Knowledge accumulation and productivity growth during Different Economic Regimes: Swedish Manufacturing Industry 1952-1975, 1975-1992, 1992-2001

Camilla Josephson[♦]
Department of Economic History
London School of Economics
Houghton Street
London WC2A 2AE

Paper for the Asia-Pacific Economic and Business History Conference

Sydney 12-14 February 2007

♦ C.Josephson@lse.ac.uk

1 Introduction

Immense research has been carried out in order to analyse what caused the world wide productivity slow down in the mid 1970s, especially considering Swedish industries since they did worse than most other industrialized countries. A general apprehension among economists is that, after 1950, productivity and industrial growth evolved through two periods, pre- and post-1975. This paper likes to propose an alternative periodisation for the Swedish case. In the last half-century TFP growth in Swedish manufacturing industries has developed through three phases rather than two: the first phase 1952-1975 was characterized by strong growth in TFP. In 1974-75 TFP growth drastically fell and remained low until 1992. In the last phase between 1992 and 2001 TFP growth recovered substantially. Roughly corresponding with the breakpoints in 1975 and 1992 there were profound changes in Swedish economic regimes; 1975 was the starting point for the disintegration of the Swedish model and in 1992 Sweden adopted a flexible exchange rate. Hence, each growth phase is characterized by relatively different economic conditions on the labour and capital markets. Sweden has a rather diversified manufacturing industry and the productivity slowdown in 1975 was not as severe in all sectors. This chapter analyses the effects of macroeconomic policies in diverse periods on a sector level, suggesting that different economic regimes affect opportunity costs of different types of investments differently for diverse types of industries. By incorporating the economic regimes and opportunity costs in the analysis of productivity periodisation I hope to provide new insights of the productivity slowdown in the mid 1970s, and the strong catching-up in the early 1990s. I argue that the degree of stability in macroeconomic policy regimes is essential for the predictability of future opportunity costs; to what extent investments are made according to future opportunity costs depends on how predictable these are. The stability of policy making is closely related to the prevailing economic regime. This chapter investigates how stability or the lack of stability in policy-making affects the predictability of opportunity costs of different types of investments, and how this in turn affects TFP growth.

A common view among economists interested in the effects of institutions is that institutional rigidities and changing economic regimes affect factor markets and, therefore, constitute an important part of the explanation for consistency and change in macroeconomic variables. However, such a view is not universally accepted and perhaps the most serious problem, emphasized by Blanchard and Wolfers (2000), is that the same institutions generating rigidities are prevailing in different periods, although these periods show very different behaviour in macroeconomic variables. Therefore, in order to motivate an analysis of how changing policy regimes and new economic conditions affect opportunity costs of investing in different growth mechanisms it is of great importance as a first step to empirically control for whether changing economic regimes are reflected in real variables. A relevant test for whether the different economic policies pre- and post-1975 produced empirical effects is to examine the relation between profits and wages during these periods. I claim that the different macroeconomic policy regimes efficiently affected macroeconomic variables. Accordingly, I expect no effects of profits on wages pre-1975, whereas I expect significant effects of profits on wages post-1975. Such an outcome would point at the indispensability of addressing the effects of the solidaristic wage policy and the Swedish tax regulation model on firms' decision-making in order to understand the high rates of TFP growth until 1975, the productivity slowdown in the period 1975-1992, and the increasing growth in TFP between 1992 and 2001.

This paper is organised in the following way: Section 2 carries out an empirical analysis of the contribution of growth in labour, capital and TFP to growth in output in the three phases. Section 3 gives a review of various economic regimes; the Swedish model pre-1975, the deregulation of the Swedish model in the period 1975-1992, and the new economic structure based on flexible exchange rates after 1992. To investigate whether the regime shifts pre- and post- 1975 are manifested in macroeconomic behaviour, section 4 empirically tests the effects of profits on blue-collar wages pre- and post-1975. Section 5 specifies the cointegrated VAR model and tests for cointegration between 5 variables in levels by testing 8 hypotheses for various growth mechanisms. Section 6 examines the importance of macroeconomic stability for investment behaviour. A simultaneous least square regression analysis compares how TFP, machinery investment, human capital in "D" and human capital in "R" react to deviations in the steady state relations in the three phases. The variables' adjustment to different steady states and direct effect of other variables reveal how the steady state relations are re-established, and hence whether TFP growth is generated by different mechanisms in different periods. Section seven survey earlier explanations for the productivity slowdown. Section 8 discusses how the economic regime of the Swedish model pre-1975 may affect opportunity costs of investing in various growth-generating activities.

The main argument is that the Swedish model pre-1975 directed investments in a way that created past-dependency in knowledge accumulation for certain industries. The specific relation between productivity and demand that the Swedish model gave rise to is also described. Section 9 provides an analysis of the consequences of the Swedish policy regimes for productivity in labour-intensive, capital-intensive and knowledge-intensive industries. Section 10 defines complementarity and discusses the importance of balance between investments in R&D and investments in current production to obtain maximum productivity growth. Section 11 presents the main conclusions made in this chapter.

2 The contribution of growth in labour, capital and TFP to growth in output in the three phases

The rate of growth in output differs in the three periods. This section shows how the contribution of labour, capital and TFP growth to output growth varies in the three phases. The contribution of labour and capital growth is measured by means of traditional growth accounting based on real estimates of working hours and the capital stock. The contribution of TFP growth is then calculated as the residual, i.e. what cannot be explained by increases of quantities of labour and capital accrue to growth in total factor productivity.

Table 1 Average annual percentage growth rates and contributions to the annual growth rate from labour, capital and TFP in four periods

Period	1951-1975	1975-1992	1992-2001	1951-2001
Labour-intensive industry				
Output growth	2.7	0.57	0.08	1.4
Labour contribution	-0.71	-0.71	-0.71	-0.70
Capital contribution	0.31	0.31	0.31	0.31
TFP Contribution	3.1	0.97	0.48	1.79
Capital-intensive industry				
Output growth	6.8	1.4	2.3	4.2
Labour contribution	-0.41	-0.41	-0.40	-0.40
Capital contribution	0.63	0.61	0.61	0.62
TFP Contribution	6.58	1.2	2.09	3.98
Knowledge-intensive industry				
Output growth	5.6	2.5	5.0	4.2
Labour contribution	0.70	-0.66	-0.65	0.65
Capital contribution	0.37	0.36	0.36	0.36
TFP Contribution	4.53	2.8	5.29	3.19

Output growth

Table 7.1 shows that output growth clearly is largest for the period 1951-1975 in all industries. Growth is strongest in capital-intensive industry with a yearly average growth of 6.8 percent. Knowledge-intensive industry also shows a strong yearly growth rate of 5.6 percent. Labour-intensive industry, however, has a slower rate of growth of 2.7 percent. In labour-intensive and capital-intensive industry output growth is nearly five times as large between 1951 and 1975 as in the period of productivity slowdown between 1975 and 1992, whereas in knowledge-intensive industry output growth is less than twice as large in the first period. Output growth in knowledge-intensive industry does not experience the same slowdown as labour and capital-intensive industries. Yearly output growth in the last period 1992-2001 recovers quite well in capital-intensive industry as it grows by 2.3 percent per year in this period, and extremely well in knowledge-intensive industry where output grows at 5 percent per year. In labour-intensive industry there is barely any output growth at all in the last period.

The contribution of labour and capital

Table 7.1 shows that the contribution of labour is stable for the whole period in both labour-intensive and capital-intensive industries; -0.70 and -0.40 respectively. The negative coefficients for labour mean that output is growing as labour hours diminish, which is explained by substitution of capital for labour and increased labour productivity. In knowledge-intensive industry, the contribution of labour hours is positive for the first period but negative for the two later periods. The contribution of capital is stable over the whole period in all three industries but at different levels; in labour-intensive industry capital contributes about 0.30 percent per year, in capital-intensive industry approximately 0.60 percent per year and in knowledge-intensive industry capital contributes about 0.35 percent per year to output growth.

The contribution of TFP

In order to compensate for labour's negative contribution to output growth, the contribution of TFP sometimes exceeds output growth. In absolute terms capital-intensive industry has the largest TFP growth during the first period 6.6 percent, second comes knowledge-intensive industry 4.5 percent. Although TFP in labour-intensive industry only contributes 3.1 percent per year to total output in absolute terms; when estimated in percentage of output, labour-intensive industry shows the largest contribution of TFP in the first period as it contributes 115 percent. During the productivity slowdown in the period 1975-1992 yearly TFP growth in labour-intensive industry is only 30 percent of its former value. In capital-intensive industry yearly TFP growth is less than 20 percent compared to the first period. In knowledge-intensive industry, however, yearly TFP growth constitutes more than 60 percent of its former value. Hence, knowledge-intensive industry did not experience a productivity slowdown as intense as the labour-intensive and capital-intensive industries did. If estimated as percentage of output variation, although output is extremely low, the contribution of TFP growth is as high or even higher during the productivity slowdown compared to the periods pre-1975 and post-1992.

In the last period between 1992 and 2001 yearly TFP growth continues to fall in labour-intensive industry; its yearly growth rate decreases by 50 percent compared to the productivity slowdown. In capital-intensive industry yearly TFP growth is approximately 75 percent higher for 1992-2001 than it was during the productivity slowdown, and in knowledge-intensive industry yearly TFP growth is nearly 90 percent higher than its growth rate in the productivity slowdown. The strongest productivity slowdown in the period 1975-1992 consequently takes place in capital-intensive industry, whereas the most substantial recovery occurs in knowledge-intensive industry. The empirics are supported by Schön (1990) who stresses that the structural problems were the greatest in capital-intensive industries, whereas adaptation to new conditions and transformation to new technologies were the strongest in knowledge-intensive industry. I can also conclude that the contribution of TFP growth expressed as a percentage of output growth does not differ that much between the periods, which implies that variations in output growth are strongly connected with variations in productivity and is less affected by changes in labour and capital growth.

3 The economic regimes

This paper claims that each growth phase is characterized by different economic regimes imposing specific regulations on the labour and capital markets. Furthermore, economic regimes also differed in terms of fixed or floating exchange rates, the degree of governmental interventions and the stability in macroeconomic policies. This section aims at describing the particular features defining the macroeconomic regime in each period.

3.1 The Swedish model

It is important to first point out that what is often understood as a unique Swedish model was not consciously worked out according to some remarkable design. The Swedish model is better understood as an ex-post outcome of hundreds of separate decisions (Stråth, 1995). It is observed that quite a few policy actions were carried out simply to counteract undesired and often unpredicted side effects of previous policy actions, in the sense that ‘interventions breed interventions’ as Lindbeck (1997) puts it. I will try to summarize the main characteristics of the Swedish model, seen from an ex-post perspective.

The major questions on the political agenda from the late thirties and onwards concerned full employment policies, and more specifically whether part of the relatively larger margin for wage increases in high-income branches should be transferred to wage increases in low-income branches. After World War II, these ideas would leave a deep impression on the shaping of Swedish policy (Jonung, 1999; 2002b). The centralisation of the Swedish unions was successfully carried out in the late thirties and forties, which gave the possibility of coordinating the wage negotiations of companies nationwide. At the same time there was a gradual changeover from occupational-based unions to a federation of Swedish industries, which made it easier to carry out the wage equalization policy. There was also a deliberate centralization on the employers' side, striving for the centralization of wage formation in order to avoid wage increases due to competition amongst employers (Lundh 2002). Rehn and Meidner, two well-known economists of Landsorganisationen 'LO' (the Swedish confederation of trade unions), worked out a wage formation formula that could obtain full employment and price stability at the same time. The Rehn-Meidner model was based upon an idea of divided missions for the government and the trade unions, where the latter would represent their members' demands for wage increases, and the former would bear the responsibility for economic stability. The only restraint for wage increases was not to exceed the yearly national productivity increase in the tradable sectors and the rate of price increase on world markets. The fixed exchange rate in the context of the Bretton Woods system was supposed to keep inflation stable (Rehn, 1984; Erixon, 2000). Wages were to correspond to the principle of 'equal pay for equal work', leading to small wage differentials between sectors and regions, and profits were to be squeezed between a fixed exchange rate and rising wage costs. Since a proper valuation of work is not practicable in reality, the market was to regulate the wages by guaranteeing labour mobility (LO, 1951).

The Rehn-Meidner model assumed that high profits in tradable sectors would lead to a substantial amount of wage drift, that in turn would raise demand for corresponding wage increases from members in branches that had not benefited from the effect of the free market. Their idea was to bring down inflation by weakening the direct influence of profits on wage formation rising out of free market forces, and at the same time offset demand for compensatory wage increases and prevent the inception of wage compensation spirals (Elvander, 1988; Rehn, 1985).

The Swedish wage policy during this period, often referred to as the 'solidaristic wage policy' was also a means to stimulate national economic growth by productivity increase on a national level primarily through structural change. By adjusting wages in all branches to the median wage level in the whole economy, the least profitable firms and sectors were eliminated. In this way decreasing profits in low productive sectors released resources to more productive ones, which called forth structural change. It also brought about a moderating effect on domestic demand. Since the policy affected low-productive industries directed towards the domestic markets much more than export-oriented industries, it sped up rationalization and made labour available for high-productive export industries. The elimination of unprofitable production units due to the solidaristic wage policy was meant to facilitate and hustle the expansion of more remunerative sectors. As resources were being transferred from low-productivity sectors to high-productivity ones, there would also be an increase in national productivity growth (Rehn, 1984; Erixon 2000; Schön 2000, p. 403). According to the solidaristic wage policy, any negative effect on aggregate employment and investment would be cancelled out by mobility-improving labour market policies and investment subsidies. However, it is disputed whether such policy actions were effective (see Lindbeck, 1983; Forslund and Krueger, 1997).

