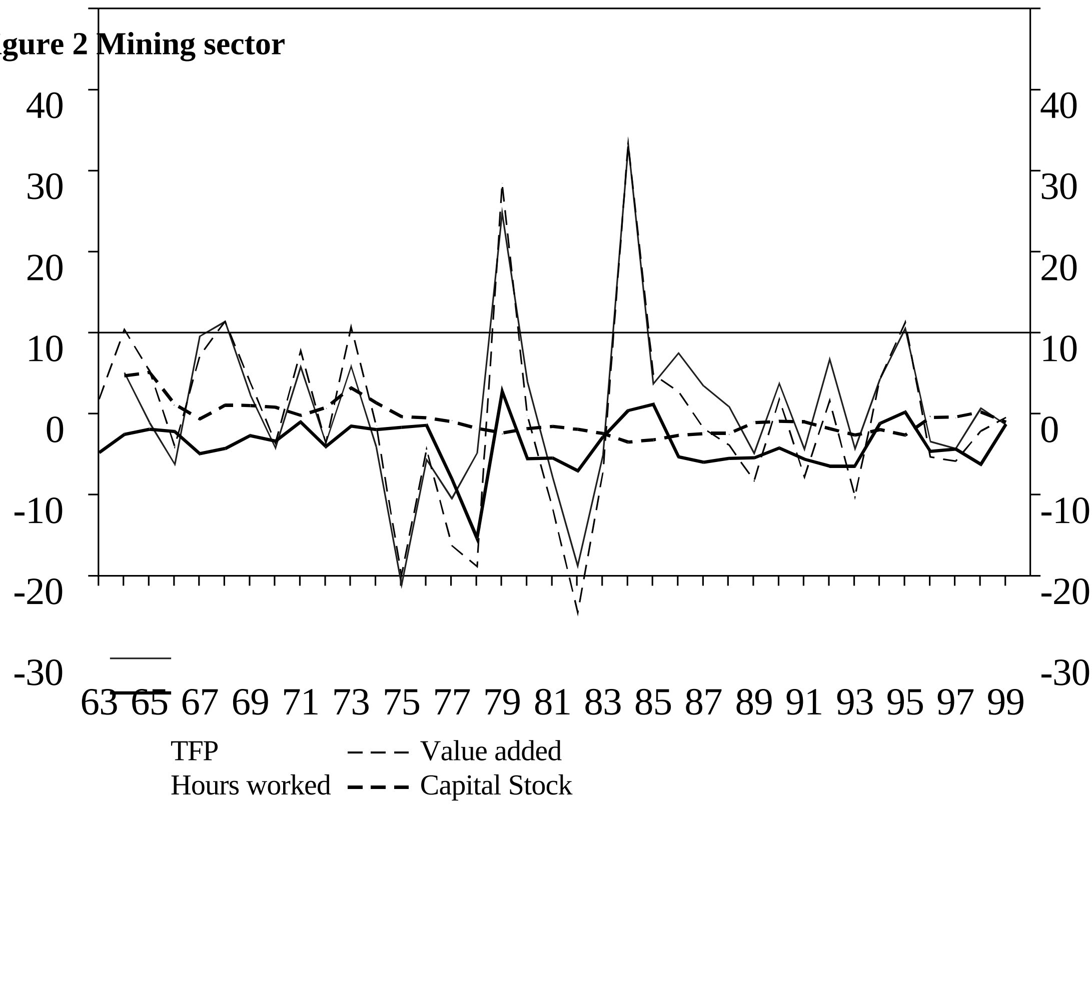


Figure 3 Manufacturing sector

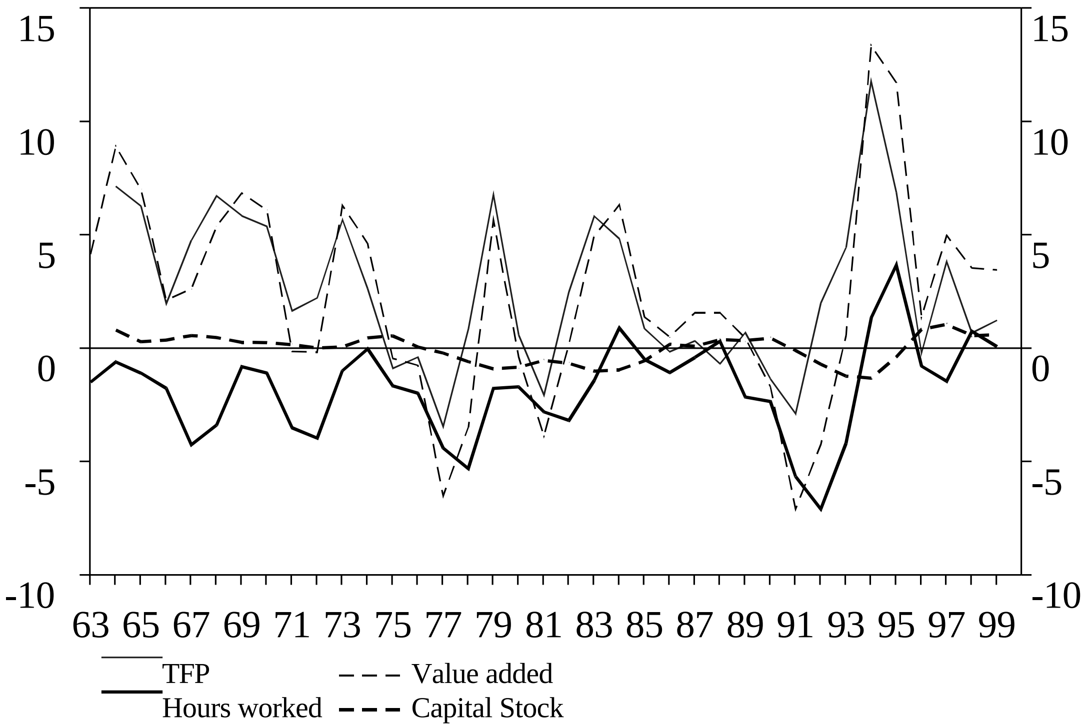


Figure 4 Electricity gas and water

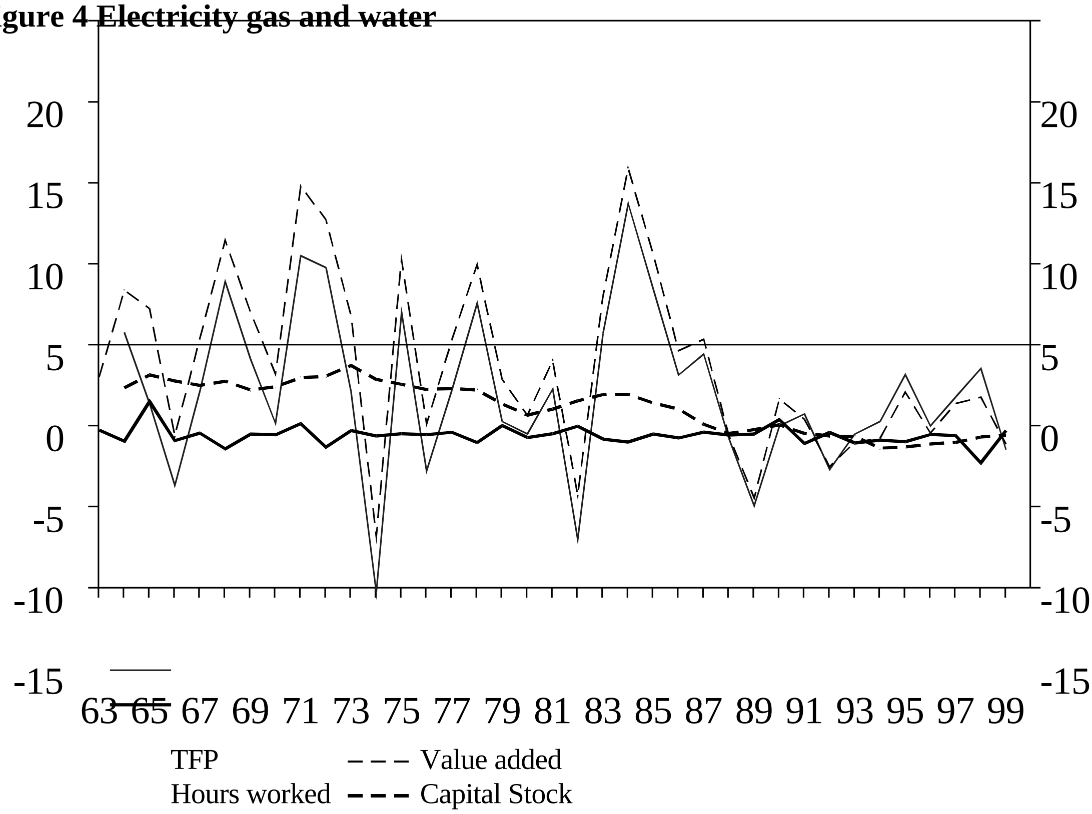


