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THE ECONOMIC RESEARCH INSTITUTE

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The Case of Sweden 1834-1991

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Working Paper No. 176
June 1997

Working Paper Series
in Economics and Finance

Finance and Economic Growth. The Case of Sweden 1834-1991*

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Summary

This study examines the long-run relationship between finance and economic growth in Sweden from the 1830s until the 1990s using recently developed econometric techniques for tests of cointegration. The role of investment, education and technological progress (patents) is accounted for as well in order to assess the relative importance of the development of the financial system for growth performance. A fairly unique set of long-run data is employed. To our knowledge, no tests of this kind have been reported previously, at least not for the European experience. The empirical work suggests that there has been a pattern of interaction among the variables examined. The estimated contribution of the financial system to economic growth is shown to depend crucially on the time period studied and the variables included in the analysis.

J.E.L. Classifications: O16

Keywords: Financial development; economic growth; cointegration; Sweden

1. Introduction

Sweden achieved one of the highest growth rates in the world during the period 1870-1970, perhaps the very highest. A number of explanations of the Swedish performance have been presented, as a rule stressing one or a few explanatory factors.[1] There exists, however, no systematic attempt to discriminate among the different hypotheses using econometric techniques. Actually, virtually no econometric work has been carried out on the long-run growth performance of the Swedish economy.

The aim of this paper is to investigate the relationship between economic growth and the development of the financial system in Sweden covering a period of more than 150 years, from the 1830's to the 1990's, using recent advances in econometrics. Although focusing on "finance and growth", we also examine empirically the role of education and technological progress in the growth process.

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* We greatly appreciate comments and assistance from Michael Bergman, Michael D. Bordo, Jesper Hansson, Göran Hägg, Olle Krantz, Anders Nilsson, Lars Pettersson, Lars G. Sandberg, Lennart Schön, seminar participants at the Stockholm School of Economics and participants at the Venice conference on Financial Institutions and Long-Run Growth.

[1] For a survey of post World War II growth, see Henrekson, Jonung and Stymne (1996).

The paper is organized as follows. First we survey recent studies on finance and growth as well as the literature on finance and growth in Sweden. Next, the development of the Swedish financial system is covered. The problem of measuring and collecting data is considered. The empirical results are presented in section 4. Section 5 concludes.

2. Finance and Economic Growth

Present theories of endogenous growth identify two major factors driving economic growth, i.e. human capital and technological progress (innovations) - see for instance Barro and Sala-i-Martin (1995). One of these, human capital, reflects the educational level of the workforce. As individuals become more specialized and better trained, their productivity increases. Innovations reflect scientific development, the invention of new production techniques and the creation of entirely new goods and services. Both of these forces may depend on the depth, the structure and the functioning of the financial system.[2]

Human capital formation generally takes the form of education. While receiving training, an individual foregoes potential income from work. Moreover, most individuals are trained for their future tasks while still young, when they have not yet accumulated enough savings to finance a temporary shortfall in income. In principle, human capital formation requires a financial system providing loans secured by the individual's future earnings. In practice, however, this link between finance and human capital is of little importance since the regular financial market is not commonly used to finance education.

If economic growth arises solely through innovations per se, there would not be a linkage from finance to growth. Merely discovering a new production technology does not generate growth, however. Innovations must be implemented through investment. Thus, the financing of investment becomes a key factor in the growth process. Without the possibility of investing in newly discovered production methods, innovators will not profit from them. This suggests that the rate of investment will depend on the functioning of the financial system.

A well-developed and well-functioning financial system may affect growth positively through investment in at least three different ways. Firstly, financial intermediaries facilitate the provision of adequate funds for investment activity. Without financial intermediaries, the economy would consist of many small savers. Firms would then face the problem of generating finance from, and negotiating loan arrangements with, a large number of people. If funds instead are pooled by a small number of banks or other intermediaries, the costs associated with gaining access to them are significantly reduced. A lack of direct access to credit would hamper investment activities.

Secondly, financial intermediaries reduce the risk borne by individual savers. A saver depositing his savings at an intermediary automatically averages out the risks of individual projects, whereas each small saver would lack the

[2] A recent summary of research on finance and growth is given by Levine (1996).

opportunity to diversify without a well developed financial system. As the financial system expands, more resources can be channelled through it at low risk to savers and more funds will be available for investment. Capital formation therefore would be expected to increase.

Thirdly, a well-functioning financial system will lead to an improved ability to assess investment projects. Financial intermediaries established to engage in large-scale lending develop a capacity to decide which projects are worth financing. They will specialize in evaluating different investment opportunities and direct available funds towards those that are most promising. The average quality of investment can be expected to rise as a result.

An important caveat in discussing possible linkages from the financial system to growth is that the direction of causality may run both ways. Economic growth may create a demand for financial intermediation. If this is true, the financial system will grow in response to general economic development. On *a priori* grounds, both lines of causation seem plausible and empirical analysis is needed to resolve the issue.

The question of whether financial development preceded economic growth or vice versa has been debated in the historical literature on growth and finance in Sweden. Sandberg (1978 and 1979) describes Sweden as an ”impoverished sophisticate” with regard to human capital and financial development. According to this view, the banking institutions and the financial system in general was of a disproportionately high quality relative to production compared to other European countries in the middle of the 19th century. Similarly, the Swedish population was better educated than the population in other European countries despite economic output being lower than in most other countries. These two factors created advantageous conditions for adopting new technologies and implementing new production techniques through capital investment. Rapid Swedish economic growth was consequently not a result of a sudden increase in human capital or financial development. Instead, technological innovation and capital investment was spurred by the presence of these advantages. Thus, we should not expect GDP and the financial system (or human capital) to be cointegrated during the 19th century since they ought not to exhibit a common trend.

In a comment on Sandberg’s interpretation of the financial and educational state of Sweden, Kindleberger (1982) disputes the description of Sweden as an ”impoverished sophisticate” with respect to finance as early as 1850. He suggests that previous authors, among them Heckscher (1954), described the Swedish banking system as underdeveloped and that many banks turned to private merchant houses for advice and support in the mid-19th century. According to Kindleberger, institutions develop in response to demand. His verdict is that Sweden may well be described as a financial sophisticate during the 19th century relative to other European countries but that the achievement of this position was not complete until around 1870. If Kindleberger’s dating is correct, this implies that a cointegrating vector can be expected since the financial development then immediately preceded rapid economic growth.[3]

[3] A caveat is that a cointegrating relationship can be expected only as long as the later development of the financial system interacted with GDP growth to some extent. Theoretically, it is possible for the financial system to grow from 1850, and then for GDP growth to start in 1870 after an interlude with both variables static.