3.2 The disintegration of the Swedish model between 1975 and 1992

Up to the 1970s the Swedish model was considered successful and progressive with regard to social development and economic growth. However, the disturbances and shocks to the economy in the 1970s put an end to the positive effects of the Swedish model. After the recession of 1971-1972 the stabilization policy failed to dampen the boom of 1973-1975. The failure of stabilization was related to supply side disturbances appearing in the form of a price system in disequilibrium. The fact that real wage costs were too high and the presence of a distorted exchange rate made the expansionary policy inadequate and inefficient (Lundberg, 1985). Economic growth slowed down in the seventies as competition increased on the export markets and the international demand for mass-produced low-margin industrial goods decreased considerably. Despite a vast reduction in relative unit labour costs, Sweden faced a gradual decline in its market share in other OECD countries. Moreover, Swedish aggregate terms of trade fell by a total of 25 percent from 1960 to 1992 (Jagren and Jakobsson, 1993). This clearly demonstrated that economic policy had to be formulated in a manner that considered the functioning of the price and wage system on microlevels. The fall of the Swedish model was essentially a political development due to the political crisis and intense confrontation between socialist and non-socialist parties, yet it delivered resilient effects of great importance for economic activity.

After the Bretton Woods-system collapsed at the beginning of the 1970s, Sweden became a member of an exchange union mainly based on the German mark. When the Swedish inflation model finally broke down in the mid-1970s after the first oil crisis, it was the end of an economic regime which had ruled for more than 25 years. At this stage the Swedish government pursued an accommodation policy striving to maintain high employment by fiscal expansion, which was to 'bridge over' the international recessions in 1973 and 1979 related to OPEC I and OPEC II. Following an accommodation policy was meant to avert the effects of sudden changes in macro-economic factors such as international demand; however, it also led to a substantial rise in the price level, an overvalued Swedish krona and low investment rates in the tradable sectors throughout the late 1970s and the 1980s (Jonung 1999; Schön, 2000). Accordingly, the Swedish model was clearly in transformation.

In order to restore profitability in Swedish manufacturing industry, which went down considerably in the seventies, the Swedish krona was devalued four times between 1976 and 1982. This is how the new macroeconomic policy regime, characterised by recurrent discretionary devaluations, was launched.[80] The devaluation in combination with the accommodation policy, made wage costs increase some 65 percent between 1975 and 1976, and created a rather steep inflation trend.[81] Moreover, it brought about wage-devaluation cycles producing strong fluctuations between overvalued and undervalued exchange rates, which increased instability and acted as an intermediary of economic uncertainty (Jakobsson, 1997).

The Swedish capital market was deregulated during the 1980s, meaning that commercial banks could lend money without direct restrictions from the central bank. Since nominal interest rates were fully deductible against high marginal personal income tax rates, almost everyone with a high income would borrow money at interest. The loans were partly

[80] For a further discussion on causes and consequences of the regime shift see Lindbeck (1997) and Freeman and Swedenborg (1997).

[81] Swedish CPI increased by approximately eight percent per year during the 1980s as compared to six percent in the other OECD countries, but Swedish open unemployment was kept low, 1.5-3.5 percent, whereas it increased sharply in the rest of the OECD (the appendix in Lindbeck, 1997).

consumed in household and other consumption, but a great deal was invested in the stock markets and, hence, the external capital supply increased for companies, which became more dependent on the stock market and monitored by market forces. Since this resulted in a rapid growth in the demand and supply of credits, a new inflationary element emerged: the outburst of asset prices, specifically the prices of real estate and shares. The sharp rise in real estate prices was followed by a strong building boom and a simultaneous boom in consumption, which together resulted in an overheated economy and a new wage-cost inflation of approximately 9 percent per year from 1984 to 1992 (Werin, 1993; Jacobsson, 1997; Schön 1994, 2000). The eighties were a decade of diverting trends as the interest rate increased at the same time as the external capital supply was raised. Due to devaluation and tax deductions, there was income redistribution from wages to profits and more capital circulated in the economy (Schön 1994).

3.3 The development in 1992-2001

In a budget proposal in January 1992, low inflation was established as the main target of Swedish macroeconomic policy. The political incentives were clearly influenced by the political agenda in the rest of Western Europe, however, Sweden differed in that policy makers believed that only a fixed exchange rate was able to keep inflation low and re-establish macro-economic stability (Jonung, 2002). Due to regulations established in the 1990s, freedom for the government to carry out Keynesian policies was much limited. The new policy succeeded in bringing down inflation to about three percent, yet it failed in the sense that new devaluations were unavoidable. In spite of the enormous increase of about 500 percent in interest rates for loans in the Swedish Central Bank in order to maintain the fixed exchange rate, Sweden adopted a floating exchange regime in 1992. The substantial depreciation that followed, approximately 20 percent, took the economy out of the crisis in 1993 (Lindbeck, 1997; Jonung 1999 and 2002b; Fregert and Jonung, 2003). The floating exchange rate had the same effects as devaluation; the domestic market became relatively less important and the importance of foreign price information and export was reinforced. The flexible exchange rate lowered the price of Swedish products on the international market via depreciation, which resulted in a strongly increasing demand for Swedish products. In the decade 1992-2001 productivity recovered substantially, especially in knowledge-intensive industries but also in capital-intensive industries.

4 The interrelation of profits and blue-collar wages pre- and post-1975

I have emphasized that a common view among economists, especially those making use of institutional theory, is that institutional rigidities and changing economic regimes affect factor markets and, therefore, constitute an important element in explaining consistency and change in macro-economic variables. However, in order to address economic regimes as an explanation for shifting rates of productivity growth in different periods, I first need to empirically control for whether the regime shift actually affected real macro-variables. A relevant test for whether the different economic policies pre- and post-1975 produced empirical effects is to examine the relation between profits and wages during the same periods. The solidaristic wage policy aimed to offset profits' effects on wages, while the policy after 1975, when the Swedish inflation model fell apart, was more favorable to promoting such effects. If the two economic regimes were effective I can expect profits to have a stronger effect on wages during the latter period compared to the pre-1975 period. The VAR model is used to contrast the effects of profits on blue-collar wages. T-statistics over two are generally considered as significant on the five percent level. Since it is not possible to separate metal manufacturing from engineering, they are both included in engineering industry.[82] Therefore, I have 9 instead of 10 industries.

[82] Due to lack of data I are not able to test for the whole period post-1975, but stop in 1994.

Table 2 Net profits effect on blue-collar wages in the short-run in 9 Swedish manufacturing industries pre- and post-1975

	1953 - 1975		1975 - 1994	
Industrial sector	Coefficient	T-stat	Coefficient	T-stat
Basic metal industries*	-0.22	-0.07		
Manufacture of non-metallic mineral products, except products of petroleum and coal	-0.06	-0.77	0.13	3.58
Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products	0.09	0.9	0.11	2.78
Manufacture of food, beverages and Tobacco	-0.03	-0.48	0.07	2.47
Manufacture of paper and paper products	0.00	1.35	0.08	3.13
Printing, publishing and allied industries	-0.2	-1.7	0.03	1.26
Textile, wearing apparel and leather industries	0.03	0.34	0.05	1.87
Manufacture of wood and wood products, including furniture	0.06	1.83	0.06	2.86
Manufacture of fabricated metal products, machinery and equipment	0.06	0.17	0.05	2.51

Note: * No estimation post-1975 due to negative log values

The VAR estimations in table 7.3 show a distinctive difference between the two periods. Before 1975 there is no short-run relation between profits and wages in any of the industries. After 1975 there is a positive and significant relation in 6 of the 9 branches; the exceptions are basic metal industry, printing and publishing industry and textile industry. Thus, the empirical analysis confirms that the different policies pre- and post-1975 to a large extent affected the relation between profits and wages.

5 Specifying the model

The main concern from an econometrical viewpoint is to find steady state relations between TFP and the other variables; therefore, an error correction model for this aim is specified. The empirical analysis follows the general-to-specific approach of Hendry (1993) based on a VAR model with I(1) restrictions (Johansen 1996).

The variables described in chapter 3 are included in the variable vector X_t, defined as

$$X_t = [\; Y_t \quad M_t \quad D_t \quad R_t \quad E_t \;]$$

where Y_t is total factor productivity (TFP), M_t is machinery investments, D_t the share of employees in higher occupational positions in organization, administration and sales of the total work force, R_t the share of employees in higher occupational positions in research, engineering and product development of the total work force, E_t is export, and t express time. All variables are in natural logarithms. The empirical analysis in this study applies to estimations based on the variable vector X_t using the cointegrated VAR approach. The series may have nonzero means and deterministic trends, as well as stochastic trends. Similarly, the cointegrating equations may have intercepts and deterministic trends. Since the asymptotic distribution of the likelihood ratio (LR) test statistic for the reduced rank test depends on the assumptions made concerning deterministic trends, I must choose one of five possibilities considered by Johansen (see Johansen 1996. pp. 80–4 for details). Some of the variables in the vector X_t contain a deterministic linear trend. A test for whether to include the trend or not suggests including a trend. It is then usually wise to include the trend since it may act as a proxy for missing variables outside the information set, meaning that I allow for both stochastic and deterministic trends. In our case a constant and a linear trend in both stationary and non-stationary directions describe the data best, hence this possibility is chosen for our models. The vector error correction form used in this study is as follows:

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \mu_0 + \alpha\beta'_0 t + \Phi D_t + \varepsilon_t$$

The long-run matrix Π can be decomposed as $\Pi = \alpha\beta'$ where α and β are two matrices of the dimension (p x r), where p is the number of variables and r is the cointegration rank, i.e. the number of cointegration relations. The β matrix represents cointegration vectors, which contain the cointegration parameters, that is, the parameters that indicate an equilibrium or long-run relation between the time series. The adjustment parameters α reflect the speed with which variables are drawn back to or drift further away from the equilibrium relation after a shock in the system. Furthermore Γ_i are p x p dimensional matrices of autoregressive coefficients. The elements $\mu_0 + \alpha\beta'_0t$ imply that a constant is included and that coefficients are restricted to the trend term, so that a linear trend is permitted in both stationary and non-stationary directions. Any dummies included in the model are denoted ΦD_t. Finally ε_t is the residual. Together with the dummies, the constant and the trend terms constitute the only deterministic components in the model.

Dummy variables are added for each industry depending on the data structure. Studying the residuals' standard deviations is usually a good way of finding any outliers; the following dummies are shown to be significant: In labour-intensive industry an intervention dummy or so-called blip dummy Φp is added for the year 1981 due to an outlier in human capital in "D". The model for labour-intensive industry has also been estimated with different types of dummies for 1994 in order to adjust for the behaviour in human capital in "R" research, engineering and product development, but human capital in "R" was still not required in the steady state relation. In capital-intensive industry two transitory dummies are added for 1975 due to outliers in TFP and export and for 1994 due to outliers in human capital in "R". For knowledge-intensive industry a shift dummy Φs is added for 1968 due to a shift in human capital in "R". Since the shift dummy is restricted not to be included in the cointegration space, it does not affect the asymptotic distribution by giving lower t-values. Important to notice is that I are referring to outliers in the residuals and not in the variables presented in chapter three. The sources for such outliers are often hard to trace. I can motivate outliers in 1975 by the shock in oil prices, furthermore I can motivate why this affect TFP and export only in the capital intensive industry, since it heavily depends on international demand and TFP is closely related to economies of scale. Yet, the reasons for why I need the other dummies I find harder to render.

Determining lag length is the first step towards specifying a well-suited statistical model for each data set. The appropriate lag length is determined by analysing information criteria such as Hannan-Quinn and Schwartz. Based on this, one lag length is here chosen as the appropriate one in the VAR model for each industry.

5.1 Identifying the number of cointegration relations

Determining the rank of a process means identifying the number of cointegration relations within a given dataset. When the data is stationary the simple equation-by-equation OLS estimator is identical to the FIML (full information maximum likelihood) estimator, but when the data contains unit roots the likelihood estimator must be derived subject to reduced rank restrictions. In other words, only when the process is stationary, can the moving average representation be generated directly by inverting the VAR model so that the time series vector at present time is expressed as a function of past and present shocks. If the VAR process is nonstationary, as in our case, the matrix for the time series vector is non-invertible, and we can only find the MA representation under the assumption of reduced rank of the Π matrix. The nonstationarity of the variables in the VAR model is accounted for by a reduced rank condition on the long-run matrix $\Pi = \alpha\beta'$. Reduced rank implies that there are fewer rows than columns or fewer columns than rows in the matrix, which is feasible because stationary linear combinations of variables compensate for the nonstationarity in the variables. Since the number of long-run steady state relations must be fewer than the number of nonstationary variables, the matrix must naturally have reduced rank. If we have five nonstationary variables we can have at most four cointegration relations. To sum up: (a) when the VAR model contains unit roots, the autoregressive lag polynomial becomes non-invertible, which can be solved provided that: (b) stationary linear combinations of the nonstationary variables of the vector process are integrated of lower order than the process itself. [83]

The procedure of finding out whether a vector can be made stationary by making linear combinations of time series in the vector is called cointegration testing or testing the rank. The trace test developed by Johansen (1988; 1991; 1996) seeks to test the rank of the matrix Π by means of the reduced rank regression technique. The trace test builds on eigenvalues λ_i. The magnitude of λ_i is an indication of how strongly linear combinations are correlated with the stationary part of the process. The trace test estimates the matrix in an unrestricted form, and then tests if we can reject the restrictions implied by the reduced rank of Π. When $\lambda_i = 0$ there is no error correction to a linear combination, hence the linear relations are non-stationary. If all λ_i , $i = 1\ldots,p$, are zero, all linear combinations are non-stationary and there are no cointegration relations among the variables. The null hypothesis is that there are at most r cointegration relations. If we have p endogenous variables, each of which has one unit root, the linearly independent cointegrating relations can range from zero to p - 1. CATS

[83] For a more exact description of how to spot the number of stationary linear combinations and thus set the rank see Johansen (1996) chapter 3 and Juselius (2003) chapter 5.

software implements VAR-based cointegration tests using the methodology developed by Johansen (1995; 1996).

In order to determine the rank we proceed sequentially from r = 0 to
r = *p* - 1 until we fail to reject the hypothesis. First, we test whether there is no cointegration relation (*r*=0) against the alternative of a stationary model (r = *p*). If that hypothesis is rejected we continue by testing whether there is at most one cointegration relation and so on until we fail to reject.