Figure 5 Construction sector

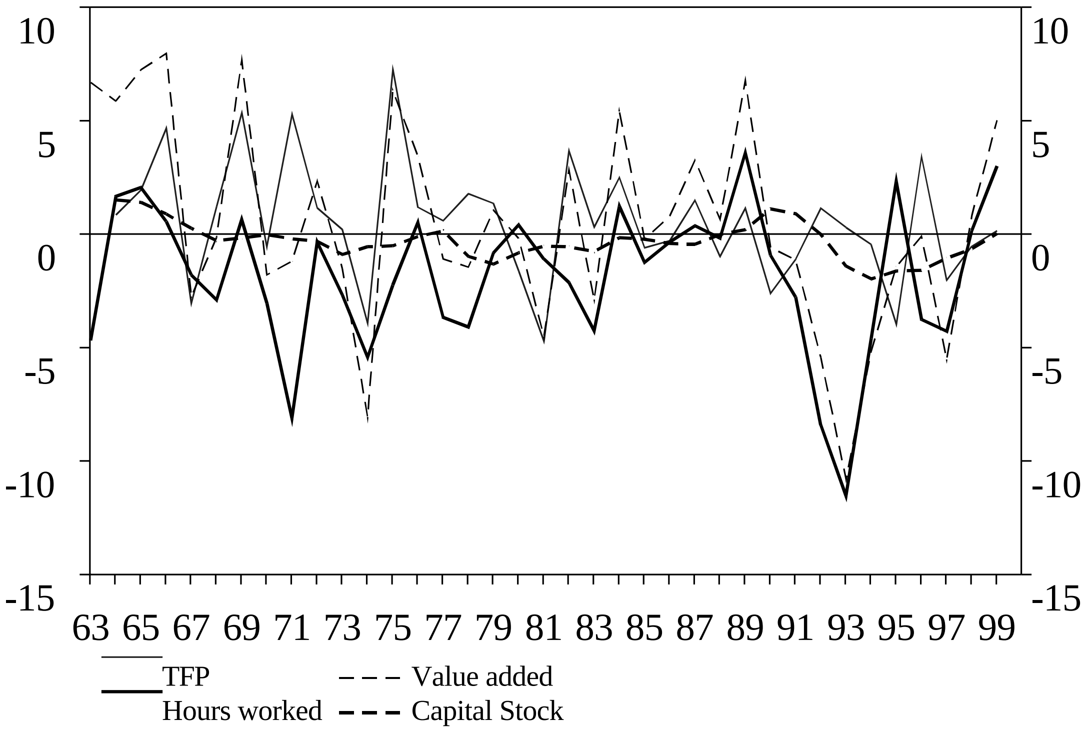


Figure 6 Wholesale and retail and restaurants

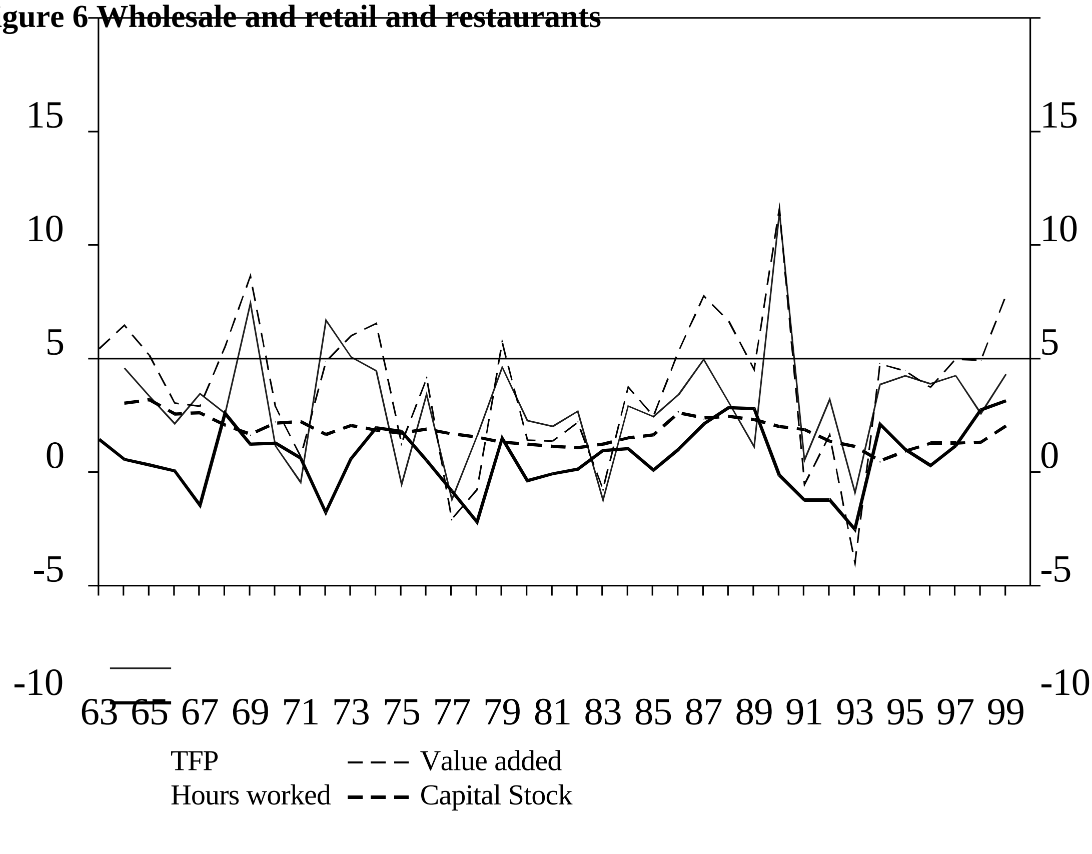


Figure 7 Transport sector