Previous research. Recent empirical research on finance and growth stresses the financial system's contribution to economic growth. In a study of 80 countries over the 1960-1989-period, King and Levine (1993b) find a strong and robust correlation between financial indicators - the ratio of liquidity of the financial system to GDP, the ratio of private bank assets to total bank assets and the ratio of credit to the private sector to GDP - and economic performance - per capita growth in real GDP, the investment rate and investment efficiency. Concerning the issue of causality, they conclude that the initial degree of financial depth significantly predicts subsequent values of growth. This finding has subsequently been confirmed by De Gregorio and Guidotti (1995) who studied 100 countries during the same period. They concluded that financial development lead to an improved growth performance.

Wachtel and Rousseau (1995) examined the relationship between finance and growth in the United States, the United Kingdom and Canada in a long-run perspective, starting in 1871. Their data is disaggregated according to various types of intermediaries. In brief, they find a robust correlation between the financial sector and economic growth, although the correlation is not significant for every type of intermediary. Their tests for Granger-causality demonstrate that financial development causes economic growth. These tests, however, are conducted in a regression framework despite the non-stationarity of the variables. Thus, they fail to capture any cointegrating relationship between growth and the various measures of financial intermediation. Not until the end of the article do they ascertain through cointegration analysis that there exists a long-run relationship between the variables. It is not specified, however, nor are causality tests carried out within this framework.

One empirical observation from the aforementioned studies should be mentioned. De Gregorio and Guidotti (1995), among others, note that the correlations between financial development and economic growth are significantly diminished or even eliminated for OECD countries, depending on the time period studied. A similar observation is made by Galetovic (1996) examining the ratio of all financial assets issued to real national wealth. He finds that financial systems develop and mature during the early stages of economic development, after which they remain roughly at the same level. These results indicate that the degree of financial intermediation captured by easily observable variables, such as the number of banks or the volume of credit granted by banks, become less suitable as proxies for total financial depth as the financial system becomes more sophisticated and ordinary banks play a reduced role relative to other financial institutions. According to these studies, we should expect to find a link between finance and growth in the earlier part of our sample for Sweden but not later, particularly not after World War II.

A possible explanation for De Gregorio's and Guidotti's (1995) and Galetovic's (1996) finding is that the growth rates in OECD countries have been more influenced by human capital intensive companies and advances in human capital formation in recent times. Such companies may face financial market restrictions reflecting their lack of physical collateral, thus forcing them to seek finance from other sources. If this phenomenon is significant, it would lower the correlation between ordinary financial intermediaries and growth since growth is more dependent on a sector without full access to the regular financial system. The absence of a continuos correlation between the financial system and growth as countries become industrialized may also suggest that once a country has achieved a certain level of financial development, the main prerequisites for growth have been established.

3. The Swedish Institutional Background[4]

Prior to the formation of banking institutions in today's shape, the public's demand for credit was met mainly by three sources: private money-lenders, various small-scale local arrangements and the Riksbank. All three of these were gradually phased out as financial intermediaries during the 19th century, the first two ceasing to exist and the third changing the scope of its activities. Like in most other European countries, merchant and trading houses played a significant role in industrial financing in Sweden. These houses long competed with the newly created commercial banks, but their market shares became successively smaller. This process was accelerated by financial crises in 1863 and 1866, when some of the most respected private money-lenders went into liquidation, but was not completed until the 1890s. Small, local demands for credit were met by various forms of pooling of funds, administered by the local church or village. Such arrangements were largely replaced by the savings banks during the 19th century.

Another important source of industrial finance was the Riksbank, a bank directly subordinate to Parliament. It functioned much like a regular commercial bank from its creation in 1668 to the end of the 19th century. Only later did it become a central bank in the modern sense. Moreover, it was by far the largest creditor to the private sector among commercial banks for most of the 19th century. In 1840, for instance, total credit granted to the non-bank public by the Riksbank was three times as large as the corresponding figure for all domestic commercial banks taken together. Bureaucracy and restrictions placed upon the Riksbank by Parliament gave private commercial banks a competitive advantage. The private sector turned increasingly to them for loans while lending from the Riksbank was channelled to the government.

The first private joint-stock commercial bank with unlimited liability in Sweden began operations in 1830. By 1848, seven others had followed. Regulation in the form of a maximum rate of interest prevented them from attracting deposits of any significance. Instead, these banks financed their lending through note issues. Nevertheless, the commercial banks gradually increased their lending relative to other financial institutions. This process accelerated when the maximum interest rate regulation was abolished in 1864 and full freedom of trade was introduced for joint-stock banks with limited liability. The remainder of the century witnessed the establishment of tight links with industry and and an expansion of their range of activity towards more firm-oriented functions, such as the underwriting of industrial bonds. As a consequence, the importance of commercial banking grew. At the end of the century, the financing role of the old merchant houses had been totally transferred to the commercial banks.

[4] The account of Swedish financial developments is based on *inter alia* Jonung (1989), Jonung (1992), Larsson and Lindgren (1992), Lindgren (1995) and Nygren (1985)

After the abolition of the interest rate regulations, the volume of bank deposits also increased, reducing the role of issuance as a generator of funds.[5] In 1897, new legislation was passed which gave the Riksbank a note-issuing monopoly. In return, commercial banks were granted the right to borrow from, and to rediscount bills in, the Riksbank, thereby making it a lender of last resort. During the same period, the Riksbank also phased out the bulk of its lending to the private sector and, starting in 1902, it acted as a central bank in the modern sense of the term.

The number of savings banks was much larger than the number of commercial banks. Most savings banks were formed to serve specific regions, usually small regions. Their aim was to promote local saving and meet the local demand for credit. Contrary to commercial banks, savings banks intended to finance their lending with public deposits, and they became pioneers in this area of banking. Initially, however, ordinary people could not afford to save any sums of significance. Consequently, savings banks generally depended on a small number of wealthy individuals. Despite explicitly aiming at the regional market for lending purposes, savings banks provided credit both to individuals and to companies. Throughout most of the 19th century, their total amount of credit to the non-bank public was roughly one half the size of commercial bank credits.