Table 3 Testing for cointegration in each branch-specific data set

Rank	Labour-intensive		Capital-intensive		Knowledge-intensive	
	Eigenvalues	p-value	Eigenvalues	p-value	Eigenvalues	p-value
r = 0	0.77	0.00	0.81	0.00	0.68	0.00
r ≤ 1	0.57	0.03	0.53	0.01	0.47	0.00
r ≤ 2	0.28	0.78	0.35	0.31	0.41	0.07
r ≤ 3	0.10	0.95	0.18	0.77	0.25	0.50
r ≤ 4	0.08	0.72	0.05	0.90	0.04	0.95

The first column presents the eigenvalues, and the second column gives the *p*-values for the null hypothesis: the process can be made stationary in at most *r* cointegration relations. Using a critical value at five per cent implies that p-values above 0.05 cannot reject the null hypothesis, and that the number of cointegration relations equals the rank tested for. The lowest rank that fails to reject should be applied in the model. The trace test clearly suggests rank two for capital-intensive and labour-intensive industry. The number of cointegration relations in knowledge-intensive industry is less certain, however. The p-values for two cointegration relations are 0.07. When the test results are uncertain, we can obtain more information by considering the number of roots inside the unit circle in the companion matrix, and the number of columns in which coefficients show significant t-values in the α-matrix. The α-coefficients present the speed of adjustment back to equilibrium, and the first column in the α-matrix corresponds to the first cointegration relation. We can thus expect significant coefficients in as many columns in the α-matrix as there are cointegration relations. The speed of adjustment to additional cointegration relations is nonsignificant or very slow

(Juselius 2003 chapter 5). Knowledge-intensive industry shows two roots inside the unit-root circle, and only the first two columns have significant α coefficients; therefore rank two is chosen for knowledge-intensive industry as well.

5.2 Identifying the cointegration relations

Identifying the cointegration relations means setting restrictions on their structure at the same time as giving these stationary linear combinations an economically meaningful interpretation. Economic theory may suggest that the cointegration relations take a specific form, which broadens the understanding of the statistical processes. First, I formulate theoretical hypotheses about the interrelations of variables, then I make use of a design matrix, in which I can restrict the cointegration vector to reflect our hypotheses, and finally I test whether the cointegrating space can be structured in the suggested way. The intention is to choose a formulation of the design matrix that can spot the steady state relation appearing in the data, which is realised by finding a linear combination of $\beta_{1,\dots,}\beta_r$ that produces a vector not significantly different from the estimated parameters in the cointegration relation.[84] A model where identifying restrictions are set on all cointegration vectors is known as the equilibrium error correction term. As mentioned, in an error correction model, the short-term dynamics of the variables in the system are influenced by the deviation from the steady state relation.

Different hypotheses on the interrelations of TFP, machinery investment, human capital in "D" administration, organisation and sales and "R" research, engineering and product development, and export will be tested on the data set for each type of industry. Each hypothesis is formulated as a restricted linear combination of certain variables, which corresponds to a steady state relation supported by economic theory. In this test I impose restrictions on just one of the vectors, leaving the second vector unrestricted. The null-hypothesis is that a linear combination is stationary, which means that the stochastic trend is cancelled and a steady state relation is identified. Cointegration testing is criticised for lack of power in terms of significance (e.g. Maddala, 1998; Kwiatkowski et al. 1992). I raise the usual critical level of significance of 0.05 to 0.1; accordingly p-values above 0.1 imply that the hypothesis of stationarity cannot be rejected. However, large p-values only confirm that the linear combination of variables is stationary. It is, therefore, important to interpret the

[84] For a more detailed explanation see Johansen (1996).

coefficients’ signs in order to determine whether the time series’ behaviour reflects the growth mechanism presented in the hypothesis. When the variables are in logarithms, as in this study, the coefficients constitute elasticities.

To be able to interpret a cointegration relation as primarily connected with a particular variable, I may normalize the former on the variable of interest, in this case, TFP. This procedure is similar to determining the dependent variable in a regression model. A key difference is that the choice of the dependent variable in a regression model changes the estimates of the regression coefficients, whereas in a cointegration relation the ratios between coefficients are the same independent of the chosen normalization. In practice, normalization means setting a chosen variable *X* to unity and then dividing all variables' coefficients with the *X*-coefficient so that *X* becomes 1 (Juselius 2003). Hence, normalising on TFP implies that all variables are divided by the TFP coefficient so that TFP becomes 1, which facilitates the interpretation of the proportional relation between the variables.

A homogeneous relation between certain variables implies that their β-coefficients sum to zero. In order to study the interrelation of TFP and the other variables, I move TFP to one side of an ‘imagined’ equation, which means that I automatically alter the signs on all the other variables’ coefficients. This exercise should ensure that coefficients within a homogeneous relation sum to one.[85] All hypotheses in this study are restricted so that all coefficients within a homogeneous relation should be positive in order to confirm the economic motivation for the hypothesis.

5.3 Formulating 8 hypotheses about economic growth

Since all industries have rank two I need to identify two cointegration relations, that is, two stationary linear combinations of variables in each industry. This section formulates eight hypotheses for homogenous relations between TFP and one or more of the other variables. I argue in line with Romer (1990) and Lucas (1988) that growth is endogenous and strongly connected with human capital accumulation. Both Romer and Lucas assume that the economic growth rate is proportional to the rate of growth in human capital so that when the amount of knowledge increases by one unit, growth increases by one unit as well. As already mentioned, this kind of one-to-one relation is referred to as homogeneity. It is feasible to test

[85] It should be noted that moving TFP to one side of an equation is purely for demonstration, and that TFP is not the only dependent variable, but that all endogenous variables are dependent.

whether a homogenous relation prevails between e.g. human capital in "R" research engineering and product development and TFP growth by restricting the linear combination of these variables to being homogeneous. Hence, testing H1 to H8 gives information of vital importance in identifying the growth mechanisms reflected by the time series long-run properties. I should, however, be very clear about one thing: Even though homogeneity between TFP and human capital in "R" cannot be rejected, it only points towards a consistent one-to-one relation between these variables over time, and does not reveal the causality between them. In order to identify which variable is dependent and which is exogenous I need to analyse the α coefficients for speed of adjustment. Moreover, when interpreting homogeneity between certain variables I should be cautious about the sign and size of other variables not included in the homogenous relation, yet included in the cointegration relation. I may find a homogenous relation between a pair of variables, which only appears if a third variable is interacting with them in a certain way. This and similar concerns will be discussed in section 5.5 as the two cointegration relations are jointly identified in each industry.

(H1) Productivity growth through embodied technological progress and learning-by-investing

Changes in the capital stock are sometimes necessary to achieve technological progress. When technological improvements are embodied in the capital stock is referred to as embodied technological progress. The idea is that net or replacement investment increases the extent of embodied technological progress because the equipment available on the market embodies the latest technology. Learning-by-investing means that diminishing factor returns are offset because knowledge creation is a side product of investment. A firm that increases its physical capital learns simultaneously how to produce more efficiently (Arrow, 1962). This hypothesis assumes that embodied technological progress and learning-by-investing are both connected with machinery investments and go hand in hand. The hypothesis is tested through restrictions to only allow homogeneity between TFP and machinery investments, meaning that TFP will increase in the same proportion as machinery investments. The following linear combination is tested for stationarity:

$$\beta_1(Y-M) + \beta_2 D + \beta_3 R + \beta_4 E \sim I(0)$$

(H2) Productivity growth through human capital accumulation in "D"

This hypothesis implies that specifically human capital in "D" generates productivity growth; hence the share of highly skilled employees in administration, organisation, and sales, of the total work force, is the most essential factor causing TFP growth. The hypothesis is tested through restrictions to only allow homogeneity between TFP and human capital in "D". The following linear combination is tested for stationarity:

$$\beta_1(Y\text{-}D) + \beta_2 M + \beta_3 R + \beta_4 E \sim I(0)$$

(H3) Productivity growth through human capital accumulation in "R"

This hypothesis implies that exclusively human capital in "R" generates productivity growth; hence, the share of highly skilled employees in research, engineering and product development, of the total work force, is the most important determinant of TFP growth. The hypothesis is tested through restrictions to only allow homogeneity between TFP, and "R". The following linear combination is tested for stationarity:

$$\beta_1(Y\text{-}R) + \beta_2 M + \beta_3 D + \beta_4 E \sim I(0)$$

(H4) Productivity growth through human capital accumulation in "D" and "R"

This hypothesis implies that human capital in both "D" and "R" is essential for growth in TFP. The motivation reads that highly skilled workers in both fields: administration, organisation and sales on the one hand and research, engineering and product development on the other are complementary and may only cause TFP growth together. The hypothesis is tested through restrictions to only allow homogeneity between TFP, "D" and "R". The following linear combination is tested for stationarity:

$$\beta_1(Y\text{-}D) + \beta_2(Y\text{-}R) + \beta_3 M + \beta_4 E \sim I(0)$$

(H5) Productivity growth through embodied technological progress, learning-by-investing and human capital accumulation in "D"

This hypothesis implies that investments in both human capital and physical capital are essential for productivity growth. More than leading to embodied technological progress and learning-by-investing, machinery investments may call forth changes in the administration and/or the organisation, which also affect productivity. This hypothesis implies that human capital in "D" and machinery investment constitutes complements which only together are able to cause TFP growth. The hypothesis is tested through restrictions to only allow homogeneity between TFP, machinery investments and "D". The following linear combination is tested for stationarity:

$$\beta_1(Y\text{-}M) + \beta_2(Y\text{-}D) + \beta_3 R + \beta_4 E \sim I(0)$$

(H6) Productivity growth through embodied technological progress, learning-by-investing and human capital accumulation in "R"

This hypothesis implies that human capital in "R" research, engineering and product development constitutes a complement to machinery investments. Hence, human capital in “R” can only generate productivity growth if accompanied by machinery investments, and vice versa. The hypothesis is tested through restrictions to only allow homogeneity between TFP, machinery investments and "R". The following linear combination is tested for stationarity:

$$\beta_1(Y\text{-}M) + \beta_2(Y\text{-}R) + \beta_3 D + \beta_4 E \sim I(0)$$

(H7) Productivity growth through embodied technological progress, learning-by-investing and human capital accumulation in "D" and "R"

This hypothesis implies that human capital in "D" and "R" and machinery investments together constitute complements, which generate productivity together. The hypothesis is tested through restrictions to only allow homogeneity between TFP, machinery investments, "D" and "R". The following linear combination is tested for stationarity:

$$\beta_1(Y\text{-}M) + \beta_2(Y\text{-}D) + \beta_3(Y\text{-}R) + \beta_4 E \sim I(0)$$

(H8) Productivity growth through economies of scale

This hypothesis implies that increased exports generate economies of scale and affect capacity utilisation, both of which give rise to increased productivity: the former by means of lowering costs and the latter by higher efficiency. The hypothesis is tested through restriction to only allow homogeneity between TFP and export. The following linear combination is tested for stationarity:

$$\beta_1(Y\text{-}E) + \beta_2 M + \beta_3 D + \beta_4 R \sim I(0)$$

Table 4 Jointly identified cointegration relations in labour-intensive, capital-intensive and knowledge-intensive industries

Labour-intensive industry χ^2 *0.08, df 2, p-value 0.96*						
Hypothesis	β Y	Β M	β D	β R	β E	β T
H1	1	-1	0.97	0.07	-0.13	0.01
H2	1	1.27	-1			-0.01
Capital-intensive industry χ^2 *1.16, df 2, p-value 0.56*						
Hypothesis	β Y	β M	β D	β R	β E	β T
H3	1	0.04		-1	0.24	0.01
H8	1		0.15	3.68	-1	-0.05
Knowledge-intensive industry χ^2 *0.47, df 2, p-value 0.79*						
Hypothesis	β Y	β M	β D	β R	β E	β T
H3	1	0.42	0.14	-1		-0.01
H5	1	-0.78	-0.22	1.84		0.02

Note: Y is TFP, M is machinery investments, D is human capital in administration, organisation and sales, R is human capital in research, engineering and product development, E is export, T is the trend, df is degrees of freedom

The results of joint identification in table 5.2 show that *p*-values in all industries are far above 0.10 and thus strongly indicating that the two hypotheses suggested in each industry are significantly different from each other. Accordingly, I claim the first cointegration relation in labour-intensive industry is identified as H1 *Productivity growth through embodied technological progress and learning-by-investing*, whereas the second cointegration relation is identified as H2 *Productivity growth through human capital accumulation in "D"*. In capital-intensive industry I assert that H3 *Productivity growth through human capital accumulation in "R"* and H8 *Productivity growth through economies of scale* represent the two steady state relations. Finally, I state that the two cointegration relations in knowledge-intensive industry are identified as H3 *Productivity growth through human capital accumulation in "R"* and H5 *Productivity growth through embodied technological progress, learning-by-investing and human capital accumulation in "D"*.

6 Adjustment mechanisms in three phases of growth

I know that TFP growth was higher in the period before 1975 and the period after 1992, but was rather low and strongly fluctuating in the period between 1975 and 1992. According to our theoretical framework, investments in research and product development are expected to increase during periods when demand decreases or is expected to decrease, whereas machinery investments are expected to rise with increasing demand. However, the extent to which investments follow expected opportunity costs depends on how predictable these are. This section analyses the influence of stability in macroeconomic policy on economic activity, and especially on investment behaviour.

I have identified two long-run steady state relations in each industry based on data for the whole period from 1952 to 2001. Although variables are cointegrated and move together in the long-run, the adjustment behaviour of individual variables may still differ in the three growth phases. The long-run steady state relations constitute an attractor set towards which endogenous variables are drawn back or moves further away after a shock in the system. Variables' adjustment to the steady state guarantees the re-establishment of long-run equilibrium. For example, endogenous growth theory identifies a long-run relationship between output growth and human capital. If a situation occurs in which the gap between output and human capital widens considerably, such that human capital increases and/or output decreases, there are several ways to close the gap e.g: (a) an increase in output or a decrease in human capital; (b) an increase in human capital accumulation with a commensurately greater increase in output; or (c) a fall in human capital accumulation with a smaller fall in output. Without a full dynamic specification of the model, it is impossible to determine which of the possibilities will occur. What I do know is that the endogenous variables' short-term dynamics must be influenced by deviations in the long-run relationship to re-establish the steady state relation. Thus, in order to determine the behaviour of each variable, I need to specify a model in which variables' adjustment to the previous period's deviation from the steady state and direct effect of other variables can be analysed. Estimating simultaneous least square regressions on the order condition for each period exposes variables' response to deviations in the steady state in different periods.