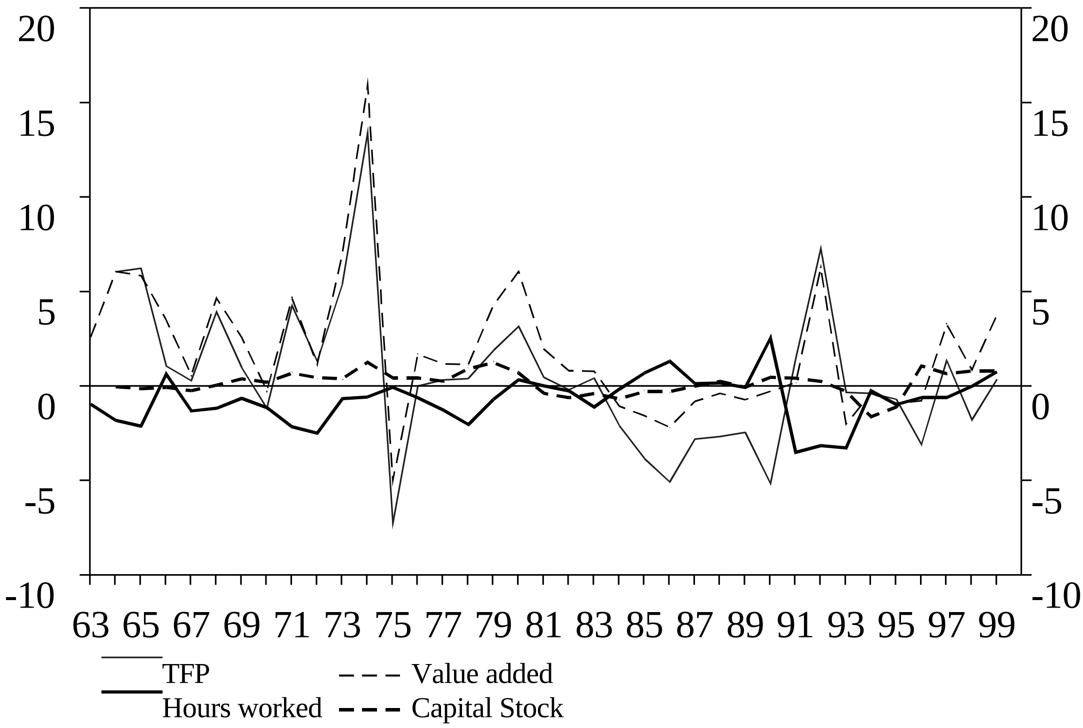


Figure 8 Banking sector & Real estate and other business

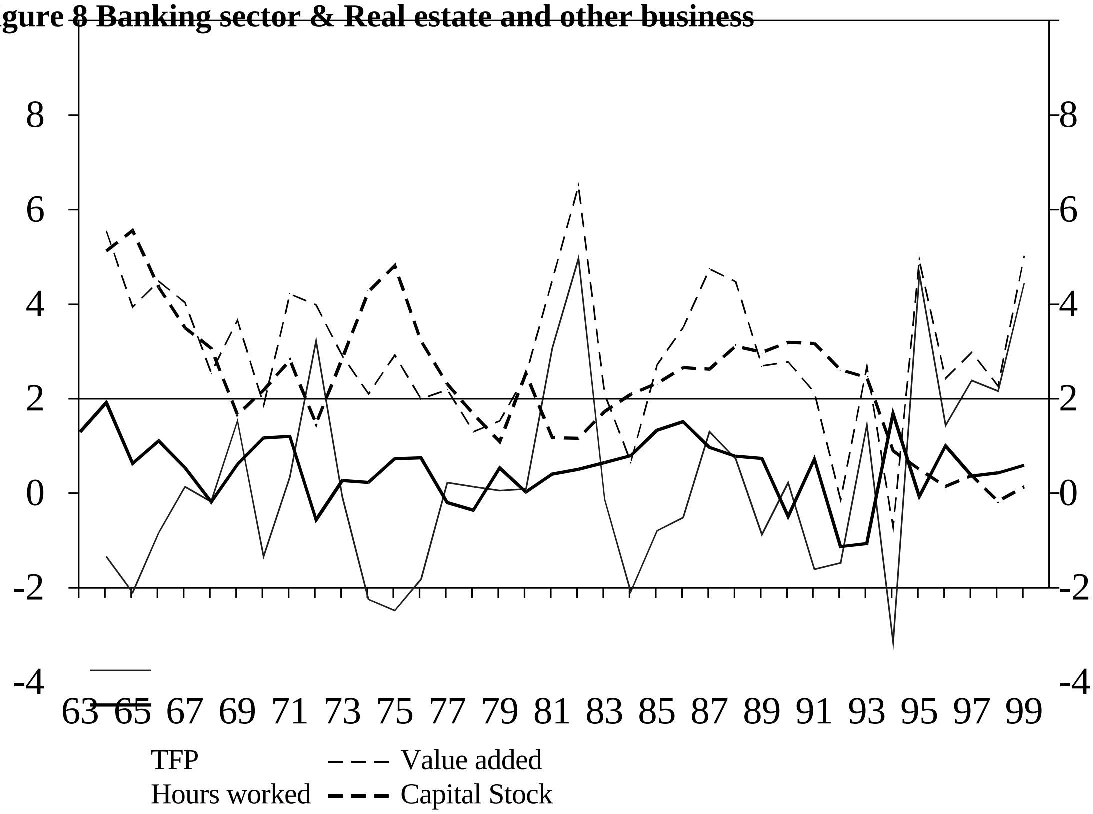
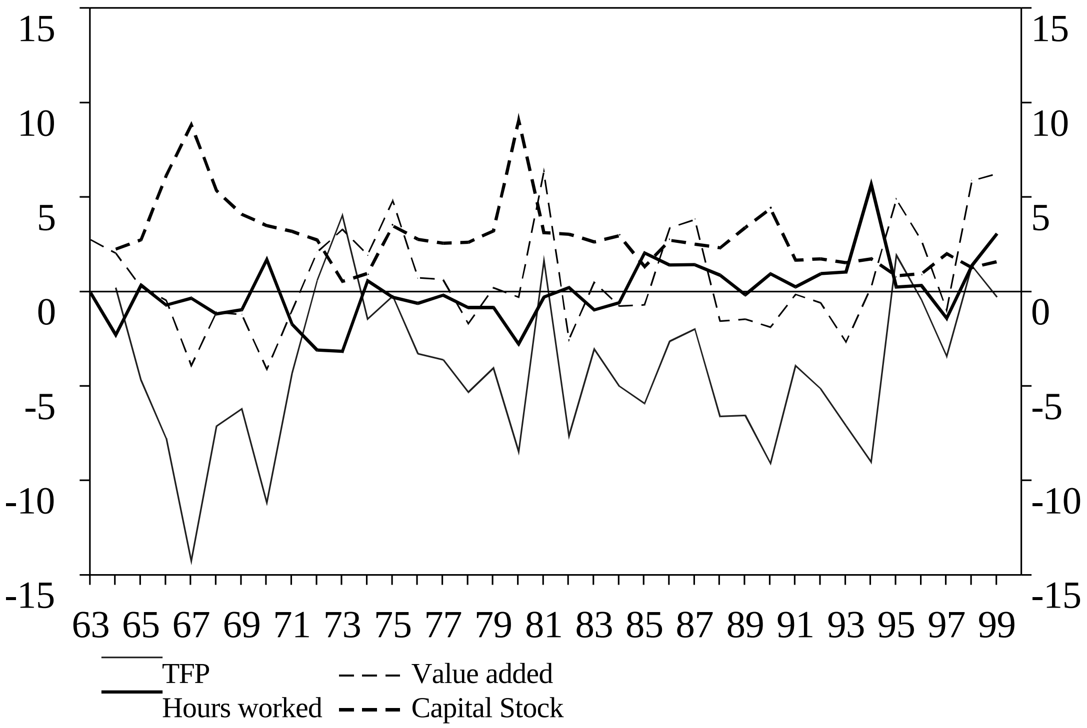