Mortgage institutions were the largest lenders in Sweden. The first mortgage association was formed in 1832 and it was followed by seven more within two decades. Their purpose was to provide stable long-term loans at a fixed interest rate to the agricultural sector. In order to finance their loans, they issued bonds abroad, an activity that was centralised in one national association, *Allmänna hypoteksbanken*, in 1861. The main recipients of their credits were the owners of large or medium-sized tracts of land, engaged in commercialised and export-oriented farming. Consequently, the average loan size was large, helping the mortgage associations to reduce their transaction costs. These mortgage institutions continued to be the largest provider of credit until the 1880s.

In the first decade of the 20th century, the demand for credit exceeded domestic supply. Commercial banks responded by borrowing abroad, by increasing their capital stock and by rediscounting bills in the Riksbank. A prohibition of commercial bank acquisition and holding of real estate and shares, in effect since 1886, led banks to create separate companies and consortia owned by the bank or the bank's owners. In addition, they further diversified their activities in the direction of corporate finance, establishing close links with industrial clients.

World War I brought an economic boom with increased exports from Sweden. This boom was transmitted to the banking sector. Post-war deflation and economic decline changed the picture dramatically. The effects on the banking system were twofold. Firstly, as smaller banks had great difficulty surviving, they merged with others. A sharp reduction in the number of commercial banks followed. Secondly, in order to recoup outstanding credit, banks were forced to become more deeply involved in the administration of industrial companies in order to keep them solvent.

[5] It did not reduce the amount of private bank notes in circulation, merely the relative importance of private notes (see Jonung (1989))

After World War I, the savings banks were able to offer higher interest rates on deposits than were the commercial banks. This enabled them to increase their market share of lending. The main development among mortgage institutions was the ever increasing significance of the *Stadshypotek*, an institution devoted to granting credits for housing. In 1923, credits granted by the *Stadshypotek* exceeded credits granted by *Allmänna hypoteksbanken* for the first time and, by 1934, credits granted by the former were twice as large as credits granted by the latter.

World War II signalled the beginning of far-reaching changes in the Swedish financial system. The outbreak of war meant a large increase in government demand for credit as well as a sharp drop in private demand. A few years after the war, a number of new financial regulations were introduced. Based on a belief that the presence of liquid assets in banks and low interest rates created a ”stable” credit market, maximum levels of lending, reserve requirements, liquidity requirements and direct controls of interest rates were implemented (see for instance Jonung (1992)). Most of these regulations were not lifted until the 1980s. In response to such regulations and to the gradually increased demand for more specialization on financial markets, new lending institutions emerged. Until the 1950s, banks and mortgage institutions clearly dominated. Since then, however, special or intermediary institutions, such as pension funds and finance corporations, have acquired considerable market shares. Since 1966, the amount of credit granted by banks have been smaller than the amount of credit granted by other institutions.

4. Choice of Data

In previous studies of the impact of the financial system on economic performance, three different growth measures have been used, most commonly the per capita growth rate in real GDP. In our view, this is the proper choice. When testing our principal hypothesis, that the financial system has exerted an influence on the development of real GDP, we will restrict the analysis to testing for the impact on per capita real GDP.

Other alternatives that have been proposed are the ratio of investment to GDP and various measures of investment efficiency. The rationale behind using investment is that it is believed to be the channel through which financial development influences growth. We, together with Temin (1995), in a discussion of Wachtel and Rousseau (1995), believe that it is misleading to use the investment variable as a proxy for growth since we are primarily interested in the relationship between finance and growth, not between finance and investment. Investment reflects this relationship only to the extent that it is correlated with growth.

The third variable that has been suggested, investment efficiency, is motivated by theoretical considerations stating that a well-developed financial system is better at monitoring investment opportunities. Investment will be more efficient, thus resulting in higher growth. Once again, this variable can be criticised on the grounds that it does not provide any information on the issue of the financial system's impact on growth unless the correlation between investment efficiency and growth is high. Using investment and investment efficiency can, however, be useful in distinguishing between the two possible hypotheses regarding the transmission mechanisms from financial development to growth. Furthermore, if the bulk of investment is debt-financed, it is possible that the correlation between GDP growth and finance found in e.g. Wachtel and Rousseau (1995) arises simply because the financial variable serves as a proxy for investment. In order to assess this possibility, we will therefore also relate the development of the financial system to investment in Sweden.

Turning to measures of financial development, Galetovic (1996) divides those previously used into three categories. The first category simply looks at interest rates, arguing that financially repressed economies generally exhibit very low, or even negative, real interest rates. We do not believe that interest rates constitute a satisfactory proxy for financial development since their links to the financial system are not straightforward.

Galetovic (1996) concludes that the second and third categories, intended to reflect the size of the financial system and the distribution of credit flows, respectively, are more relevant measures. The size of the financial sector may be measured, as in King and Levine (1993b), as the ratio of liquid liabilities to GDP. Another possibility is to use the money multiplier as an indicator of the financial system's capacity to create money and hence its financial depth. King and Levine (1993b) also use the ratio of domestic deposit money bank assets to total domestic bank assets arguing that the central bank generally performs other functions than investment financing. The latter approach would clearly be inappropriate in this context since the Swedish *Riksbank* performed many functions normally associated with commercial banks during the 19th century. Thus, despite the fact that all these measures provide a good first approximation of financial development, we think it is possible to find better measures of the financial system.

King and Levine (1993b) assume that credit provided to the private sector generates increases in investment and productivity to a much larger extent than do credits granted to the public sector. They also argue that loans to the private sector are scrutinized more carefully and that the improved quality of investment emanating from financial intermediaries' evaluation of project viability are more significant for private sector credits. Variables such as the ratio of financial sector claims on the private sector to either total domestic credit or real GDP are therefore likely to give a good approximation of the availability of funds to potential investors.

We adhere to King and Levine's (1993b) view and focus on the volume of credit granted by the financial sector to the private sector. The availability of data from the 19th century limits our options. Nevertheless, we are able to use total credit granted to the non-bank public from commercial banks, savings banks and mortgage institutions. We include *Riksbank* lending to the private sector in commercial bank lending until 1902. Lending from rural credit banks and insurance companies are included from World War II, and the public pension funds (*AP-fonderna)* from their inception in 1959. Finally, our variable includes credits granted by finance corporations and investment companies starting 1968 and 1975 respectively; at those points in time they provided 1 and 0.1 percent of total lending, respectively.