I claim that variables' adjustment to disturbances in the steady state relations will diminish substantially in periods when future opportunity costs are less predictable, whereas investments will adjust more to movements in the steady state the more predictable future opportunity costs are. It is conceivable that periods with stable macroeconomic policy induce more predictable opportunity costs, whereas instabilities in macroeconomic policy are likely to engender uncertainty among investors. Similar to Jonung (1999) I look at the consequences of instable policy-making for investments, more specifically, how stability or the lack of stability influences the predictability of opportunity costs of different types of investments. The fast moves between devaluations and wage-cost crises in the economic regime between 1975 and 1992 did not offer one-sided incentives for investment decisions in the short-run. Such a situation would possibly encourage more long-run investments, e.g. in developing new techniques and inventing new products. Then again, given that investment in research and product development always takes place at the expense of current production, board of directors would have to risk losing the opportunity to make short-run profits from mark-ups e.g. as a result of increased exports after further devaluations. Investing according to long-term perspectives would block out other alternatives and thereby fail to secure possible short-run devaluation profits. This situation leads to continuous high opportunity costs of directing R&D investments to create innovation-based mark-ups, especially in capital-intensive industries due to their strong dependence on demand and considerable possibilities of making profits on economies of scale and mark-ups in case of future devaluations. The frequent cost crises and devaluations, which characterised the economic regime in the late 1970s and the 1980s, gave rise to uncertainty among investors and thus resources were not allocated in relation to long-term competitive factor prices on the world market. Especially industries that were heavily dependent on export experienced low returns during crises and rather high returns following devaluations. Moreover, there were growing expectations of a future devaluation of the Swedish krona from the second half of the 1980s, which were reflected in interest rate differentials of 2-4 percentage points between Swedish and German bonds (Lindbeck, 1997).

The period 1975-1992 suffered from both low demand and weak predictability of opportunity costs; consequently I can expect the coefficients for CR1 and CR2, indicating variables adjustment, to be smaller in the equations for machinery investments and human capital in “D” administration, organisation and sales, and human capital in “R” research, engineering and product development during this period. On the other hand, the same variables are expected to show large adjustment coefficients in the period 1952-1975, since the ruling macroeconomic policy during the Swedish model was much more stable. In particular wage costs were foreseeable since wages were not affected by profits but were kept at a low level corresponding to national average productivity. It has been shown that macroeconomic instability was lower in Sweden compared to most other OECD countries until about 1970 (Lindbeck, 1975, pp. 88-89; Boltho, 1989). The period from 1992 to 2001 was once more characterised by macroeconomic stability. Setting low inflation as the main target for macroeconomic policy in 1992 was a governmental means to restore macroeconomic stability. Policy makers were, however, forced to abandon the idea of a fixed exchange rate in order to repress inflation, and only when the Swedish exchange rate was made flexible in 1992, a new period of macroeconomic stability was initiated. Bergvall (2005) shows that the choice of exchange rate regime clearly influenced macro-economic stability in Sweden in the early 1990s; output would have been substantially more volatile under a hypothetical fixed exchange rate regime compared to the actual exchange rate regime. A similar result is reported by Ghost (1997). Furthermore, the new regulations established in the 1990s limited the possibility for the government to carry out Keynesian policies, which brought an end to short-term oscillations between profits and cost crises. Accordingly, I can expect the adjustment in machinery investments as well as investments in human capital in “D” and “R” to have been fairly large during this period. The flexible exchange rate, however, increased the difficulty of foreseeing future profits, and since total wage-costs were influenced by profits, relative factor costs and opportunity costs, they were less predictable in 1992-2001, compared to the period 1952-1975.

Negative signs of the cointegration relations (CRs) imply adjustment behaviour, whereas positive signs mean that variables react to changes in the steady states by drifting further away. All other coefficients should be interpreted according to ordinary least square regressions. In order to provide reader friendly tables I only present the coefficients in the tables; the complete output is shown in appendix C. The sample starts in 1954 due to differentiations and 1 lag

6.1 Adjustment dynamics in labour-intensive industry in three periods

The first cointegration relation in labour-intensive industry reflects embodied technological progress and learning-by-investing, tested by homogeneity between machinery investments and TFP. The second cointegration relation reflects endogenous growth through human capital in organisation, administration and sales, tested by homogeneity between TFP and “D”. Accordingly TFP, machinery investments and “D” are the variables that are foremost expected to re-establish the steady state. The table below present TFP, Machinery investments and Human capital in “D” as endogenous variables in an SLS equation system; the coefficients report what impact e.g. CR1 and export have on these variables in the three phases.

Table 5 Identification of the short-run dynamics for TFP, machinery investment and human capital in "D" in labour-intensive industry in three periods

Period	1954-1975	1975-1992	1992-2001
		TFP	
Constant	-0.01	-0.01	0.02
CR1	-0.48	-0.63	-0.51
CR2	-0.41	-0.63	-0.45
(d)D			
(d)E	0.26		0.33
R2	0. 52	0.73	0.72
		Machinery investments	
Constant	0.03	0.03	-0.1
CR1	2.85	0.40	1.22
CR2	1.57		1.24
(d)R			-0.52
(d)E			1.34
R2	0.73	0.22	0.88
		Human capital in "D"	
Constant	0.05	0.01	0.07
CR1	-0.66		-0.30
CR2	-0.53		-0.47
(d)M		0.27	
(d)E			-0.57
R2	0.38	0.29	0.59

Note: see table 4 for abbreviations. The complete output is found in Appendix C

The results in table 5 very much support our hypothesis: Adjustment is larger in the variables constituting endogenous relationships with TFP the first period when macroeconomic stability produces more predictable opportunity costs. Machinery investments and human capital in "D" show much weaker adjustment during the productivity slow-down between 1975 and 1992, when economic policies are unstable and hence future opportunity costs are less predictable. In the last period 1992-2001, when the economy adopts a flexible exchange rate and a stable economic policy regime is re-established, variables show a larger adjustment to deviations in the steady state, than during the productivity slowdown. The fact that TFP adjusts to both cointegration relations (CR1 and CR2) in all three periods, and stronger during the productivity slowdown, is rather logical. Since the two other variables included in the homogeneous relation, machinery investments adjust only weakly to CR1 and human capital in “D” does not adjust at all in the period 1975-1992, the steady state can only be re-established by a falling TFP growth. Export has a positive and rather large effect on machinery investments and TFP in the last period, which may indicate productivity gains due to embodied technological progress and learning-by-investing.

6. 2 Adjustment dynamics in capital-intensive industry in three periods

The first cointegration relation in capital-intensive industry reflects endogenous growth through human capital in engineering, research and product development, which is tested by homogeneity between TFP and “R”. The second cointegration reflects economies of scale, tested by homogeneity between TFP and export. Hence, TFP, human capital in “R” and export are expected to be the primary variables to re-establish the steady states. However, export is shown not to adjust to any of the steady states, whereas machinery investments do; which is logical considering that demand, estimated by export, is argued to be the common stochastic trend driving the whole system. Accordingly I include machinery investments instead of export in the model.

Table 6 Identification of the short-run dynamics for TFP, machinery investment, human capital in "R" in capital-intensive industry in the three periods

Period	1954-1975	1975-1992	1992-2001
TFP			
Constant	-0.01	-0.03	-0.01
CR1	-0.81	-0.75	-0.60
CR2	-0.21	-0.25	-0.11
(d)E	0.42	0.61	0.14
R2	0.72	0.87	0.67
Machinery investments			
Constant	0.12	-0.01	0.01
CR1	-0.28	1.07	3.23
CR2			0.61
(d)D			-1.89
(d)R	-0.36		-0.63
(d)E	-0.71		
R2	0.11	0.19	0.86
Human capital in "R"			
Constant	0.06	0.01	0.02
CR1	-0.56		-0.99
CR2	-0.35	-0.10	-0.39
(d)M			
(d)E			0.33
R2	0.56	0.23	0.54

Note: CR is the cointegration relation, M is machinery investments, D is human capital in organisation, administration and sales, R is human capital in research, engineering and product development, E is export. The complete output is found in Appendix C

Table 6 shows that TFP adjusts rather quickly to the two cointegration relations during all three periods, just as with labour intensive industry. For capital-intensive industry I also find strong support for our assumptions. Adjustment is larger in the first period ruled by macroeconomic stability and high predictability of opportunity costs. Adjustment towards the steady states in human capital in "R" is much weaker during the productivity slowdown than in the periods before and after, as expected. Furthermore, I find empirical support for the argument that productivity and investments in machinery were closely related to demand during the wage and inflation policy of pre-1975, since machinery investments react to export rather than to CR1 and CR2 in the first period. In the last period 1992-2001, when a stable economic policy regime is re-established as the economy changes to a flexible exchange rate, machinery investments show a very large adjustment to deviations in CR1. In contrast to labour-intensive industry, export has a large effect on TFP during the productivity slowdown in capital-intensive industry, meaning that demand has a more important role for fluctuations in TFP during the productivity slowdown. The strong cost and devaluation cycles in this period specifically affected capital-intensive industry due to its strong demand dependency.

6.3 Adjustment dynamics in knowledge-intensive industry in three periods

The first cointegration relation in knowledge-intensive industry reflects endogenous growth through human capital in research, engineering and product development, which is tested by homogeneity between TFP and human capital in “R”. The second cointegration reflects embodied technological progress, learning-by-investing and endogenous growth through human capital in organisation, administration and sales, tested by homogeneity between TFP, machinery investment and “D”. Accordingly, TFP, human capital in “R”, machinery investments and human capital in “D” are the variables expected to re-establish the long-run steady states.

Table 7 Identification of the short-run dynamics for TFP, machinery investment, human capital in "D" and human capital in "R" in knowledge-intensive industry

Period	1954-1975	1975-1992	1992-2001
		TFP	
Constant	0.02	-0.04	-0.04
CR1	-0.98	-0.57	-0.70
CR2	-0.51	-0.19	-0.43
(d)D	-0.09		
(d)E		0.38	0.81
R2	0.91	0.82	0.88
		Machinery investments	
Constant	0.12	-0.06	-0.05
CR1	-0.25	1.09	0.45
CR2		1.23	0.54
(d)D			
(d)R	-0.73	0.69	
(d)E			0,28
R2	0.39	0.45	0.92
		Human capital in "D"	
Constant		0.09	0,03
CR1			-0.39
CR2		-0.25	-0.12
R2		0.16	0.76
		Human capital in "R"	
Constant	0.11	0.02	0.04
CR1	-0.89		-0.44
CR2	-0.51		-0.36
(d)E	-0.75	-0.29	
R2	0.40	0.09	0.54

Note: CR is the cointegration relation, M is machinery investments, D is human capital in organisation, administration and sales, R is human capital in research, engineering and product development, E is export. The complete output is found in Appendix C

Table 7 shows that the adjustment behaviour of TFP to the two cointegration relations is extremely fast in the first and rather fast in the third period, whereas it is a little slower during the productivity slowdown. Considering machinery investments and human capital in "D", I find no support for a slower adjustment to the steady states during the period of unstable economic policy 1975-1992, whereas human capital in "R" adjusts according to our hypothesis. In the first period machinery investment adjusts to the first cointegration relation and is negatively related to human capital in "R". Yet, during the productivity slowdown machinery investment reacts by drifting further away from both CRs and is positively related to human capital in “R”, which contradicts our hypothesis that investments in R&D and machinery investments always have opposite opportunity costs. This indicates that the aim was to substitute machinery for lower skilled workers rather than increasing investments in research and product development, possibly there was also a case of labour hoarding. In the post-1992 period machinery investment reacts to both steady states by drifting further away and shows a negative relation to human capital in “R”, which again is in accordance with our hypothesis on reverse opportunity costs of research and current production. Human capital in “D” shows no adjustments in the first period, but during the productivity slowdown it adjusts to CR2. In the last period, however, “D” adjusts to both steady states. Human capital in “R” adjusts to both steady states in the pre-1975 and post-1992 periods, whereas there is no adjustment during the productivity slowdown. Accordingly, I find some empirical support for our hypotheses on stability in economic policy-making, predictability in opportunity costs and adjustment behaviour.

Export has a large effect on TFP during the last period, which indicates that the complementarity between different types of knowledge accumulation is reinforced once demand for highly technological products rises. A general aspect regarding all three industries is that investments in human capital in “R” research, engineering and product development seems to be more sensitive for the predictability of opportunity costs than do the other variables.

7 Former explanations for the productivity slowdown

The slowdown in productivity of the Swedish manufacturing industry is generally agreed to be the result of exogenous factors affecting all industrialised countries. There are, however, several different ideas as to what made the Swedish productivity fall so deep, and why Swedish industries did so poorly in adjusting to the slowdown. This section aims at discussing the leading ideas on this topic. It is commonly argued that Sweden’s lower capital intensity constituted the main source of its unfavourable development.[86] There was clearly a falling rate of return to physical capital from 1950 until 1992, when the Swedish krona was floated. However, this was also the intention of the Rehn-Meidner model, which aimed to squeeze profits between rising wage costs and fixed exchange rates. From 1975 on, Swedish gross

[86] See Långtidsutredningen, 1999/2000; Lindbeck 1997; Fregert and Jonung (2003).

investments have grown more slowly than the gross national product; comparing the aggregate Swedish investment share with the OECD average shows a fall from a level of about 2.5 percentage points above the OECD average in the 1960s to a level of about 2 percentage points below the average in the 1980s.[87] Reduced capital intensity i.e. a falling investment/output ratio implies a lower capital/labour ratio, which is claimed to reduce GDP per capita in the long-run.[88] Aggregate investments in the manufacturing sector could be kept at a high level until the mid-1970, partly because interest rates were kept down by capital market regulations, partly because the rapid inflation was not fully reflected in nominal interest rates, and partly due to governmental investment subsidies to industries with specific profitability problems. The reduction of profit tax for firms that invested in their own production functioned as an investment subsidy in both the 1970s and the 1980s (Agell, Englund, Södersten, 1995; Lindbeck, 1990). In turn, this led to accentuated problems for basic Swedish industries such as mining, steel and shipbuilding, since more investments implied larger overcapacity on the international markets (Schön, 1994).