Figure 9 Community and social services



Appendix 2 Decomposition of TFP into Trend and cycle

Figure 10 Agriculture sector

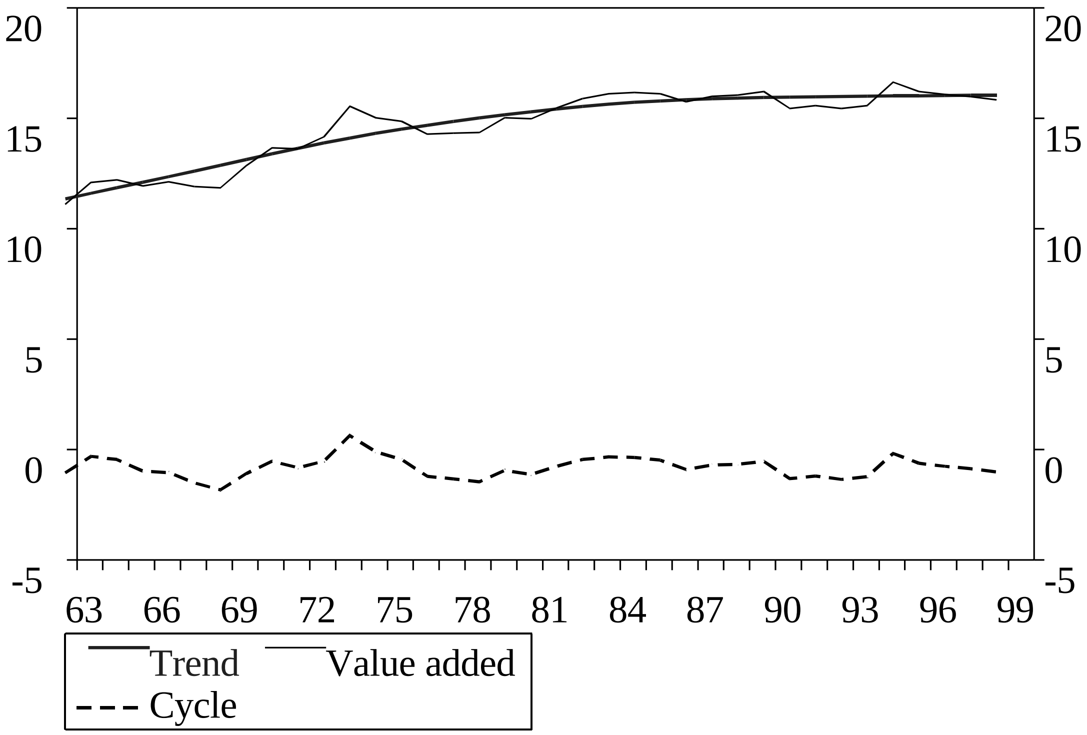


Figure 11 Mining Sector:

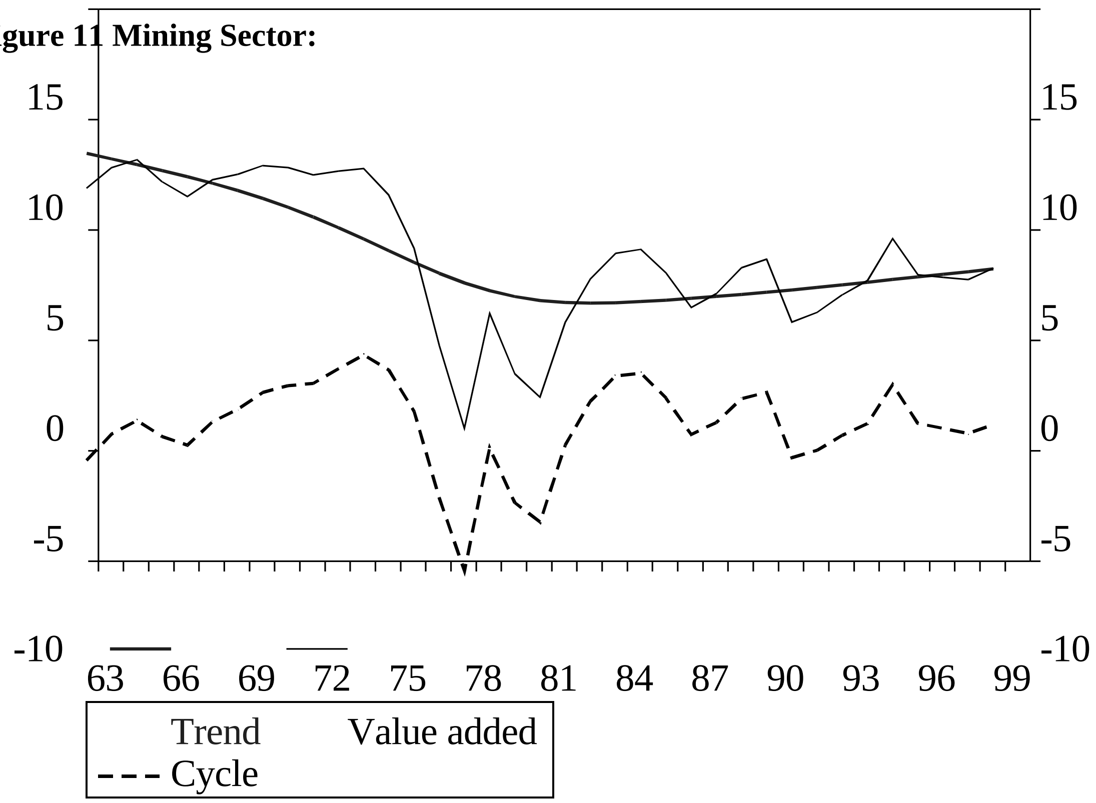


Figure 12 Manufacturing sector

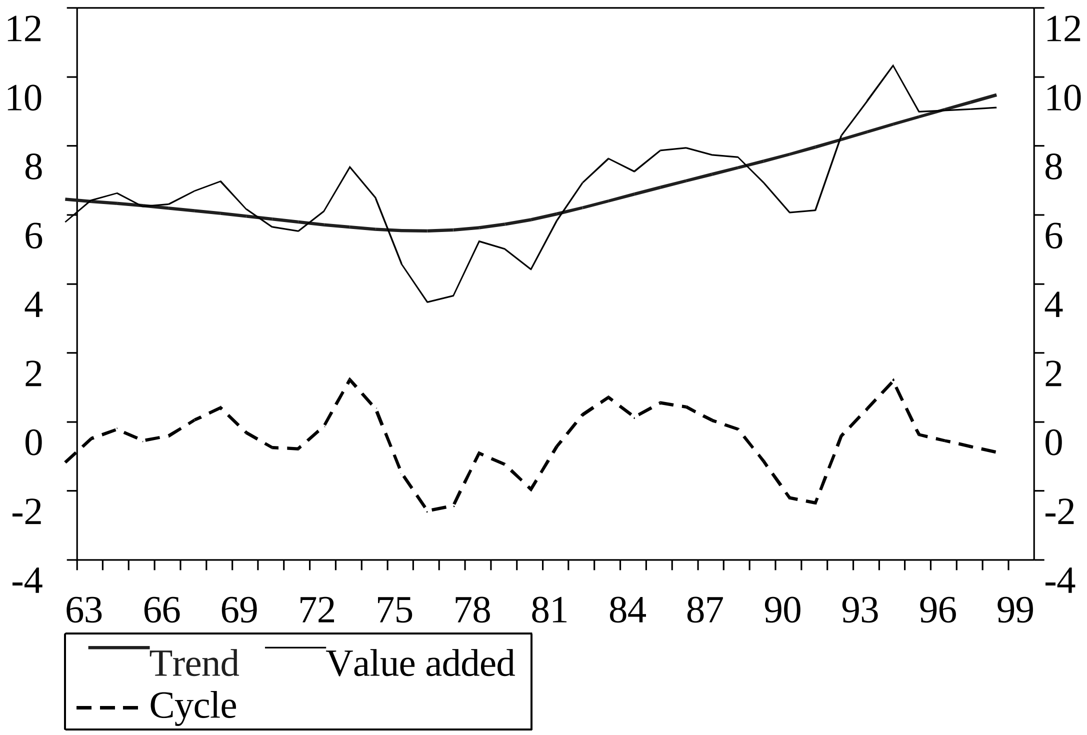


Figure 13 Electricity and gas sector