Since it is highly unrealistic to assume that financial sector lending is the sole or main driving force behind the growth process, we also attempt to isolate the potential effects of more conventional factors. Here, we select two such factors: the education level of the workforce and the flow of innovations. To adequately measure the stock of human capital is a monumental task in itself, and any proxy measure will obviously have limitations. We construct a proxy for the additional human capital produced each year based on years of schooling adjusted for different levels of education. We use data for the *folkskola* (public primary school), children receiving education at home (common in the beginning of our sample), the *grundskola* (nine-year primary school gradually replacing the then seven-year *folkskola* during the 1950s and 1960s), the municipal intermediate schools, the *realexamen* (lower certificate exam), the *studentexamen* (higher certificate exam), the *gymnasium* (secondary school introduced in the late 1960s) and the universities and graduate schools.[6]

As a proxy for technological innovation, we use the number of patent applications registered at *Patent- och registeringsverket* (the Swedish Patent bureau). We include applications from both domestic and foreign citizens. Finally, it is imperative to control for population growth. All variables are therefore measured per capita (in the case of human capital, this aspect is built into the construction of the variable) except for patents, since technological progress is non-rival and benefits everyone.

Our aim in putting together the data set has been twofold. First, we attempt to use series that go as far back as possible. Second, we try to make the data as consistent over time as possible. All data series are based on annual data. A more detailed description of the data sources is given below in the data appendix.

[insert Table 1 here]

5. Empirical Results

Virtually all empirical studies of finance and growth are confined to cross-country studies for the post-war era.[7] Consequently, these studies have been carried out in a regression framework. The regression technique, however, is only valid for stationary variables. This poses no problem in cross-country studies for short periods of time but when analysing long-run relationships, an examination of the time series properties of the variables is necessary. We are interested in long-term relationships between finance and growth since we want to go beyond the link between finance and short term fluctuations in growth emphasized by standard regression techniques.

Traditionally, the approach to non-stationarity has been to apply regression techniques to the first-order differences of the time series. Recent econometric advances, initiated by Engle and Granger (1987), however, have produced the cointegration technique, which incorporates both short-run dynamics emanating from first-order differences and common long-run trend movements among the variables in question. It demonstrates that, in spite of the fact that the variables in themselves are non-stationary, there may exist a linear combination of variables that is stationary. If such a stationary linear combination exists among a set of non-stationary variables,

[6] In our attempts to construct our human capital variable, we have benefitted immensely from Albers (1996) and from discussions with Anders Nilsson and Lars Pettersson at the Department of Economic History, Lund University.

they are said to be cointegrated. Failing to account for this long-run relationship will result in misspecified models. We therefore extend the empirical work on finance and economic growth by applying cointegration analysis, which takes both non-stationarity and common long-run trends into account, applying it to data for Sweden. As far as we know, this technique has not been applied consistently to the field of finance and growth.

In order to formally assess the adequacy of using cointegration instead of regression analysis, we must establish whether the variables are stationary or not by testing for the presence of unit roots to ascertain the order of integration. We employ the standard procedure in the form both of augmented Dickey-Fuller tests (Said and Dickey (1984)) and of Phillips-Perron tests (Phillips and Perron (1988)) with a constant and a linear time trend. The results are presented in Table 2.

[insert Table 2 here]

The critical value at the 5 percent level is -3.45. According to Table 2, the null hypothesis of a unit root cannot be rejected in any case, except perhaps for INVEST, using the Phillips-Perron test. The call for a rejection of a unit root for INVEST with the Phillips-Perron test is marginal. Since the Dickey-Fuller test indicates the presence of a unit root, we adhere to the null hypothesis. Similar tests are performed for the differences of each variable to rule out integrations of a higher order than one. The null hypothesis of a unit root in differences is emphatically rejected for each variable. Since the time series are found to be integrated of order one, we conclude that ordinary regression analysis is inadmissible in this context.

In testing for cointegration, we follow the Johansen (1988) procedure (a nice presentation of the application of the method can be found in Enders (1995)). The model is a Vector Error Correction model that can be derived from a VAR specification in levels (see for instance Enders (1995)). It can be written in the form

$$\Delta x_t = \Pi x_{t-1} + \Pi_1 \Delta x_{t-1} + \Pi_2 \Delta x_{t-2} + \ldots + \Pi_{t-p+1} \Delta x_{t-p+1} + \varepsilon_t \qquad (1)$$

where x denotes the vector of variables. The rank of the Π matrix, i.e. the matrix with coefficients for the variables in levels, will determine the number of long-run stationary, or cointegrating, relationships among the variables in levels. We test the rank of Π , employing the λ-trace and λ-max tests outlined in Johansen and Juselius (1990) and Enders (1995).

Since the rank of a matrix determines the number of linearly independent rows, the rank will also equal the number of distinct cointegrating vectors. After determining the rank of the matrix, and hence the number of cointegrating vectors, these vectors are derived from Π by dividing it into two matrixes, α and β, such that

[7] See for instance De Gregorio and Guidotti (1995), Galetovic (1996), King and Levine (1993b) and Wachtel and Rousseau (1995)

$$\Pi = \alpha \beta'. \qquad (2)$$

β' is formed by the eigenvectors associated with each eigenvalue found to be different from zero and α is simply chosen to fulfil the relationship in (2). The long-run relationship - or the cointegrating vectors - between the variables in the model are given by the rows of β'. Since we use the natural logarithms of the series, the coefficients in β can be interpreted as elasticities.

The parameters in α are the weights by which each cointegrating vector enter the equations. They can be interpreted as speed of adjustment parameters, in the sense that they measure the degree to which each variable adjusts to deviations from the long-run stationary relationship. If no entry in α for a single variable is significantly different from zero, then that variable is weakly exogenous in the long run as it does not adjust when the variables differ from their long-run equilibrium.

Model design. Cointegration analysis, especially when causality is studied, tends to become unmanageable as additional variables are added to the model. Furthermore, to our knowledge, there are no previous empirical studies of the causes of long-run growth in Sweden. Thus, we have no prior empirical information on the proper variables to include in the analysis. We therefore start with the rather unrealistic model where financial sector credit to the non-bank public is the only factor affecting growth. This simple model is also suitable for a direct comparison with Wachtel's and Rousseau's (1995) regression model, since the only omitted variable in relation to their model is the money stock. Next, in order to discriminate against the possibility that bank lending merely serves as a proxy for investment, we estimate the model with INVEST as a third variable. Since human capital is one of few variables that seems to be robustly correlated with growth performance regardless of model specification, we add the variable HUMAN to our basic model. Finally, we include PATENT together with financial lending and GDP, to capture any interaction between the financial sector, innovation and investment.