Most explanations of why productivity remained low for so long address, in one way or another, the macroeconomic policy in the 1970s and 80s. Instabilities in the macroeconomic policy between 1975 and 1992 is a frequently addressed justification for the failure to adjust to new economic conditions.[89] In the period 1950-1975 the macroeconomic policy intended to smooth private investments over time by tax regulations and subsidies, and to stabilise investments in housing and infrastructure by means of governmental control. The economic regime was characterised by macroeconomic stability. The period between 1975 and 1992 stood in stark contrast to the former period, since it was characterised by oscillations between cost crises and new mark-ups between labour cost and labour productivity due to repeated devaluations, which gave rise to uncertainty among investors who postponed investments. Since cost crises drove up real wages very high, which magnified total wage costs, capital formation was held down.

[87] Långtidsutredningen 1999/2000, SOU 2000:7. bilaga 1, table 2.1.
[88] See Jonung (1999; 2002) and Jonung & Fregert (2003), p. 163.
[89] For a further discussion on the Swedish stabilization policy and its effects on long-term growth see Torsten Persson (1990), Wissén (1982), Lindbeck (1997), Calmfors (1993), Jonung (1999), Werin (1993), Jonung & Fregert (2003), SOU 1993:16

7.1 Slower quality improvements and negative balance of trade

One obvious reason for Sweden's lower rate of GDP per capita growth relative to other OECD countries is that the value of what was produced for export had decreased in relation to the value of imports i.e. there were deteriorating terms of trade. Although this does not explain the productivity slowdown, it helps understand its context. The expansion of Swedish trade and the internationalisation of Swedish production made an effective control of international capital movements impossible. Since Sweden had a negative balance of trade and was forced to borrow money abroad, this transferred the international interest rates to Sweden. Borrowing money abroad also meant that a considerable part of Swedish production was used for paying off instalments, which lowered the prospect of national consumption and investments. Capital then became more costly as interest rates increased due to the international debt crisis in 1981-82 (Molander, 1992; Schön, 1994; Englund, 1995). The reason for lower investments is thus attributed to the cost of and access to capital. It is furthermore argued that the quality development of Swedish products over time was not as fast as the quality development of products produced abroad, which is interpreted as a consequence of insufficient investments in research and product development. Deteriorating terms of trade and falling productivity come hand in hand. Given that Swedish products did not keep pace with international quality development our productivity fell relative to theirs, which forced Swedish firms to lower their relative export prices. This forced Sweden to adjust wages downwards (Mitchell, 1992; Edin and Holmlund, 1995; Edin and Torpel, 1997). Like the United States, Sweden was a leader in product quality after World War II; however, the US managed to keep their leading position whereas Sweden lagged behind from the mid 1960s and onwards (Lindbeck, 1983; 1997).

7.2 The size of R&D investments and the share of high-technology production

It is generally argued that there is a strong correlation between the size of R&D investments and the share of highly technological industrial production within the country.[90] But in Sweden the share of high technological production is relatively low and an important part of production in the engineering industries takes place abroad. Given that some of the productivity gains from innovations only show when they are implemented within production,

[90] Fregert and Jonung (2003), Lindbeck (1997), Cf. Mansfield et al. (1979) for correlations between R&D, implemented patents and growth in the U.S.

they do not affect industrial productivity in Sweden. Furthermore it is shown that, in contrast to the intention of the Swedish reallocation policy, a relatively small part of Swedish production was reallocated to highly technological production until the early 1990s (Ohlsson and Vinell, 1987; Hansson and Lundberg, 1995; NUTEK, 1996). Yet, at the same time, Sweden maintained a relatively high level of R&D spending and the number of patents remained high. In 1990 Swedish multinational firms produced 44 percent of their value added in Sweden, whereas the corresponding Figure for R&D was 83 percent. It is argued that Sweden would have had a bigger opportunity to increase productivity over all lines of production if a larger part of high technology production had taken place in Sweden (Fors and Svensson, 1994).

7.3 The macroeconomic policy created rigidities and 'iron triangles'

Some economists argue that the Swedish model created obstacles to high technological industrial production. Structural change in terms of closing down old branches and allocating resources to new high technological branches was hampered by rigidities in the Swedish economic regime 1975. Furthermore, the policy before the taxation reform in 1992 favoured large established traditional industries, which were sheltered by means of devaluations that increased profitability without any structural changes. In turn, this prevented efficient capital allocation to production with the highest marginal returns (Henrekson, 1996a, 1996b; Henrekson and Johansson 1999; Henrekson, Jonung and Stymne, 1996; Lindbeck, 1994; 1995). The high taxation on factor incomes is addressed as an essential problem preventing economic activities from taking place in the most profitable fields. The fact that the supply of human capital was inelastic, due to wage policies that did not stimulate investments in education, further aggravated the lack of investments in high technology production.[91] The enrolment in higher education fell in the eighties due to the falling wages for high skilled workers, which in turn raised the cost of R&D in the late 1980s and the 1990s because of low supply of skilled labour. Furthermore, the low productivity is due to deficiencies in the market structure, especially the dominant role of a small number of large firms and the cartelization of large sectors imply weak competitive pressure (Jagren and Jakobsson, 1993; Fölster and

[91] For a further discussion on economic incentives and higher education in Sweden see Edin, Fredriksson and Holmlund, 1994. For a discussion on the Swedish education standard and productivity see UHÄ, 1985; Fägerlind, 1995 and Sohlman, 1996.

Peltzman, 1997; Lindbeck, 1997; Leamer and Lundborg, 1997). Finally, the close cooperation of politicians, regulators and the regulated firms constituted what Lindbeck calls ‘iron triangles’ serving as barriers to entry for outsiders, which made entrance in some manufacturing harder for small firms (Lindbeck, 1983; Lindbeck et al, 1994; Lundström et al. 1993)

7.4 The productivity paradox – an economic history perspective

A more economic history based explanation has been proposed, emphasizing instead that Swedish structural change was profound from the late 1970s on, but experienced a delay in showing high output or productivity growth rates. This approach emphasises that Sweden rather exhibited a clear case of the “productivity paradox”, term used by David (1990), which is argued to have also appeared in connection with earlier periods of technological shifts and structural transformation (Schön 1990; 1992; 2000). According to this view, innovations create new complementarities in the economy linking different activities and skills into new development blocks. The concept development block was launched by the Swedish economist Erik Dahmén in 1950 and it has been an important inspiration to the economic history view presented by Schön. In periods of structural transformation the emergence of such new linkages leads to bottle necks and imbalances that reduce the productivity effects from the innovations. In the course of a few decades, however, the new technologies are more effectively diffused and are taken into more rational use. Thus, productivity growth will accelerate when transformation gives way to rationalisation. The interpretation is then, that the decades after the Second World War were characterised by the effective diffusion of standardised technologies for mechanisation and automation of industries with strong rationalisation and high productivity growth. However, from the crisis of the 1970s and even more pronounced in the 1980s there was considerable innovative activity in Swedish industry but the productivity effects were delayed until the 1990s.

8 Economic regimes and opportunity costs

This section incorporates the economic regimes and opportunity costs in the analysis of productivity periodisation. In line with most economists, I argue that the productivity slowdown in the Swedish manufacturing sector in the mid 1970s was primarily the result of exogenous factors affecting all industrial countries, and cannot be attributed to domestic economic policies. It is, however, commonly argued that Sweden stands out in the extent of its failure to adjust to the slowdown, and that failure is frequently blamed on its macroeconomic policies in the period 1975-1992. In contrast to former approaches explaining the productivity slowdown, I address the consequences of the macroeconomic regime before 1975. I claim that the policy of the Swedish model from the beginning of the 1950s produced distorted opportunity costs, not so much of the amount of investments in R&D but to the orientation of research, that led to past-dependency and lock-in effects concerning the accumulation of knowledge.

Since most industrialised countries experienced a deterioration of economic performance beginning in the mid-1970s, the uniform nature of the slowdown in TFP growth among nations raises scepticism about country-specific explanations. Since the slowdown foremost reflects a decline in the underlying rate of technological change, which is hardly susceptible to government influence, such an approach is argued to be inappropriate (see e.g. Bosworth and Rivlin, 1987 p. 29). I take one step further and analyse the effects of macroeconomic policies in diverse periods on a sector level, suggesting that different economic regimes affect opportunity costs of different types of investments differently for diverse types of industries. Sweden has a rather diversified manufacturing industry and the productivity slowdown was not as severe in all sectors; accordingly, a sector-specific examination appears more appealing than a country-specific one. Besides, the effectiveness in the Swedish policy regimes is already shown by the opposite profit-wage relation pre- and post-1975.

Earlier research has frequently pointed out that reduced capital intensity and, hence, a lower capital/labour ratio, mechanically leads to a lower GDP per capita in the long-run (e.g. Jonung & Fregert 2003; Henreksen, 1999). This thesis has revealed that TFP growth is generated by means of different mechanisms in diverse industries depending on the industry’s method of production. Based on this information, I call into question the argument that reduced capital intensity mechanically leads to lower productivity. A reduced investment/output ratio will only lead to lower GDP if investment also includes investments in human capital, otherwise physical capital per units of output may decrease at the same time as more human capital is used in production. Accordingly, the argument only holds if the decrease in the physical capital/output ratio is stronger than the increase in the human capital/output ratio, since the accumulation of human capital would not sufficiently compensate for the decline in physical capital accumulation. I also concluded in chapter five that productivity can be generated by different types of capital: firstly, by human capital in terms of highly skilled workers in two different fields; administration, organisation and business, on the one hand, and engineering, research and product development, on the other. Secondly, physical capital in terms of new machinery affects productivity through embodied technological progress and learning-by-investing. In addition, in capital-intensive industry economies of scale are shown to affect productivity.

8.1 The solidaristic wage policy and opportunity costs

The solidaristic wage policy aimed to bring down inflation by weakening the direct influence of profits on wage formation rising out of free market forces. The idea was to adjust wages in all branches to the median wage level in the whole economy, which in turn was to be compatible with average labour productivity for each kind of work. Sectors that at the time were leading the development of industrial innovations had considerably higher labour productivity than the average in Swedish manufacturing industry (Schön, 2004). Thus, given that wages depend on productivity in the long-run, the wage increase should normally have been stronger in the leading sectors. The Swedish wage-policy subsequently created mark-ups for those firms whose labour productivity exceeded average productivity. According to Romer (1990) firms make research investments in order to obtain temporary monopoly profits through mark-ups. The size of such a mark-up is largely affected by elasticity of demand. Since the solidaristic wage policy fixed wages to the average productivity in tradable sectors, leading firms could extend mark-ups simply by increasing output as long as demand was high enough. I argue that this essentially decreased their incentives to direct research and product development to experimenting with innovations in order to increase or maintain mark-ups. In general terms, the more a firm's labour productivity exceeded its labour cost, the more mark-ups it gained by simply increasing output, and the higher was its opportunity costs of directing R&D investments in elaborating new techniques and diversifying output, as an alternative to increasing factor employment and directing R&D to enlarge-scale and efficiency in current production.

The fact that wages could be kept below productivity in leading branches made them more competitive on the export market and more resistant to the free trade price pressure for a longer period of time. There are consequently two reasons for increased opportunity costs of directing R&D investments toward alternative technologies: Firstly the mark-up due to the difference between firms' marginal productivity and the fixed wage cost. Secondly, since the low wages increased the tradable firm's competitiveness on the export market, the amount of profits gained on mark-ups was positively affected by the maintained high level of demand, which in certain cases also increased the scope for economies of scale. The solidaristic wage policy also contributed to lower opportunity costs of investments in research and the building up of human capital by means of reducing the wage gap between high skilled and low skilled workers, meaning that the cost of highly skilled workers was relatively lower during this period.[92] But, on the other hand, there were lower incentives for enrolling in higher education during this period.

8.2 Tax regulations and opportunity costs

Decreasing wage differences and the socialization of costs of labour mobility[93] led initially to increasing profit differences among firms, which was desirable for speeding up rationalization in the economy. Because profit differences also had undesirable effects on the distribution of income, policy makers used taxation and regulation of the capital market to offset such effects and support investments that had a positive effect on productivity. There was progressive taxation of capital incomes when profits were distributed among investors. But if profits were kept within firms there were favourable regulations for capital depreciations, and on funded capital there was no tax at all. The idea was to stimulate firms to plough back profits into reinvestments.

Since reinvested capital was subject to lower or no taxation, the net return on capital reinvested in firms was ex-ante higher. As advantageous capital regulation and tax deductions created artificially low costs of funded capital, and as profits essentially grew in proportion to output, the opportunity cost mechanism, which otherwise would have channelled R&D investments into the most productivity-accumulating activity, was not working properly.

---

[92] For an empirical investigation of the wage gap between engineers and blue-collar workers see Pettersson (1983), for data on the wage gap between white-collar workers and blue-collar workers see Svensson (2004).

[93] That is, labour was intended to move from low productivity sectors to high productivity sectors at the same time as wages were the same in all sectors. Socialisation of costs means that taxes on capital in high productivity sectors should pay for labour mobility.

Moreover, those firms making vast profits invested largely in extending output by means of present production techniques, whereas research was directed to furthering efficiency and scale in current technologies, in a situation where real comparative advantages based on real factor price information called for R&D investments in higher quality products and developing flexible production techniques that were less related to scale.

The economic policy between 1950 and 1975 aspired to raise investments in R&D by lowering the relative cost of highly skilled workers, which in turn would decrease opportunity costs of R&D. The amount of investments in R&D was high enough; the problem was the orientation towards which researchers were directed. The rate of learning is essentially higher when adopting new techniques and experimenting with new products. Hence there was a falling rate of return on continued development of known production techniques.