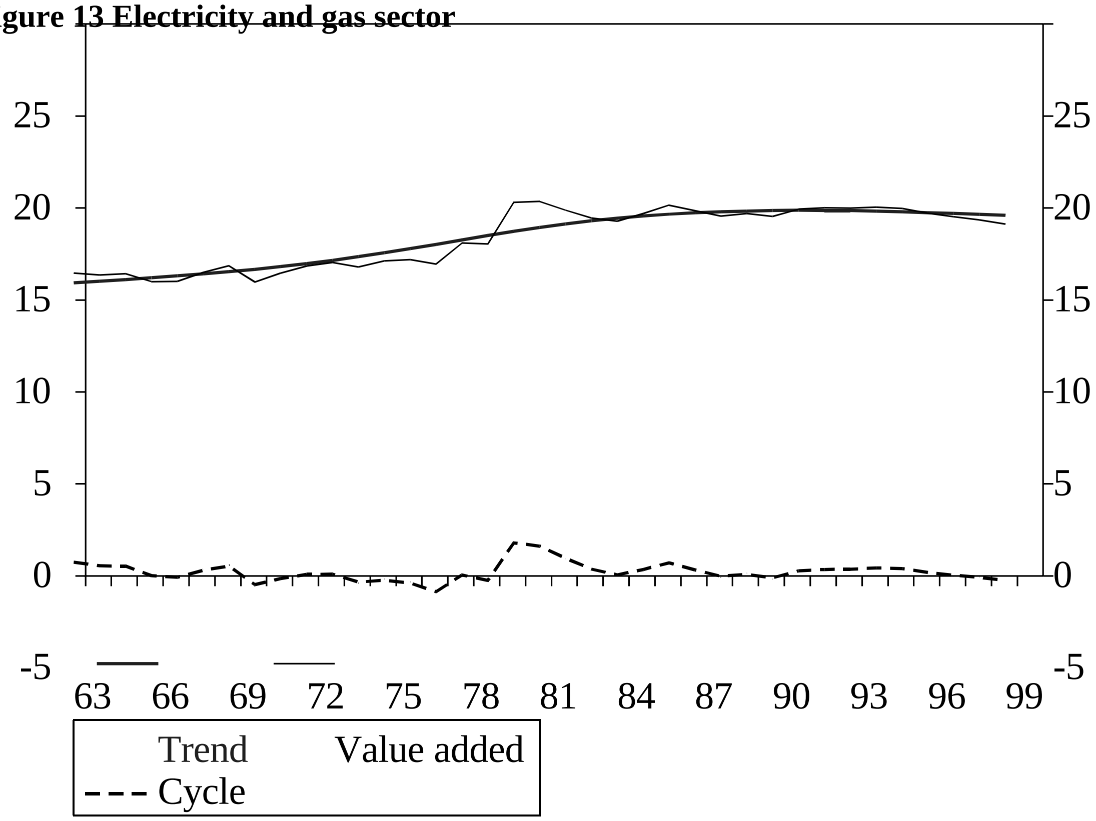


Figure 14 Construction sector

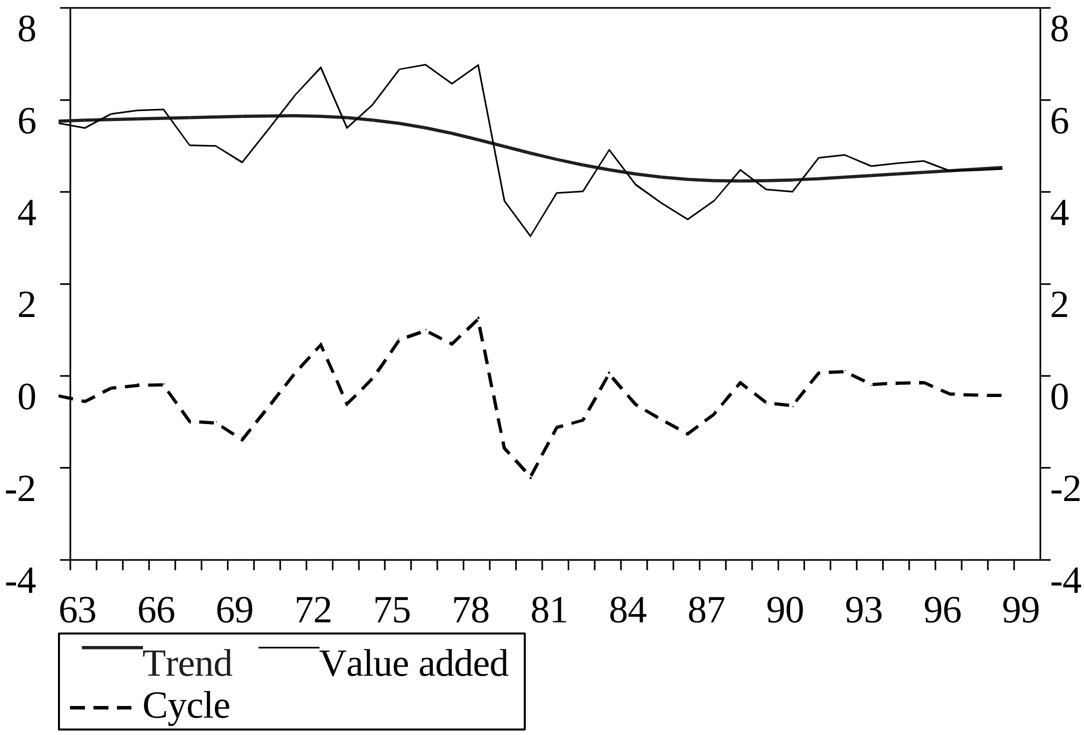


Figure 15 Wholesale and retail sector

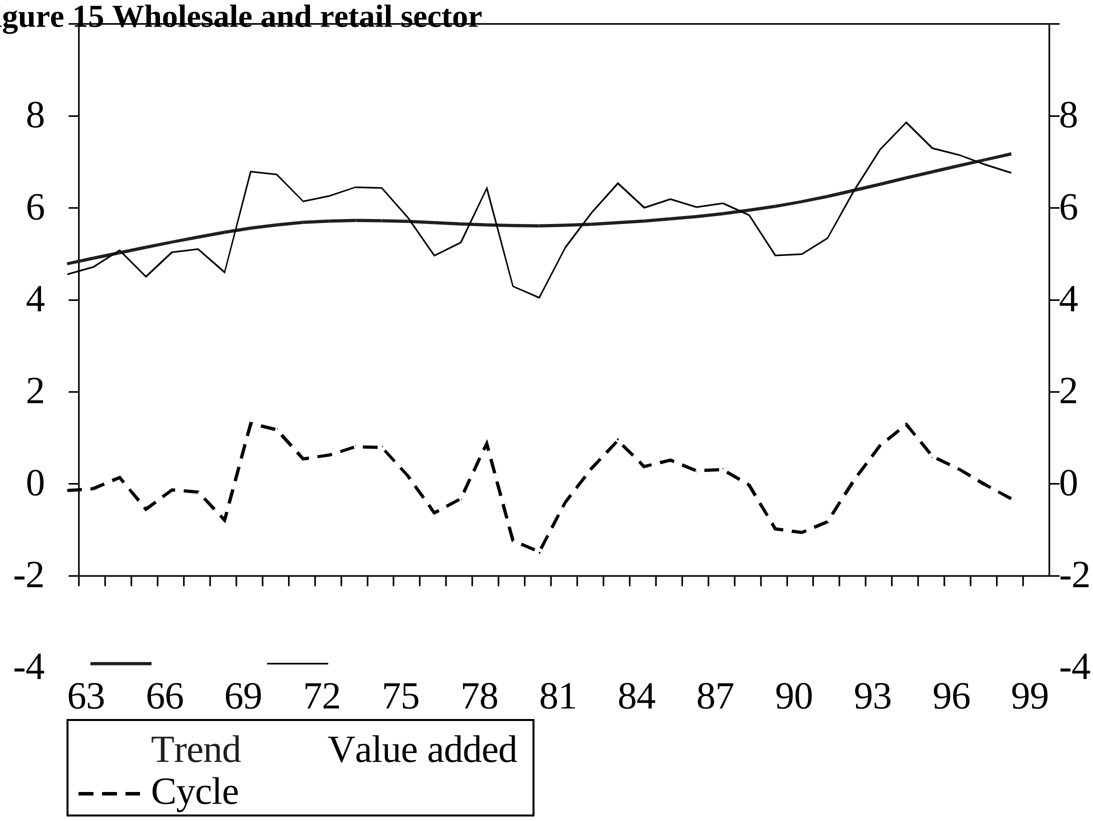