Due to the long time period covered, we introduce a number of dummy variables, all set at the value of 1 for the relevant period and 0 otherwise. The dummy variables used are listed in table 3. All dummy variables are entered outside the cointegrating space, thus reflecting changes in the drift of the variables. Dummy variables are not included unless the coefficient is significantly different from zero or they improve the residual properties. In addition, all models include a constant as a drift term.

[insert Table 3 here]

Previous findings by, for instance, De Gregorio and Guidotti (1995) indicate that the connection between finance and growth found in cross-country regressions is mostly due to the inclusion of non-OECD countries. This result is consistent with the hypothesis that the importance of the financial sector for growth is greatest during the early stages of a country's industrialization process. Since our analysis cover such a long time period, structural changes in the relationships among the variables are likely to have occurred. All the models, therefore, are estimated recursively to assess the stability of the parameter values. The recursive analysis, in combination with our prior knowledge of the historical process, suggests possible breaking points at around 1890 (after which most of the private lenders unaccounted for in our financial measure had been driven out of business) and World War II. Consequently, we also estimate each model for the pre-1890, the 1890-1939 and the post-World War II subsample in order to establish whether or not the cointegrating relationship is stable over time.

The two long-run hypotheses we test can be formulated in terms of α, β and Π. First, in order for economic growth and financial development to affect each other, there must exist at least one cointegrating vector in a model including GDP and the financial sector proxy. If we fail to establish the presence of at least one cointegrating vector, there is no long-run connection between finance and growth. Furthermore, if other variables are included in the long-run relationship, it must not be the case that both the coefficients in β for GDP and the financial measure equal zero. If they do, the cointegrating vector will merely state a relationship between other variables.

The second hypothesis concerns causality. In order for financial development to precede economic growth, it must be weakly exogenous in the long run. That is, the finance variable must not adjust in response to deviations from the cointegrating relationships. This can be analysed by testing whether or not the α-parameters for the equation with (the first difference of) financial development as dependent variable are equal to zero. Similarly, GDP is weakly exogenous in the long run if the corresponding α-parameters in the equation with (the first difference of) GDP as dependent variable are equal to zero.

The empirical results are presented in Tables 4-6. It displays the time periods covered, the endogenous variables (i.e. variables included in the cointegrating relationship), dummy variables, the lag length, the cointegrating vectors, the speed of adjustment-matrix (α-matrix) with t-values, residual test statistics for normality and autocorrelation and, where applicable, test statistics for the constrained parameters in the cointegrating vector and the α-matrix.

Lag lengths are determined by successively reducing an undifferenced VAR model with the relevant variables. The number of cointegrating vectors are determined by the λ-trace-test and λ-max-test. The critical values originate from Johansen and Juselius (1990). We use the test statistic for the 10 percent level. However, when dummy variables are included, the distribution of the test statistic is affected. Where applicable, the critical values have therefore been approximated through simulation using the simulation programme DisCo designed by Johansen and Nielsen (1993).[8]

Economic growth and financial development. First, starting from the simple structure only including GDP and the financial measure in the model, we identify a unique cointegrating relationship for the full sample as well as for each of the three sub-samples. The results from these models are presented in Table 4. The estimated parameters of the cointegrating vectors are all as expected, implying that a higher level of financial sector lending corresponds to a higher level of GDP. For the post-World War II period, however, the coefficient on lending is not significantly different from zero. Furthermore, recursive estimation of the full sample generates estimates of the long-run relationship that for a substantial period are very close to the 95 percent confidence bound for parameter constancy. Since, in addition, the coefficients on finance are significantly different during the sub-periods estimated, we cannot conclude that the relationship between finance and growth is stable across the one and a half century studied. The magnitude of the coefficients indicate that the financial sector impact on GDP was at its height in the period 1890-1939.

On the issue of causality, the α-parameters for the two sub-samples where financial development is significant in the cointegrating vector suggest an interaction between the financial system and growth. The two phenomena reinforce each other. The full sample predicts that GDP alone adjusts to changes in the financial system but, since the system is not stable, this finding can be ignored. Given the limitations of a model with only these two variables, these results should be regarded as suggestive. They have been included mainly as a first yardstick and because they correspond to the variables used by Wachtel and Rousseau (1995) - apart from the money stock.

[insert Table 4 here]

Economic growth, financial development and investment. We now turn to a model with GDP, the financial variable and investment (see Table 5). In this design, we examine whether financial sector lending merely serves as a proxy for investment or if it exhibits some growth generating impact of its own. Since investment data is only available from 1861, we do not attempt to estimate the pre-1890-period separately. Interestingly enough, recursive estimation of the full sample does not reveal the presence of structural breaks, despite the fact that the estimates differ from one sub-sample to the other. The three dummy variables included allowing for differences in the drift of variables in different periods appears to be responsible, thus, reinforcing the evidence for important structural breaks occuring in 1890 and during World War II.

From the full sample, we find that finance does not play an independent role, separate from investment, in generating growth. The hypothesis that the long-run relationship between finance and investment exhibits unit elasticity cannot be rejected at any reasonable level. Furthermore, the speed of adjustment parameters suggest that it is financial lending that responds to changes in investment, and not investment that increases as more credit is made available. Investment thus exerts a positive influence on GDP. These findings support the hypothesis that financial lending merely serves as a proxy for investment when the relationship with economic growth is examined. The financial system's positive influence on GDP that was found in the previous section consequently vanishes.

[8] Neither the test statistics for lag length, nor the statistics for the number of cointegrating vectors are reported. They are available from the authors on request.

During the period 1890-1939, our data set produces evidence in favour of finance having a positive impact on growth. We find two stationary relationships between the variables, one between GDP and investment and one between investment and finance. The second relationship states that financial lending and investment move together in the long run since the hypothesis that the elasticity for either variable with respect to the other is equal to unity cannot be rejected at any reasonable level. Contrary to the findings from the full sample, both investment and finance adjust to deviations from the long-run relationship, implying that an increase in finance increases investment as well as vice versa. Since the first relationship indicate that investment influence GDP positively for this sub-sample, an increase in finance affects GDP through the level of investment. Furthermore, if the volume of credit is high relative to investment, GDP increases. Consequently, our results identify a positive impact of finance on growth for this period. The direction of causation, however, is not one-way. The speed of adjustment-parameters once again indicate a pattern of interaction among the three variables used.