The Swedish capital and taxation policy intended to assign investment subsidies to large export firms. But the rapid speed of inflation and the asymmetric taxation of different types of assets, which implied varying capital costs depending on the type of investment and financing, were clearly not intentional effects of policy in the Swedish model (McLure and Norman, 1997; Agell, Englund and Södersten, 1995). Since this resulted in strong differences in capital costs for different types of production and among sectors and firms, the opportunity costs of various investments in fact differed for labour-intensive, capital-intensive and knowledge-intensive industries.

8.3 Demand and opportunity costs

It appears paradoxical that access to capital at lower costs would raise opportunity costs of investments in R&D, yet it did for a certain type of research and product development. Capital became largely accessible through tax deductions; on funded capital i.e. profits that were re-invested in the firms production there were no tax at all. Hence, low-cost capital was available for firms making large profits. When taking into account why certain companies made such large profits, the role of demand is recognized. High demand entails additional output, which calls forth further employment of new machines and labour. Increased demand for final goods automatically means more demand for production factors, which normally raises the prices of labour and capital. However, the solidaristic wage policy and the tax policy kept the cost of labour and capital at a low level. The removal of trade barriers and major improvements in transportation and communication in the 1950s and 1960s promoted a rapid expansion of the international market for manufactured goods, which in turn brought about economies of scale and increased efficiency within manufacturing production. The productivity rise was thus to a large extent export-led with large gains in labour productivity. The fact that profits increase with demand, whereas the cost of extra employment of labour and capital is rather inelastic, makes profits extremely dependent on demand. Since firms want to extend their profits, they will earmark R&D investments for techniques building on large-scale and higher efficiency, and spend fewer resources on inventing new products and more advanced production techniques. Such investment behaviour implies a production technique in which capital to an increasing extent substitutes for labour. In the period between 1963 and 1973 the overall capital-labour substitution in Swedish manufacturing industries was nearly three times the rate in the US (the appendix in Lindbeck, 1997). The strong connection between demand and profits, and possibly a shrinking labour supply before the 1970s, made Swedish industries invest in labour saving techniques by substituting capital for labour. I claim that if profits and productivity had been less related to demand, industries would have invested in production techniques where capital and labours skills are complementary. Using production techniques by means of which labour learns and becomes more skilful, increases the rate of knowledge accumulation; such techniques were to a large extent developed in knowledge-intensive industry, but not sufficiently in labour and capital-intensive industry.

High levels of demand often initiate large-scale production, and economies of scale have been shown to affect productivity in capital-intensive industries. Moreover, since both embodied technological progress and learning-by-investing are dependent on new machinery investments, they are indirectly also dependent on demand. The implication is to learn by the actual work; hence, more production should increase learning. As long as demand increases, productivity will continue to rise; but there are rapidly falling rates of learning on old products. Therefore, as soon as demand diminishes and new machinery investments cease, productivity falls as well. It all develops into a spiral where increasing demand increases productivity, leading to mark-ups and higher profits, which in turn increases the opportunity costs of directing research to new technologies. Consequently, firms continue to direct investment to growth building on large scales and more output. Yet the up-going spiral only continues given sustained demand; as soon as demand falls there is a down-ward spiral instead. Falling demand means falling factor employment, decreasing productivity and an absence of profits. When profits drop, the capital coming from tax deductions is reduced, this implies increasing costs of capital. Hence, even though opportunity costs of investments in R&D directed to new technologies fall, it is more difficult and costly to get hold of capital. Because the Swedish manufacturing sector was more dependent on demand, especially on the world market, than were other Western Economies, the strong fall in demand due to the oil crises (OPEC I and OPEC II) had more severe effects on the Swedish economy. The former investments in larger production flows became a comparative disadvantage as efficient production would require large-scale and optimal capacity utilisation in order to be profitable; falling demand made this unviable. The new economic conditions with more fierce competition, shrinking markets and relatively lower market prices did not favour high capacity utilisation, which forced these sectors into a severe crisis. The fact that manufacturing industries were affected more than the rest of the economy, and that capital-intensive industry with its many large firms, due to scale asset specificity and therefore high demand dependency, was affected the hardest, supports this argument.

8.4 Opportunity costs, past-dependency and lock-in effects

In line with Schön (1994) and Lindbeck (1997) I argue that the pre-1992 economic policy led to lock-in effects of capital in large industries. Moreover, Schön emphasizes the importance of structural inertia or resistance to change for such lock-in effects. Nevertheless, I call attention to the locking-in of human capital, rather than physic capital, as critical for industries failing to adjust to new conditions. This section adds to the analysis the importance of past-dependency in knowledge accumulation for such lock-in effects. More specifically I point out product-specific learning as the crucial source of past-dependency and locked-in knowledge. I maintain, as discussed in chapter two, that product-specific learning constitutes the principal source of knowledge accumulation in manufacturing industries. Additional knowledge builds up when producing and carrying out research on one kind of product with a specific production technique. However, knowledge earned by producing this type of good by means of this technique is not easily transferred to different types of good or to producing the same good with a different production method, hence, learning is highly past-dependent.

In some industries e.g. large-scale process industries, mark-ups were strongly related to demand and demand-related innovations such as large scale technologies and improved efficiency. The aim of tax regulation policies was to direct profits earned by mark-ups to

R&D investments, but since the size of mark-ups was so strongly related to demand in industries with a large share of fixed capital, the same policy instead prevented experiments with new technologies and/or innovating higher quality products, as increasing the scale of current production was more profitable.

The strong dependence of Swedish productivity on demand and the large sunken costs due to past-dependent knowledge accumulation enforced a more severe rationalization of Swedish industries than needed in most other industrial economies when the crisis hit in the mid 1970s. First, the composition of resources within the leading sectors was rearranged so that only the most efficient production units survived. Second, R&D resources were transferred from current production techniques to new techniques and higher quality products.

9 The effects of economic policy regimes on specific industries

The aim of this section is to provide more details of how different economic regimes affected productivity growth in labour-intensive, capital-intensive and knowledge-intensive industries.

9.1 Labour-intensive industry – Textile, wood and wooden products

A considerable part of the labour-intensive industry, such as the food industry and building materials industry was highly protected and almost exclusively directed towards the domestic market. However, I will focus on a competitive part of labour-intensive industry, textiles and wood and wooden products. The consequence of the solidaristic wage policy was quite the opposite in labour-intensive industry, compared to capital-intensive and knowledge-intensive industries. Since productivity in labour-intensive industry generally was lower than the average industrial productivity, labour costs tended to exceed labour productivity. Adjusting wages in all branches to the median wage level for each kind of work in the whole economy meant that low productive firms and sectors in open competition had to close down. Decreasing profits in low productive sectors – such as labour-intensive industries – would then release resources to more productive ones - such as knowledge-intensive industry. The solidaristic wage policy forced a profound structural transformation aiming at eliminating unprofitable production units. The policy regime gained effective results in labour-intensive industries where a large number of unprofitable firms disappeared. The number of workers in labour-intensive industry fell drastically over the whole period from 1952 to 2001. Entire industries like textiles and a large part of the ready-made clothing industry were forced to close down due to competition from less industrialised countries with lower wage costs. The main part of the released manpower of these industries was however, not transferred to knowledge-intensive industry but was employed in the service sector (Lindbeck 1983).

The industrial makeover also meant that diversification, new design and high quality materials became new targets in order to survive. The transformation of the ready-made clothing industry shows that more human capital in engineering and innovating more advanced techniques are not the only ways to increase productivity. Even though most of the clothing industry had to close down, modest investments in a build up of human capital directed towards creating a demand for Swedish design by means of niche products of current fashion, succeeded in making a few companies productive. Swedish cloth designers have advanced considerably on the European market the last decade. A large part of the manufacturing of ready-made clothes still takes place in low wage-cost countries, whereas the production units in Sweden consist of highly skilled workers in organisation, administration business and design creation.

The wooden product sector, which was dependent on both foreign and domestic demand, made medium-sized profits in the pre-1975 period that were mainly invested in new machinery that substituted capital for labour. The sawmill industry invested in scale increasing techniques and capacity expanded continually until 1975, but in 1975 the produced quantity fell by more than 20 percent (Josefsson, 1985). The fall in demand was foremost due to strongly decreasing domestic investments in housing as a consequence of the breaking up of the Swedish model. Since investments in scale enlargements and new plants made productivity closer related to capacity utilisation, investments turned into sunken costs as demand fell. The falling demand and the ensuing wage-cost crisis forced a substantial part of the wooden industry to close down.

9.2 Capital-intensive industry – The steel industry

Since tax deductions stimulated re-investment in firms, a large amount of the profit was invested in R&D. Yet, because productivity was strongly related to demand, researchers were mainly occupied with upgrading and improving already established technology. Although the steel industry developed technological advantages over competitors, these improvements were not enough to make up for the lower wage costs and raw material in new industrialising countries. Since the knowledge earned by producing plain steel is not completely transferable to producing high quality steel, and since techniques related to scale are not fully compatible with techniques for producing more advanced products, the industry experienced lock-in effects regarding their accumulated knowledge. As mentioned, such lock-in effects appear when decisions are made to accumulate knowledge in a certain field, but it turns out that knowledge accumulated in a different field would have led to relatively higher returns, due to superior knowledge accumulation in that field and/or higher demand for that type of product. In the 1970s, competitors were able to produce the same amount of similar quality at lower costs, which resulted in that new and highly efficient large-scale production plants became unprofitable. Consequently, in the early 1980s Swedish steel industry had to close down the production of plain steel.

The Swedish steel industry should have abandoned plain steel and invested strictly in developing high quality steel. Furthermore, investments in research should exclusively have been directed to innovative production techniques for high quality steel. I will look into why the Swedish steel industry did not realize investments this way. Firstly, I assert that if blue-collar wages had been dependent on profits, as they would have been without the solidaristic wage policy, then the steel industry would have experienced the following: (1) The wage cost would have been higher and the industry would have experienced competition from other steel producing countries with lower costs much earlier. (2) The opportunity costs of further investments in producing plain steel would have increased whereas the opportunity costs of investing in producing high quality steel would have decreased. (3) Higher wage costs would have avoided much of the profits made by mark-ups, meaning that the industry would have got around the strong connection between mark-ups and scale. Since mark-ups increased with scale it was rational to invest in capacity increasing techniques and it seemed less attractive to invest in new production techniques or develop new products.

Secondly, I assert that if there had been the same tax on re-invested capital as for distributing the capital among capital-owners or investing outside the company, then the Swedish steel industry would have faced higher costs of capital which in turn would have necessitated higher returns on investments to cover capital costs. It has been shown that higher pressure forces investors to take higher risks and consider untried alternatives (see Baumol 1961). Therefore, when access to low-cost capital is high internally, investments are more likely to be realised in known areas with moderate returns, which increases the risk of past-dependency in knowledge accumulation.

Thirdly, demand had been stable since the Second World War and many countries, not only Sweden, indicated a continued increase in the consumption of plain steel in the early 1970s. Although the market moved from Western Europe to Asia and South America and Brazil became our strongest competitor producing plain steel. From the late 1950s on, the Swedish government invested substantially in modernising the infrastructure and in the construction of schools and hospitals, and it subsidized residential construction in order to solve the problem of cramped housing accommodation, which was largely the result of the baby-boom in the 1940s. As the Swedish model fell apart, domestic investments in housing and infrastructure sharply decreased, and as a consequence demand for plain steel fell drastically.

In the 1970s, the Swedish steel industry experienced a crisis due mainly to three features: (1) The investments made in increasing the capacity of plain steel production was of little use in developing higher quality steel, which created a lock-in effect for accumulated knowledge, and sunken costs of investments in new factory premises for plain steel. (2) Demand developed in directions that were largely unfavourable for Swedish production of plain steel. The long construction boom came to an end, and both foreign and domestic demand for plain steel decreased strongly. Moreover, as new materials such as thermosetting plastic appeared, the amount of plain steel used in cars, trains, ship-building and similar products, fell sharply and was substituted. (3) New industrialised countries emerged, such as Brazil and South Korea, which could provide plain steel of much lower costs than Sweden. Besides, these countries were more favourably located in terms of the new markets in America and Asia.

Whether past-dependency in knowledge accumulation leads to comparative advantages or lock-in effects is closely related to future demand; in the case of the Swedish steel industry the shifting demand conditions rendered a large part of the knowledge accumulated in the 1960s and 1970s irrelevant. Although the Swedish steel industry experienced that an ex-ante efficient decision turned out to be an ex-post inefficient one, it also showed an ability to adapt to a second set of circumstances. It managed to transform investments in the 1980s, giving up the production of plain steel and developing better techniques for producing high quality steel.

In the 1990s, with the increasing demand for high quality steel, productivity in the Swedish steel industry increased once again.

9.3 Knowledge-intensive industry – The engineering industry

The engineering industry, dominated by the production of vehicles, machinery and electronic equipment, does not build on large-scale process technology and its relatively low share of fixed capital makes its productivity less dependent on fluctuations in demand. Pre-1975 investments were not primarily labour saving but capital and skilled labour constituted complements. Since the mark-ups due to low wage costs and relatively higher labour productivity were not as large as in capital-intensive industry, the access to cheap capital, due to tax deduction on re-invested capital, was of less importance in knowledge-intensive industries. Hence, the risk of directing R&D investments towards past-dependent knowledge accumulation because of too easy access to low-cost capital was relatively smaller. Large numbers of the total work force in engineering industries are employed in positions requiring high education and advanced skills; therefore, the solidaristic wage policy of squeezing wage gaps between high skilled and low skilled workers had a positive effect on the amount of R&D investments in engineering industries.[94] The relatively low cost of skilled labour and the fact that larger scale did not lower production costs made R&D investments in innovations and new techniques, in order to create mark-ups, more favourable than amplifying current production. Hence, the engineering industry was less struck by lock-in effects of knowledge accumulation than capital-intensive industry. Productivity increases as innovations are implemented in the production process and new products reach the market. As with capital-intensive industry the size of mark-ups depend on elasticity in demand; however, innovations by themselves are able to widen markets and create new markets through lowering production costs and offering higher qualities, whereas productivity in capital intensive industry is more dependent on the demand conditions created by policy regimes.