Figure 16 Transport sector 7

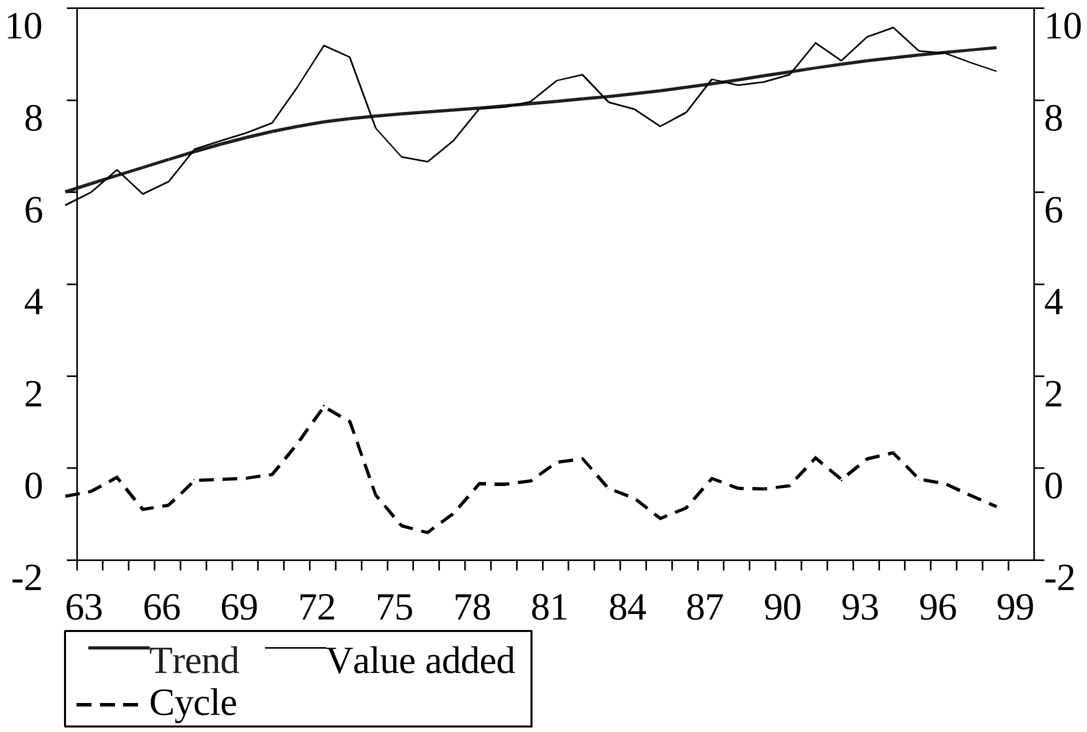
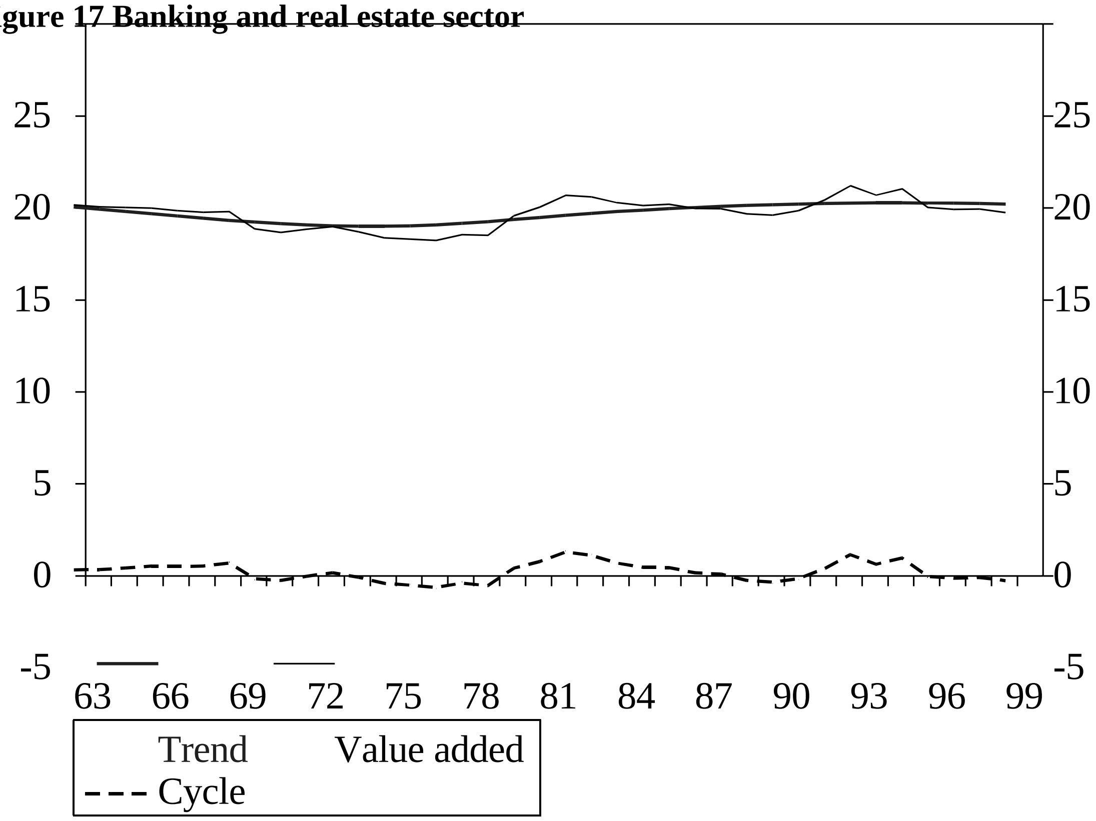
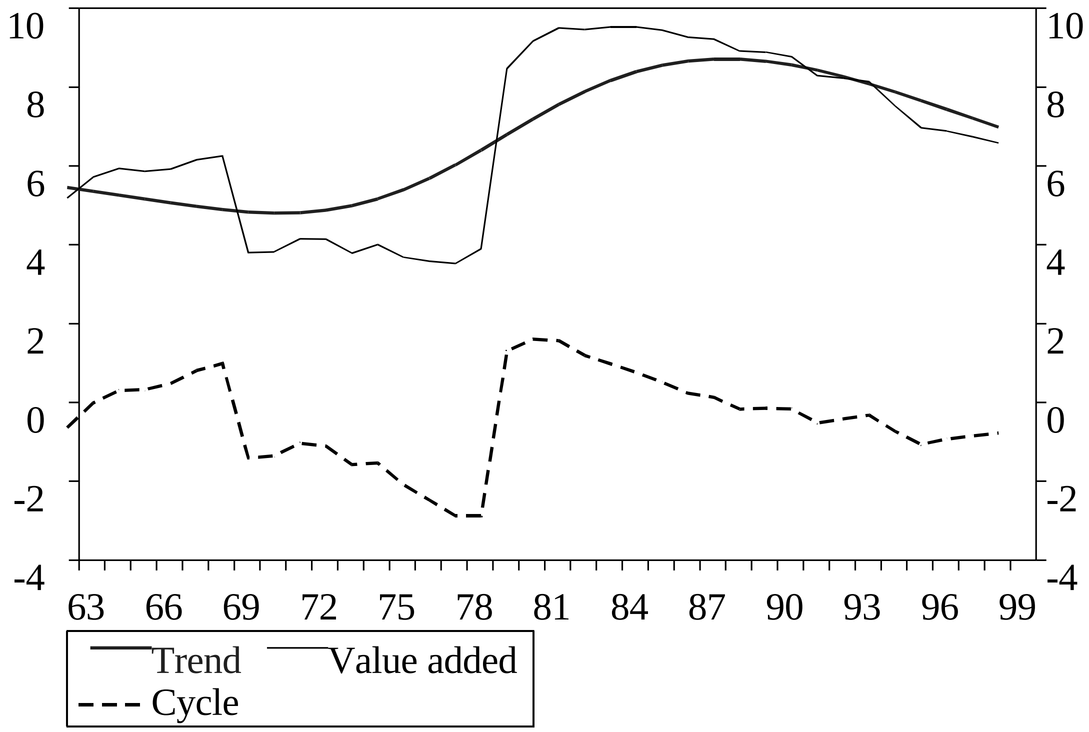