The post-World War II sample generates two cointegrating vectors which can be divided into one relationship between finance and investment and one between investment (or finance) and GDP. The coefficients differ from the full sample and from the period 1890-1939. The influence of investment on GDP is larger and the response to deviations from the long run equilibrium is rapid. Adjustment takes place in both GDP and investment. The relation between the financial system and investment is no longer one to one as the coefficient on finance in the second cointegrating vector is merely -0.261. Finally, and surprisingly, neither investment nor finance responds to deviations from the stationary relationship. Instead, GDP becomes lower as investment rises relative to finance. This, in turn, will create an excessive amount of investment relative to GDP and, hence, reduce investment. This complex adjustment process, along with the altered connection between financial lending and the other variables, may be due to the extensive capital controls introduced in Sweden shortly after World War II.

[insert Table 5 here]

Economic growth, financial developments and human capital formation. Introducing human capital into the model changes the results significantly. No cointegrating vector is found for any of the sub-samples and the one that is found for the full sample turns out to be unstable if estimated recursively. It also exhibits some undesirable residual properties. We relate this result to the notion of Sweden being an impoverished sophisticate in the middle of the 19th century (Sandberg (1979)). According to this view, the amount of human capital and financial sophistication was substantial in relation to the level of output. The educational and financial sophistication enhanced the growth rate by facilitating rapid technological progress, but it was through its presence rather than its development immediately before the increase in Swedish growth rates in the late 19th century. If this notion is correct, we would not expect to find a long-run stationary relationship between either variable and GDP in this period, since the presence rather than the increase of human capital and a developed financial system enhanced economic growth. Our results for the 19th century does not contradict this view.

Economic growth, financial development and patent applications. Apart from human capital formation, technological progress is a prime factor generally believed to affect growth positively. To the extent that patents is a good proxy for technological progress, we would therefore expect it to be cointegrated with GDP. Our estimates, however, suggest otherwise. For the full sample, a unique cointegrating vector is identified, but the coefficient for patents is insignificant (see Table 6). The relationship between finance and growth found in the bivariate analysis is confirmed, with a slightly larger coefficient on finance. Despite its insignificance in the cointegrating vector, the inclusion of the patent variable alters the adjustment pattern. In addition to GDP responding to an increase in financial lending, financial lending now increases in response to increases in GDP. Furthermore, a large amount of credit relative to GDP appears to precede an upturn of patent applications. However, just like the case with only GDP and finance in the analysis, the hypothesis of normally distributed residuals can be rejected and recursive estimation produces estimates that are close to the 95 percent confidence bounds and do not look stable. The sub-sample estimates also reveal different patterns over time, making the full sample estimates inconclusive.

The estimates for the period 1836-1890 display shortcomings similar to the full sample. That is, the residuals are not normally distributed, nor do the coefficients appear to be stable when estimated recursively.

[insert Table 6 here]

Nevertheless, the coefficients are qualitatively identical to (though significantly different from) the estimates without patents. The relation among the variables during the next sub-sample, 1890-1939, is different. We identify one cointegrating vector determining a stationary long-run relationship between financial lending and patent applications. The coefficient for GDP is not significantly different from zero and neither is the speed of adjustment parameter for GDP. Thus, the cointegrating relationship suggests that patents increase when the availability of credit is large in relation to patents, and vice versa. The bulk of the adjustment takes place in patent applications.

For the post-World War II period, we find a new pattern. There are two cointegrating vectors exhibiting long-run relationships between, on the one hand, GDP and, on the other hand, financial lending and patent applications. The magnitude of the coefficient for patents suggests that patents have played an important role in generating growth in this period. Both GDP and patents respond to deviations from the long-run equilibrium between the two variables, but, once again, patent applications are more sensitive to deviations than GDP. According to this model, financial lending adjusts to deviations from the relationship between GDP and finance, contradicting the previous observation that capital controls may have prevented the financial system from responding to deviations.[9]

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[9] We have attempted to estimate models including four, or even all five, of the variables but the complex interaction pattern makes the results hard to interprete, and it adds no further insights. For the full sample, reasonable lag lengths generally produce autocorrelated and non-normally distributed residuals, in addition to estimates that are unstable over time. For the shorter sample periods, limited evidence emerges in support of the conclusions arrived at in the analyses with three variables at a time. The estimates from these models are not

6. Conclusions

Our exploratory study covering a long period of Swedish growth and financial history suggests caution in drawing firm conclusions concerning finance and economic growth. Excluding other variables from the analysis, we identify a link between the volume of credit and the level of GDP prior to World War II. The financial system appears to have had the largest impact on GDP in the period 1890-1939. These findings are consistent with studies indicating that the role of the financial system in promoting growth was significant during the early stages of economic development, but not among OECD countries during the last 30 years. We do not, however, find any stable relationship between finance and growth for the whole period studied. Our estimates suggest an interaction among the variables studied, rather than any one-way causal relation.

After correcting for structural breaks with dummy variables, thus allowing the drift of the variables to vary in different periods, we identify a stable relationship among finance, investment and GDP for the full sample. An increase in investment precedes an increase in GDP. The stationary relationship between investment and financial lending indicates that the long run elasticity between them is unity. Furthermore, judging from the full sample estimates, the financial variable adjusts to deviations from the stationary relationship whereas investment does not. Thus, our results indicate that the positive impact of financial development on growth in the bivariate analysis of the full sample arises because the financial variable acts as a proxy for investment.

The evidence from the 1890-1939 period implies a more positive interpretation of the impact of financial development on economic growth. In this period, investment responds to increases in finance as well as the other way round, suggesting that financial lending played an independent role. Furthermore, GDP rises when the level of finance is high relative to investment as well as when the level of investment is high relative to GDP. Thus, we find support for the finding that the development of the financial system had a positive impact on growth prior to World War II.

We find no stable cointegrating relationship among financial lending, education and economic growth for any period. This is consistent with the notion of Sweden being ”impoverished” with regard to production and ”sophisticated” with regard to human capital and the financial system in the middle of the 19th century.