10 Complementarity between research and factor employment in the long-run

I define complementarity as the phenomenon arising when an increase in the quantity and/or quality of one production factor increases the marginal product of another. I emphasise the

[94] The signs of supply constrains regarding the supply of skilled labour at points of expansion is only shown to matter for the period 1978-1979 (Lundberg, 1985).

importance of complementarity between different types of knowledge accumulation in the long-run, meaning that important innovations within production techniques and the development of new products give large possibilities for knowledge accumulation through embodied technological progress and learning-by-investing as demand for these products increases. Research and product development result in new knowledge and innovations that increase returns to R&D investments, but will also affect returns to factor employment, since embodied technological progress and learning-by-investing will increase when the innovations are put to use. In capital-intensive industry where the investments in R&D, made pre-1975, to a large extent led to past-dependency and lock-in effects, there was a rather reduced scope for complementarity between research and embodied technological progress and learning-by-investing in the following period. This constitutes an additional explanation for why productivity fell so low for such a long time in capital-intensive industries.

Moving the level of knowledge accumulation through research investments too far forward, at the expense of feedback from production experience, reduces the growth rate. In order to fully exploit the knowledge generated by R&D investments in new production techniques and higher quality products, the new knowledge must be put into practice (see Aghion and Howitt 1998). Based on Young's (1992,1993a) articles, this study argues that, since the long-run rate of growth depends on both types of knowledge accumulation (and on economies of scale in capital-intensive industry), devoting too many resources to research and product development at the expense of embodied technological progress and learning-by-investing can cause a slowdown in the long-run rate of growth. The low demand and modest perspectives for developing markets for new products in the second half of the 1970s and the 1980s delayed or even blocked advances through R&D investments from being implemented in high technological production, which is an additional explanation for the deep productivity slowdown in Swedish manufacturing industries. However, once demand picked up at the beginning of the1990s, the new knowledge developed in R&D could be implemented in industrial production. When new techniques or products, foremost based on microelectronics, were put into practice, it gave rise to both embodied technological progress and a high speed of learning-by-investing. There was an accumulated innovation surge comparable to what happened after World War II (C.f. Kindleberger, 1973 and Aldcroft, 1978). The complementarity argument is supported by the low TFP growth in the period 1975-1992, and by the vast increase in productivity growth after 1992, especially in knowledge-intensive industry.

The fact that learning on technologically more advanced products involves more advantageous conditions for knowledge accumulation explains why TFP grew so strongly in knowledge-intensive industries producing high technology goods, and with a stronger increase in demand in the 1990s. When innovations are implemented in the production process, the level of demand affects productivity through other elements as well: embodied technological progress, increased learning-by-investing, higher efficiency and possibly economies of scale. In contrast to what is argued by Jones there are, at least to some extent, scale effects involved in the effect of knowledge accumulation on productivity when looking at complementarity between e.g. research, on the one hand, and embodied technological progress and learning-by-investing, on the other, over time. When demand for products based on e.g. microelectronics increases, there is a large scope for knowledge accumulation through complementarity between the innovations themselves e.g. a new data chip, and its embodiment in the production process. Then new knowledge is engendered simply by expanding factor employment, as using the new technique or product give rise to increasing embodied technological progress and additional learning.

Following Young (1993b) I argue that in recent models of endogenous growth and innovation, the suggestion that new technologies always substitute for previous ones are overemphasized; new technologies may just as frequently complement older technologies, and hence creating rather than destroying rents. Especially in knowledge-intensive industry the acknowledgment of the potential for complementarity among inventions allows for a much richer interpretation of the growth process, creating the possibility of threshold effects and bringing to the forefront the interplay between opportunity costs for investments in various productivity-generating mechanisms and the expectations of investors and economic actors. A glance at the cyclical characteristics of TFP growth in knowledge-intensive industry indicates the fruitfulness of such interpretation.

11 Conclusion

This paper deals with TFP growth in three phases characterised by different growth patterns and various economic regimes. The first phase from 1952 to 1975 is characterised by a high rate of growth in TFP. The second phase between 1975 and 1992 – known as the productivity slowdown – shows a low and strongly fluctuating growth rate in TFP. The last phase between 1992 and 2001 reflects a fast catching-up in TFP growth in capital-intensive and knowledge-intensive industries. Roughly in accordance with the breaking-points between periods, I can identify shifts in macroeconomic policy regimes. In order to establish that policy regimes actually produce real effects on market conditions I estimate a VAR model for the effects of profits on blue-collar wages. It is confirmed that the pre-1975 Swedish model was effective in offsetting the effects of profits on wages, and that the policy after 1975 was just as effective in producing such effects. Hence an analysis of how the changed policy regimes and new economic conditions affected the opportunity costs of investing in different growth mechanisms is well motivated.

I argue that the degree of stability in macroeconomic policy regimes is essential for the predictability of future opportunity costs. Empirical results based on simultaneous least square regressions for each period in each industry support our hypotheses. It is shown that adjustment in variables included in the homogeneous relation with TFP was larger in the first period when macroeconomic stability produced more predictable opportunity costs, whereas adjustment was much slower or even absent in the period 1975-1992 when economic policies were unstable and hence future opportunity costs were less predictable. In the last period 1992-2001, when stable economic policy was re-established, much due to the flexible exchange rate, variables showed a larger adjustment to deviations in the steady state than during the productivity slowdown. Slow or no adjustment in the other variables included in the homogeneous relation indicates that the steady state could only be re-established by a falling TFP growth.

It is generally claimed that rigidities and instabilities in the macroeconomic policy after 1975 hampered growth. As an alternative to this approach I address the consequences of the macroeconomic regime before 1975. I claim that the wage and inflation policy, constituting the Swedish model from the beginning of the 1950s, distorted the opportunity costs of investments. The most severe productivity slowdown took place in capital-intensive industry, whereas knowledge-intensive industry showed the greatest catch-up after 1992. I assert that, because productivity in labour-intensive, capital-intensive and knowledge-intensive industries are differently related to demand, and because their productivity is generated by means of different mechanisms, they were differently affected by the Swedish model. The solidaristic wage policy and tax regulations affected opportunity costs of investing in different growth mechanisms differently, especially considering the use and orientation of R&D investments. Since productivity was firmly related to demand, and because firms aimed at maximizing profits and not productivity, most of the R&D investments in capital intensive industry were directed to increasing scale and improving efficiency in existing technologies. At the same time, opportunity costs of exploiting new production techniques and developing high quality products rose in proportion to the degree of demand dependency in productivity, which resulted in a past-dependent knowledge accumulation in capital-intensive industries. Past-dependency means that experimenting with a new technique rapidly gives birth to increased knowledge; the more this technique is tried-out the more knowledge is accumulated and the more advantageous the technique becomes over untried alternatives. However, gaining knowledge by experimenting on new techniques is rather time and resource consuming, and as in capital-intensive industry nearly all resources were directed to increasing scale and improving efficiency in the prevalent techniques rather than practicing on new ones, it took time to accumulate knowledge about new techniques once demand fell in the mid 1970s. The concept of past-dependent knowledge accumulation giving rise to lock-in effects is put forward as the main explanation for why capital-intensive industry lagged behind albeit large amounts invested in R&D. Since productivity was so closely related to demand and knowledge was mainly accumulated in techniques building on scale, and because rates of learning rapidly fell on old products, capital-intensive industries suffered more from increased competition and falling demand in world markets.

The experience in knowledge-intensive industry was different. The facts that production did not build on large-scale process industries and that the share of fixed capital was rather low made productivity in knowledge-intensive industry less dependent on variations in demand. The squeezed wage gaps between high skilled and low skilled workers, due to the solidaristic wage policy, had a positive effect on R&D investments in engineering industries, since a large part of the total work force had positions requiring high proficiency in engineering and product development. The fairly low cost of skilled labour, and the fact that productivity was scale neutral, made R&D investments in innovations and new techniques more favourable than investing in increased scale in order to create mark-ups. Knowledge-intensive industry stayed clearer of past-dependent knowledge accumulation and suffered less from lock-in effects than capital-intensive industry. When demand increased at the beginning of the 1990s, the innovations made by R&D investments in knowledge-intensive industry were implemented in the production process, which partly explains the rather fast catch-up in this industry.

Finally, the importance of complementarity between different types of knowledge accumulation in the long-run is addressed, meaning that new techniques and higher quality products provide better prospects for productivity growth through embodied technological progress and learning-by-investing. Firstly, increasing research and product development produce higher expertise and innovations that increase returns to R&D investments. Secondly, since embodied technological progress and learning-by-investing will increase when using more advanced production techniques resulting from innovations; increasing research and product development also have positive impacts on returns to increased factor employment. Due to its investments in R&D made pre-1975, capital-intensive industry experienced past-dependency and lock-in effects in its knowledge accumulation; therefore the scope for complementarity of R&D investments, and embodied technological progress and learning-by-investing was much reduced. This constitutes an important explanation for the severe productivity slowdown and the failure to adjust to new conditions in capital-intensive industry.

References

Statistical sources

Commercial Accounts (*Kommersiella Meddelanden*, Kommerskollegium)

National Accounts, Schön, *Historiska nationalräkenskaper för Sverige: Industri och hantverk 1800-1980*

Statistics Sweden (SCB) Statistical Reports Serie I (*Statistiska Meddelanden I*)

Statistics Sweden (SCB) Statistical Reports Serie N (*Statistiska Meddelanden N*)

Statistics Sweden (SCB) Wages, Part 2: Agricultural and Industrial workers

Statistics Sweden (SCB) Foreign trade, Part 2: Sweden's import and exports

Statistics Sweden (SCB) Manufacturing, Part 1: Data grouped according to Swedish industrial classification of all economic activities

Statistics Sweden (SCB) Specially ordered statistics

Literature

Agell, J., Berg, L. (1996), "Does Financial Deregulation Cause a Consumption Boom?" *The Scandinavian Journal of Economy*, 98(4), pp. 579-601.

Agell, J., Englund, P., Södersten, J. (1995), S*vensk skattepolitik i teori och praktik. 1991 års skattereform.* SOU 1995:104, Suppl. 1. Stockholm: Allmänna förlaget.

Andersen T.M., Calmfors, L., Englund, P. (1990), "Macroeconomic Strategies Towards Internal and External Balance in the Nordic Countries; Comments." *The Scandinavian Journal of Economics*, 92(2) pp. 177-214.

Andersson, T., Fredriksson, T., Svensson, R. (1996), *Multinational restructuring, internationalisation and small economies: The Swedish case.* London: Routledge.

Bergström, V., Södersten, J. (1979), "Nominella och Reala Vinster i Svensk Industri." *SE-Banken Kvartaltidsskrift*, (1/2), pp. 47-57.

Bergvall, A. (2005), "Exchange rate regimes and macroeconomic stability: the case of Sweden." *Economic Papers Oxford* , 57(3), pp. 422-446.

Björklund, A., Palme, M., Svensson, I. (1995), "Tax Reforms and Income Distribution: An Assessment Using Different Income Concepts." *Swedish Economic Policy Review*, Autumn, 2(2), pp. 229-265.

Boltho, A. (1989), “Did Policy Activism Work?” *European Economic Review,* Dec., 33(9), pp. 1709-1726.

Bond, P., Otterson, P. (1997), “Technique as the site of knowledge accumulation and innovation opportunity.” *Innovation in Technology Management - The Key to Global Leadership.* PICMET’97: Portland International Conference on Management and Technology, p. 190.

Bordo, M., Jonung, L. (1996), “Internationella växelkurssystem och valutaunioner. Några lärdomar rörande Sverige och EMU.” bil. 1 till EMU-utredningen, SOU 1996:158.

Boskin, M.J., Dulberger, E.R., Gordon, R. J., Griliches, Z., Jorgenson, D. W. (1996), *Toward a more accurate measure of the cost of living*. Final report to the Senate Finance Committee. Washington DC: U.S. Government Printing Office.

Branson, W.H. (1989), *Macroeconomic Theory and Policy*, 3rd ed., Harper and Row, New York.

Braunerhjelm, P. (1993), “Nyetablering och småföretagande i svensk industri.” In *Den långa vägen.* Ed.: Braunerhjelm, P., Stockholm IUI, ch. 4.

Burmeister, E. (1980), *Capital theory and dynamics*. Cambridge surveys of economic literature, (Cambridge U.P., cop. 1980).

Calmfors, L. (1993), “Lessons from the Macroeconomic Experience of Sweden.” *European Journal of Political Economy,* Mar. 1993, 9(1), pp. 25-72.

Calmfors, L., Driffill, J. (1988), “Bargaining structure, corporation and macroeconomic performance.” *Economic policy*, 6, pp. 13-61.

Dahlman, C. (1979), ”The problem of externality.” *Journal of Law and Economics*, 22, pp. 141-162.

Dahmén, E. (1950), *Svensk industriell företagarverksamhet. Kausalanalys av den industriella utvecklingen 1919-1939*. Del I-II. Industriens Utredningsinstitut, Stockholm.

Davis, S.J., Henrekson, M. (1999), “Explaining National Differences in the Size and Industry Distribution Employment.” *Small Business Economics*, 12(1), pp. 59-83.

Edin, P-A., Fredriksson, P., Holmlund, B. (1994), “Utbildningsnivå och utbildningsavkastning i Sverige.” in *Ekonomiska rådets årsbok 1993.* Stockholm: Konjunkturinstitutet, 1994, pp. 7-37.

Edin, P-A., Holmlund, B. (1995), “The Swedish wage structure: The rise and fall of solidarity wage policy?” in *Differences and changes in wage structure.* Eds.: Freeman, R., Katz L. Chicago: University of Chicago press, pp. 307-343.

Edin, P-A., Topel, R. (1997), “Wage policy and restructuring – The Swedish labour market since 1960.” in Freeman, R., Swedenborg, B., Topel, R. 1997, *Reforming the welfare state…*

Edmondson, A.C., Winslow, A.B., Bohmer, R.M.J. (2003), “Learning How and Learning What: Effects of Tacit and Codified Knowledge on Performance Improvement Following Technology Adoption.” *Decision Sciences*, 34(2), pp. 197-224.