Figure 17 Banking and real estate sector



Community services



References:

Barro, R J (1998), 'Notes on growth accounting', *NBER Working Paper No 6654*, Cambridge, MA.

Barro, R J and X.Sala-I-Martin, (1991), 'Convergance across states and regions', *Brooking Papers on Economic Activity, no 1*, pages 107 – 158.

Barro, R J and Xavier Sala-i-Martin (1991), Economic Growth, Newyork, McGraw.

Basu, S and Fernald, J (2000) 'Why is productivity procyclical ? Why do we care?' *NBER Working Paper No 7940*, Cambridge, MA..

Bean, C and Crafts, N (1996), ' British economic growth since 1945: relative economic decline and renaissance? In (eds) Crafts, N and Toniolo, G (1996), *Economic growth in Europé since 1945*, Cambridge University Press.

Bloom, N and Reenen, J V (2000), 'Patents, Productivity and Market Value in a Panel of British Firms', *The Institute for Fiscal Studies, Working Paper, No. 00/21*, London.

Bernard, A and Jones, C (1996a), 'Productivity across industries and countries: time series theory and evidence' , *Review of Economics and Statistics, Vol 78, no 1*, pp 135-146.

Bernard, A and Jones, C (1996b), "Comparing apples to oranges: productivity convergence and measurement across industries and countries", *American Economic Review, December,* pages 1, 216 –238.

Bentzel, R, Walfridson, B Hjalmarson, L and Hansen, B (1991), *'Kapitalbildning, kapitalutnyttjande och produktivitet', Expertrapport Nr. 3* till produktitetsdelegationen.

Cameron, G (1997), Innovation and economic growth, D.Phil. Thesis, University of Oxford

Cogley, T and Nason, J M (1992), "Effects of the Hodrick-Prescott filter on trend and differences stationary time series: Implications for business cycle research", University of British Columbia, mimeo, August.

Denison, E F (1962), The sources of economic growth in the United States and the alternatives before us, Washington DC, Committee for Economic development, Supplementary Paper no. 13.

Grilliches Z (1997), "The Simon Kuznets Memorial Lecture", unpublished, Harward University, October

Gust, C and Marquez, J (2000), 'Productivity Developments abroad', *Federal Reserve Bulletin*, October 2000.

Hansson B (1989:2), 'Construction of Swedish Capital Stocks, 1963-87: An Application of the Hulten-Wykoff Studies, Department of Economics, Uppsala University.

Harvey, A and Jaeger, A (1993), 'Detrending, stylised facts and the business cycle', *Journal of Applied Econometrics*, *8*, pages 231-47.

Jorgenson, D (1988), ’Productivity and postwar US economic growth’, *Journal of Economic Perspectives, vol 4, no 2,* pp 23-42.

Jorgenson, D W and Grilliches Z (1967) ” The explanation of Productivity change”, *Review of economic studies* 34 (july), 249-280.

King, R and Rebelo, S (1993), 'Low-frequency filtering and real business cycles', *Journal of Economic Dynamics and Control*, 17, pages 207-31.

Kendrick, J W (1961), Productivity Trends in the United States, Princeton NJ, Princeton University Press.

Koskinen, L, Markowski A, Nandakumar, P, and Öller, L (19987), 'Three seminr papers on output gap', *National Institute of Economic Research Working Paper, No.55*.

Kydland, F (1994), 'Business cycles and aggregate labour market fluctuations', in Cooley T.F, (ed) Frontiers of business cycle research.

Laylard P R G and Walters A A (1978), ' Microeconomic theory', Mcgraw-Hillbook company Newyork.

Lindbeck, A (2000), 'Swedish Economic Growth in an International Perspective', in *Swedish Economic Policy Review, Volume 1, Number 1*, Spring 2000.

Lucas, R E (1977), "Understanding Business Cycles", in K.Brunner and A.H. Melzer (eds), Stabilisation of the Domestic and International Economy (Carnegie-Rochester, Conference Serise on Public Policy, 5; North Holland, Amsterdam) 7-29.

Mankiw, G N (1995), " The growth of nations", *Brookings Papers on Economic Activity,*

OECD Report (1996), ' Industry productivity, international comparison and measurement issues'.

Oulten, N and O’ Mahony, M (1994), Productivity and Growth: a study of British industry, 1954-1986, Cambridge University Press. Kendrick, J.W. (1961). Productivity Trends in the United States, Princeton NJ, Princeton University Press.

Romer, P M (1986), " Increasing returns and long-run growth", *Journal of Poltical Economy*, 94 (5), pp, 1002-1037.

Swedberg, P (1999), in "Tillväxt och ekonomisk politik", Lars Calmfors & Mats Persson (red.)

OECD (2000), A new economy?- The role of innovation and information technology in recent OECD economic growth. OECD report DSTI/IND/STP/ICCP(2000)1/REV1

Ahn, S and Hemmings, P (2000), 'Policy influences on economic growth in OECD countries: An evaluation of the evidence', Economics Department Working papers No.246.

Summers, R. and Heston, A (1999), "The Penn world table (mark 5): An expanded set of international comparisons: 1950: 1988" *Quarterly Journal of Economics*, 106, 327-368, May.

Senhadji, A (1999), 'Sources of Economic Growth: An Extensive Growth Accounting Exercise', *IMF working paper*, WP/99/77.

Solow, R M (1957), "Technical Change and the Aggregate Production Function", *Review of Economics and Statistics, Vol.39*, pp.312-20.