The availability of financial lending appears to have increased the number of patent applications in the period 1890-1939, although the reverse is also true. Patents, however, appear to have been more responsive to finance than vice versa. During the post-World War II period, the elasticity of GDP with respect to patents is very large, suggesting an important role for patents, and hence for technological progress, in explaining growth during the

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reported, since no firm and additional conclusions with regard to the impact of the financial system on growth can be drawn from them.

past 50 years. This is consistent with the view that far-reaching controls of the Swedish financial markets reduced their role as a generator of growth.

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Data Appendix

Population data are from Statistics Sweden, series. Data on Swedish GDP consists of a series excluding unpaid household work compiled by Lennart Schön et al. (1996). The series is constructed from a large number of annual series on output in different sectors and can be regarded as being of fairly high quality. The same holds for most of the series used. The price level is measured by the consumer price index published by Statistics Sweden. All series are reported in 1949 prices. Investment data are from Krantz and Nilsson (1975) for the period 1861-1970 and from Statistics Sweden thereafter. Schelin (1978) provides data on *folkskolan* (elementary school) and children educated at home 1847-1881. BiSOS provides annual data on *folkskolan* and children educated at home 1882-1910 and on the higher certificate exams 1876-1910. Some early figures on the number of university students are taken from Agardh and Ljungberg (1863). All other data on education are from Statistics Sweden. Patent data are originally from *Patent- och registreringsverket.*[10]

Financial sector lending to the private sector is constructed from five different sources. Credits granted by the Riksbank between 1800 and 1924 are from *Sveriges Riksbank 1668-1924. Bankens tillkomst och verksamhet*, volume 5. Private commercial bank lending in the period 1834-1874 is from the same source and consist of end-of-year data. From 1875 to the present day, data on commercial bank lending are from *Riksbankens årsbok* and consist of yearly averages of monthly data. Data on savings banks are from Nygren (1967) for the period 1834-1901, from *Allmän sparbanksstatistik* (annual publication) for 1902-1987 and from Statistics Sweden for 1988-1992. For most periods prior to 1876, lending from savings banks are assumed to follow the same pattern as deposits due to the absence of yearly data for the former. Lending from mortgage institutions for the period 1834-1858 are from the Finance committee's report to Parliament in 1860 and from Statistics Sweden for the remaining period. Unfortunately, these data are published at five-year intervals for the period 1870-1910 and not at all for 1859-1869. We have therefore annualized them through linear interpolation. From 1950 onwards, mortgage institution lending is from Statistics Sweden. All other financial sector data are from Statistics Sweden.

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[10] We are very grateful to Olle Krantz at Umeå University for supplying the patent application series.

Table 1. Description of variables

Variable name	Description
GDP	Per capita GDP
FINANCE	Total lending from the financial sector to the non-bank public per capita
INVEST	Total investment per capita
HUMAN	Increase in years of schooling
PATENT	The number of patent applications

Table 2. Dickey-Fuller and Phillips-Perron tests for unit roots

Variable	Number of lags	Dickey-Fuller test statistic	Phillips-Perron test statistic	Dickey-Fuller test statistic for first differences	Phillips-Perron test statistic for first differences
GDP	5	-2.05	-2.24	-6.21	-11.97
FINANCE	1	-2.99	-2.41	-7.45	-8.64
INVEST	2	-2.85	-3.52	-7.19	-13.17
PATENT	1	-0.36	-0.84	-9.75	-17.28
HUMAN	1	-2.03	-2.31	-4.88	-6.00

Table 3. Dummy variables

Variable	Years equal to 1
PRIVATE	1834-1890
WWI	1914-1918
WWII	1939-1945
POSTWWII	1946-1991
DEREGULATION	1987-1991

Table 4. Economic growth and financial development: cointegration results

Period	1834-1991	1834-1890	1890-1939
Endogenous variables	GDP FINANCE	GDP FINANCE	GDP FINANCE
Dummy Variables	WWI, WWII, PRIVATE, POSTWWII		WWI
Number of lags	6	2	2
λ-trace test statistic 0	14.71 *	21.66 *	13.93 *
1	0.32	1.18	0.22
Cointegrating vector (β)	(1, -0.363)	(1, -0.302)	(1, -0.724)
Speed of adjustment-parameters (α) (t-values in parentheses)	-0.067 (-3.01) 0.036 (1.37)	-0.237 (-2.49) 0.330 (2.53)	-0.232 (-3.11) 0.159 (2.20)
R^2 GDP	0.234	0.120	0.369
FINANCE	0.352	0.139	0.392
Residual tests: normality: (p-values in parentheses)	χ^2 (4)=9.619 (0.05)	χ^2 (4)=9.069 (0.06)	χ^2 (4)=4.565 (0.33)
autocorrelation:	χ^2 (4)=7.030 (0.13) χ^2 (4)=3.379 (0.50)	χ^2 (4)=8.800 (0.07) χ^2 (4)=0.664 (0.96)	χ^2 (4)=11.778 (0.02) χ^2 (4)=6.208 (0.18)

Notes: *The endogenous variables are GDP and FINANCE. The* λ*-trace test statistics are tested for the null hypothesis that the number of cointegrating vectors are equal to the figure on the row of the test statistic against the alternative hypothesis that the number of cointegrating vectors is larger than the figure. An asterisk indicates that the null hypothesis is rejected at the 10 percent level. In the* β*- and* α*-matrices, they are listed in the order GDP and FINANCE. All coefficients in the cointegrating vectors are significantly different from zero at the 1 percent level. The speed of adjustment-matrix (*α*-matrix) are presented with t-values in parentheses. The residual test statistic for normally distributed residuals is the test used in the software CATS and is described in Hansen and Juselius (1995). The residual test statistics for zero autocorrelation are the Lagrange multiplier tests for first and fourth order autocorrelation, respectively.*

Table 5. Economic growth, financial development and investment: cointegration results