Einarsson, T., Marquis, M.H. (1997), “Home production with endogenous growth.” *Journal of Monetary Economics*, 39(3), pp. 551-569.

Elvander, N. (1988), *Den svenska modellen.* Stockholm: Allmänna Förlaget.

Fors, G., Svensson, R. (1994), “R&D in Swedish multinational corporations.” Working paper No 406, Stockholm: IUI.

Forslund, A., Krueger, A.B. (1997), “An evaluation of the Swedish active labour market policy: New and received wisdom.” in Freeman, R., Swedenborg, B., Topel, R. 1997, *Reforming the welfare state…*

Fägerlind, I. (1991), “Utbildningsstandarden i Sverige 1970-1990 och produktivitetsutvecklingen.” in *Arbetskraft, arbetsmarknad och produktivitet.* Expert rapport nr 4, produktivitetsdelegationen. Stockholm: Allmänna Förlaget, pp. 225-256.

Fölster, S., Henrekson, M. (1999), “Growth and the public sector: a critique of the critics.” *European Journal of Political Economy*, 15(2), pp. 337-358.

Fölster, S., Lindström, E. (1994), *Sveriges offentliga sektor i europeisk konkurrens.* Appendix 6, EG-Konsekvensutredningen. Stockholm: Fritzes.

Fölster, S., Peltzman, S. (1997), “The social costs of regulation and lack of competition in Sweden.” in Freeman, R., Swedenborg, B., Topel, R. 1997.

Henrekson, M. (1996a), “Sweden´s Relative Economic Performance: Lagging Behind or Staying on Top?” *The Economic Journal*, 106(439), PP. 1747-1759.

Henrekson, M. (1996b), *Företagandets villkor. Spelregler för sysselsättning och tillväxt.* Stockholm: SNS förlag.

Henrekson, M., Johansson, D. (1999), “Institutional Effects on the Evolution of the Size Distribution of Firms.” *Small Business Economics*, 12(1), pp. 11-23.

Henrekson, M., Jonung, L., Stymne, J. (1996), “Economic growth and the Swedish model.” in *Ekonomic growth in Europe since 1945.* Eds.: Crafts, N., Toniota, G., Cambridge: Cambridge U. Press, p. 240.

Fägerlind, I. (1991), "Utbildningsstandarden i Sverige 1970-1990 och produktivitetsutvecklingen." in *Arbetskraft, arbetsmarknad och produktivitet.* Expert rapport nr 4, produktivitetsdelegationen. Stockholm: Allmänna Förlaget, pp. 225-256.

Fölster, S., Henrekson, M. (1999), "Growth and the public sector: a critique of the critics." *European Journal of Political Economy*, 15(2), pp. 337-358.

Fölster, S., Lindström, E. (1994), *Sveriges offentliga sektor i europeisk konkurrens.* Appendix 6, EG-Konsekvensutredningen. Stockholm: Fritzes.

Fölster, S., Peltzman, S. (1997), "The social costs of regulation and lack of competition in Sweden." in Freeman, R., Swedenborg, B., Topel, R. 1997.

Henrekson, M. (1996a), "Sweden´s Relative Economic Performance: Lagging Behind or Staying on Top?" *The Economic Journal*, 106(439), PP. 1747-1759.

Henrekson, M. (1996b), *Företagandets villkor. Spelregler för sysselsättning och tillväxt.* Stockholm: SNS förlag.

Henrekson, M., Johansson, D. (1999), "Institutional Effects on the Evolution of the Size Distribution of Firms." *Small Business Economics*, 12(1), pp. 11-23.

Henrekson, M., Jonung, L., Stymne, J. (1996), "Economic growth and the Swedish model." in *Ekonomic growth in Europe since 1945.* Eds.: Crafts, N., Toniota, G., Cambridge: Cambridge U. Press, p. 240.

Jacobsen, H.J., Schultz, C. (1990), "A general equilibrium macromodel with wage bargaining." *Scandinavian journal of economics,* 92, pp. 379-398.

Jacobson, T. (1995), "Simulating small-samples properties of the maximum likelihood cointegration method: Estimating and testing." *Finnish economic papers,* 8(2), pp. 96-107.

Jagrén, L., Jakobson, U. (1993), *Den underliggande konkurrenskraften.* Appendix 15, SOU 1993:16. Stockholm: Allmänna Förlaget.

Jakobson, U. (1996), "Räcker reformerna av den svenska modellen?" in *Vad vill Sverige med EU?* Konjunkturrådets rapport, Stockholm: SNS Förlag.

Jakobsson, U. (1997), "Den svenska devalveringscykeln." *Ekonomisk debatt,* Vol. 25, pp. 141-154.

Jonung, L. (2002), "National or International Inflation Targeting? The Wicksellian Dilemma of the Euro-outs." *Journal of public policy*, 22(2), pp. 183-197.

Jonung, L. (2002), "Tillbaka till konvertibilitetsprincipen? Penning- och finanspolitiska regimer i ett historiskt perspektiv." bil. 3 i SOU 2002:16, *Stabiliseringspolitik i valutaunionen,* Stockholm.

Jorgenson, D.W., Gollop, F.M., Fraumeni, B.M. (1987), *Productivity and U.S. economic growth.* Cambridge, Mass.: Harvard University Press.

Jorgenson, D., Griliches, Z. (1967), "The explanation of productivity change." *Review of Economic studies*, 34, July, pp. 249-83.

Josefsson, M. (1985), "Skogsindustri." in *Svensk Industri*, Industriförbundets Förlag.

Lindbeck, A. (1975), *Swedish economic policy.* London: Macmillan.

Lindbeck, A. (1983), "Interpreting income distribution in a welfare state: the case of Sweden." *European economic Review*, 22(2), pp. 227-256.

Lindbeck, A. (1988), "Consequences of the advanced welfare state." *The World Economy*, 11(1), pp. 19-37.

Lindbeck, A. (1990), "The Swedish experience." Institute for International Economic Studies, seminar paper No. 482.

Lindbeck, A. (1994), "Overshooting, reform and retreat of the welfare state." *The economist*, 142(1), pp. 1-19.

Lindbeck, A. (1995), "Hazardous welfare-state dynamics." *The American Economic Review*, 85(2), pp. 9-15.

Lindbeck, A. (1997) "The Swedish Experiment." *Journal of Economic Literature*, 35(3), pp. 1273-1319.

Lindbeck, A. et al. (1994), *Turning Sweden around.* Cambridge, MA: MIT Press.

Lundberg, E., Knox, A.D., editors. London 1955: International Economic Association, (1952), "The business cycle in the post-war world." *proceedings of a conference in Oxford held by the International Economic Association.*

Lundh, C. (1991), *Åldersstruktur och industriell omvandling I Sverige 1945-1985*. Befolkningsekonomiska stiftelsen BEST, Lund.

Lundh, C. (2002), *Spelets regler: institutioner och lönebildning på den svenska arbetsmarknaden 1850-2000*. Stockholm: SNS förl. (Kristianstad: Kristianstads boktr.)

Lundh, C., Ohlsson, R. (1994), *Från arbetskraftimport till flyktinginvandring.* Stockholm: SNS (Studieförbundet näringsliv och samhälle).

Lundström, A. et al. (1993), "De nya och små företagens roll i svensk ekonomi." Expert report No. 18, *Nya villkor för ekonomi och politik*, SOU 1993:16, Stockholm: Fritzes.

Långtidsutredningen. (1995), SOU 1995:4. Stockholm: Allmänna Förlaget.

Långtidsutredningen. (1999/2000), SOU 2000:7. Stockholm: Allmänna Förlaget.

McKinsey Global Institute (1995), *Sweden's economic performance.* Stockholm, sept. 1995.

McLure Jr, C.E., Norrman, E. (1997), "Tax policy in Sweden." in Freeman, R., Swedenborg, B., Topel, R. 1997, *Reforming the welfare state…*

Meyer-Krahmer, F., Schmoch, U. (1998), "Science-based technologies: university-industry interactions in four fields." *Research Policy*, 27(8), pp. 835-851.

Molander, P. (1992), *Statsskulden och budgetprocessen.* Report to ESO, Ds 1992:26. Stockholm: Fritzes.

Myhrman, J. (1994), *Hur Sverige blev rikt.* Stockholm: SNS.

NUTEC (Närings och Teknikutvecklingsinstitutet). (1996), *Svenskt näringsliv och näringspolitik.* Stockholm: Fritzes.

Ohlsson, L., Vinell, L. (1987), *Tillväxtens drivkrafter.* Stockholm: Industriförbundets förlag.

Oliner, S. D. and Sichel, D. E. (2000), "The resurgence of growth in the late 1990s: is information technology the story?" *Journal of economic perspectives,* 14(4), pp. 3-22.

Persson, T. (1990), "Stabiliseringspolitikens möjligheter: En instabil historia." i Persson, T., Vredin, A., red., *Inflation, arbetslöshet och stabiliseringspolitik,* Ekonomiska rådets årsbok 1989, Konjunkturinstitutet, Stockholm.

Pettersson, L. (1983), "Ingenjörsutbildning och Kapitalbildning 1933-1973." *Skrifter utgivna av Ekonomisk-Historiska Föreningen,* Lund, Vol. XXXIX.

Rehn, G. (1984), *Cooperation between the government and workers' and employers' organizations on labour market policy in Sweden*. Stockholm : Swedish Institute.

Rehn, G. (1985), *Swedish active labour market policy : retrospect and prospect*. Stockholm : Swedish Institute for Social Research.

Rehn, G. (1998), "The problem of stability: an analysis and some policy proposals." *Swedish economics /* edited by Bo Sandelin. Vol. 9 / Erik Lundberg.. Repr.. London: Routledge, pp. 30-54.

Rivlin, A.M. (red.); Bosworth, B.P.(1987), *Den svenska ekonomins framtidsutsikter*. Stockholm : SNS, 1987.

Rothstein, B. (1991), "State structure and variations in corporatism: The Swedish case." *Scandinavian political studies,* 14, pp. 149-171.

Ruist, E. (1985), "Metallindustri." in *Svensk Industri,* Industriförbundets Förlag

SAF. (1996), *Fakta om Sveriges ekonomi.* Stockholm.

Persson, T. (1990), "Stabiliseringspolitikens möjligheter: En instabil historia." i Persson, T., Vredin, A., red., *Inflation, arbetslöshet och stabiliseringspolitik,* Ekonomiska rådets årsbok 1989, Konjunkturinstitutet, Stockholm.

Pettersson, L. (1983), “Ingenjörsutbildning och Kapitalbildning 1933-1973.” *Skrifter utgivna av Ekonomisk-Historiska Föreningen*, Lund, Vol. XXXIX.

Rehn, G. (1984), *Cooperation between the government and workers' and employers' organizations on labour market policy in Sweden*. Stockholm : Swedish Institute.

Rehn, G. (1985), *Swedish active labour market policy : retrospect and prospect*. Stockholm : Swedish Institute for Social Research.

Rehn, G. (1998), “The problem of stability: an analysis and some policy proposals.” *Swedish economics /* edited by Bo Sandelin. Vol. 9 / Erik Lundberg.. Repr.. London: Routledge, pp. 30-54.

Rivlin, A.M. (red.); Bosworth, B.P.(1987), *Den svenska ekonomins framtidsutsikter*. Stockholm : SNS, 1987.

Rothstein, B. (1991), “State structure and variations in corporatism: The Swedish case.” *Scandinavian political studies*, 14, pp. 149-171.

Ruist, E. (1985), “Metallindustri.” in *Svensk Industri*, Industriförbundets Förlag

SAF. (1996), *Fakta om Sveriges ekonomi.* Stockholm.

Schön. L., (1989), *From war economy to State Dept Policy*. Riksgäldskontoret, Stockholm

Schön, L. (1990), *Elektricitetens betydelse för svensk industriell utveckling.* Vattenfall, SUD., U(S) 1990/60.

Schön, L. (1992), *Trädbränslen i Sverige 1800-1990 : användning och prisutveckling*. Vällingby: Vattenfall.

Schön, L. (1998), “Industrial Crises in a Model of Long Cycles: Sweden in an International Perspective.” in Myllyntaus, T. (ed), *Economic Crises and Restructuring in History*. Frankfurt.

Schön, L. (2000), “Electricity, technological change and productivity in Swedish industry, 1890-1990.” *The European Review of Economic History*, 4(2).

Schön, L. (2000), *En modern svensk ekonomisk historia: tillväxt och omvandling under två sekel.* 1. uppl., Stockholm: SNS förl.

SOU 1993:16, *Nya villkor för ekonomi och politik.* Finansdepartementet, Stockholm.

SOU. (1997), *Välfärd i verkligheten pengarna räcker inte.* Department of Social Affairs, Stockholm.

Stråth, B. (1996), *The organisation of labour markets.* London: Routledge.

Svennilson, I. (1954), *Growth and Stagnation in the European economy.* Geneva: United Nations Economic Commission for Europe.

Svensson, L. (2004), “Industrial Dynamics, Labour Demand and Wage Differentials in the Swedish Manufacturing Industry 1930- 1990.” In Lundh,C., Olofsson, J., Schön, L., Svensson, L. *Wage formation, labour market institutions and economic transformation in Sweden 1860-2000.* Stockholm: Almqvist & Wiksell International, 2004 (Malmö: Prinfo/Team offset & media).

UHÄ. (1985), *Civilingenjörsutbildning i kris – resurser och kvalitet.* UHÄ-rapport 1985:15, Stockholm.

Werlin, L., red. (1993), *Från räntereglering till inflationsnorm,* SNS, Kristianstad.

World Bank. *World tables.* (computer file). Washington, DC: International Reconstructing and Development, various years.

Zetterberg, H., Ljungberg, C.J. (1997), *Vårt land – den svenska socialstaten.* Stockholm: City University Press.

Örtengren, J. et al. (1988), *Expansion, avveckling, företagsvärdering i svensk industri.* Stockholm: IUI.

Östermark, R., Höglund, R. (1999), “Simulating competing cointegration tests in a bivariate system.” *Journal of Applied Statistics,* 26(7), pp. 831-846.