Period		1861-1991	1890-1939	1946-1991
Endogenous variables		GDP, FINANCE, INVEST	GDP, FINANCE, INVEST	GDP, FINANCE, INVEST
Dummy Variables		WWI, WWII, POSTWWII	WWI	DEREGULATION
Number of lags		6	2	7
λ-trace test statistic	0	38.27 *	33.86 *	84.63 *
	1	13.45 *	13.10 *	22.51 *
	2	0.91	0.26	0.83
Cointegrating vectors (β)		(1, 0, -0.665) (0, 1, -1.089)	(1, 0, -0.650) (0, 1, -0.906)	(1, 0, -1.546) (0, -0.261, 1)
Speed of adjustment-parameters (α) (t-values in parentheses)		-0.117 (-2.36) 0.057 (1.13) 0.240 (1.75)	-0.251 (-2.81) 0.050 (0.61) 0.138 (0.63)	-1.029 (-4.24) -0.301 (0.78) 0.806 (2.03)
		0.024 (1.11) -0.066 (-3.05) -0.077 (-0.11)	0.185 (3.37) -0.156 (-3.09) 0.291 (2.15)	-1.005 (-3.80) 0.446 (1.07) 0.517 (1.19)
R^2	GDP	0.250	0.406	0.707
	FINANCE	0.478	0.481	0.488
	INVEST	0.297	0.393	0.689
Residual tests: normality: (p-values in parentheses)		χ^2 (6)=10.32 (0.11)	χ^2 (6)=4.01 (0.68)	χ^2 (6)=10.43 (0.11)
autocorrelation:		χ^2 (9)=16.44 (0.06) χ^2 (9)=14.15 (0.12)	χ^2 (9)=12.55 (0.18) χ^2 (9)=6.16 (0.72)	χ^2 (9)=10.03 (0.35) χ^2 (9)=4.85 (0.85)
Parameter tests (p-values in parentheses)		β_{22} = -β_{23} χ^2 (1)=0.53 (0.47) α_1 = 0: χ^2 (1)=5.47 (0.07) α_3 = 0: χ^2 (1)=4.35 (0.11)	β_{22} = -β_{23}: χ^2 (1)=1.74 (0.19) α_2 = 0: χ^2 (1)=11.70 (0.00) α_3 = 0: χ^2 (1)=10.88 (0.00)	β_{22} = -β_{23}: χ^2 (1)=20.73 (0.00) α_2= 0: χ^2 (1)=2.59 (0.27)

Notes: *The endogenous variables are GDP, FINANCE and INVEST. The* λ*-trace test statistics are tested for the null hypothesis that the number of cointegrating vectors are equal to the figure on the row of the test statistic against the alternative hypothesis that the number of cointegrating vectors is larger than the figure. An asterisk indicates that the null hypothesis is rejected at the 10 percent level. In the* β*- and* α*-matrices, they are listed in the order GDP, FINANCE and INVEST. All non-zero coefficients in the cointegrating vectors are significantly different from zero at the 1 percent level. The speed of adjustment-parameters (*α*-matrix) are listed groups of three. The top group indicates the speed of adjustment with respect to the first cointegrating vector and, where present, the bottom group indicates speed of adjustment with respect to the second cointegrating vector. The speed of adjustment-parameters are presented with t-values in parentheses. The residual test statistic for normally distributed residuals is the test used in the software CATS and is described in Hansen and Juselius (1995). The residual test statistics for zero autocorrelation are the Lagrange multiplier tests for first and fourth order autocorrelation, respectively.*

Table 6. Economic growth, financial development and patent applications: cointegration results

Period	1836-1991	1836-1890	1890-1939	1946-1991
Endogenous variables	GDP, FINANCE, PATENT	GDP, FINANCE, PATENT	GDP, FINANCE, PATENT	GDP, FINANCE, PATENT
Dummy Variables	WWI, WWII, MERCHANT, POSTWWII		WWI	DEREGULATION
Number of lags	6	2	5	5
λ-trace test statistic 0	36.17 *	27.70 *	40.28 *	52.69 *
1	10.58	10.99	7.36	18.79 *
2	0.15	0.09	0.67	0.19
Cointegrating vector (β)	(1, -0.425, 0)	(1, -0.280, 0)	(0, 1, -0.985)	(1, -0.511, 0) (1, 0, -2.984)
Speed of adjustment-parameters (α) (t-values in parentheses)	-0.085 (-3.20) 0.060 (1.98) -0.316 (-3.19)	-0.304 (-2.79) 0.114 (0.81) 0.682 (1.26)	0.080 (1.89) -0.100 (-2.50) 0.484 (5.33)	-0.129 (-1.51) 0.382 (3.40) -0.139 (-1.19) -0.033 (-1.99) -0.039 (-1.79) 0.095 (4.17)
R^2 GDP	0.240	0.165	0.571	0.622
FINANCE	0.388	0.093	0.594	0.608
PATENT	0.247	0.328	0.660	0.532
Residual tests: normality: (p-values in parentheses)	χ^2 (6)=51.76 (0.00)	χ^2 (6)=21.14 (0.00)	χ^2 (6)=3.95 (0.68)	χ^2 (6)=1.73 (0.94)
autocorrelation:	χ^2 (9)=14.53 (0.10) χ^2 (9)=12.97 (0.16)	χ^2 (9)=2.27 (0.99) χ^2 (9)=5.41 (0.80)	χ^2 (9)=8.44 (0.49) χ^2 (9)=9.26 (0.41)	χ^2 (9)=13.55 (0.14) χ^2 (9)=8.80 (0.46)
Parameter tests (p-values in parentheses)	$\beta_3 = 0$: χ^2 (1)=0.14 (0.71) $\beta_3 = \alpha_2=0$ χ^2 (2)=3.99 (0.14)	$\beta_3 = 0$: χ^2 (1)=0.52 (0.47) $\beta_3 =\alpha_2=\alpha_3=0$ χ^2 (1)=3.15 (0.37)	$\beta_1 = 0$: χ^2 (1)=0.52 (0.47) $\beta_1 = \alpha_1 =0$ χ^2 (2)=3.57 (0.12)	α_1=0 χ^2 (2)=6.49 (0.04)

Notes: *The endogenous variables are GDP, FINANCE and PATENT. The λ-trace test statistics are tested for the null hypothesis that the number of cointegrating vectors are equal to the figure on the row of the test statistic against the alternative hypothesis that the number of cointegrating vectors is larger than the figure. An asterisk indicates that the null hypothesis is rejected at the 10 percent level. In the β- and α-matrices, they are listed in the order GDP, FINANCE and PATENT. All non-zero coefficients in the cointegrating vectors are significantly different from zero at the 1 percent level. The speed of adjustment-parameters (α-matrix) are listed groups of three. The top group indicates the speed of adjustment with respect to the first cointegrating vector and, where present, the bottom group indicates speed of adjustment with respect to the second cointegrating vector. The speed of adjustment-parameters are presented with t-values in parentheses. The residual test statistic for normally distributed residuals is the test used in the software CATS and is described in Hansen and Juselius (1995). The residual test statistics for zero autocorrelation are the Lagrange multiplier tests for first and fourth order autocorrelation, respectively.*