Discussion Paper 63

Institute for Empirical Macroeconomics
Federal Reserve Bank of Minneapolis
250 Marquette Avenue
Minneapolis, Minnesota 55480-0291

May 1992

THE SWEDISH BUSINESS CYCLE: STYLIZED FACTS OVER 130 YEARS

John Hassler* Petter Lundvik*

Torsten Persson* Paul Söderlind*

Institute for International Economic Studies
Stockholm University

*Prepared for the 5th volume of *FIEF Studies in Labor Markets and Economic Policy*. We gratefully acknowledge financial support from the Bank of Sweden Tercentenary Foundation, the Swedish Social-Science Research Council and The Jan Wallander Foundation. We thank Kerstin Blomquist and Maria Gil for secretarial and editorial assistance and Gunnar Jonsson for research assistance. Finally, we thank participants in the FIEF Workshop on August 26, 1991—particularly our discussants Klaus Neusser and Erling Steigum—participants in seminars at the IIES and at the Federal Reserve Bank of Minneapolis, Lars Svensson, and Anders Vredin for their helpful comments.

1. Introduction

During the last half century, the interest by government policymakers and commercial forecasters in business cycle fluctuations has been on a stable trend. The interest by the economics profession, at least in the empirical regularities of business cycles, has been much more cyclical. The empirical research on business cycles peaked most recently in the last decade. This recent research basically follows two tracks. One track—which is the one Englund, Vredin, and Warne follow in their companion paper—is inspired by the advances in the methodology of time-series econometrics. The other track—which is the one we follow in this paper—is inspired by the research program laid out in the seminal paper by Lucas (1977).

Lucas emphasized the idea of "business cycle regularities", a set of common facts in the form of correlation coefficients and standard deviations, as well as the complementary idea that "business cycles are all alike" across countries and time. Since his paper, a large body of research has developed trying to measure and model such regularities empirically. The vast majority of the existing studies deal with US data from the postwar period, however. Much less is known about other countries and other time periods. In Europe, in particular, macroeconomists have been slow to respond. And it is only in the last few years that European researchers have systematically tried to assemble basic facts about business cycles. Recent studies include the work by Danthine and Girardin (1989), Blackburn and Ravn (1990), Brandner and Neusser (1990), Correia, Neves and Rebelo (1990), and Englund, Persson and Svensson (1990). We believe that such documentation of simple stylized facts is a necessary and important inductive stage in research on macroeconomic phenomena. Of course, there will always be some classical qualitative questions in macroeconomics. But, at least to us, it seems absolutely essential to know more precisely what facts one is supposed to explain when developing theoretical models.

In this paper, we try to establish such stylized facts for Swedish business cycles.

The scope of our study may well be unique in two respects. First, our yearly data goes back to the 1860s for most variables. Most other studies use quarterly data for the postwar period, which gives about as many observations. However, in a study of business cycles, one does not want to count the number of observations but the number of cycles. Second, our data include a large number of variables. In addition to the usual aggregate GDP–components, our data include relative prices, labor market variables, nominal and financial variables, variables in foreign trade, and measures of foreign output fluctuations. We believe that these data are of relatively high quality, in international comparison. Section 2 of the paper describes our data set and Appendix 1 gives complete sources for our data.

Any study of business cycles faces the problem of decomposing some raw time series, so as to extract a cyclical component. Explicitly or implicitly, the researcher must then adopt a definition of business cycles. We try to take an explicit stand. We follow modern business cycle theory in viewing business cycles as comovements of deviations from trend in macroeconomic aggregates. To sharpen this definition, we follow most practitioners in viewing business cycles as having an average length of about 5 years. In section 3, we draw on our definition when deciding how to filter our raw time series, so as to extract their cyclical components. We end up preferring a so called band–pass filter, but throughout the paper we check our results against results that rely on other popular filtering methods. Appendix 2 contains a technical discussion of the different filters that we consider, while Appendix 3 discusses statistical inference on filtered data. Section 3 also serves to introduce most of the statistics that we use to characterize our business–cycle facts in the following sections.

In Section 4, we take a look at the broad business–cycle facts. To document these facts, we mostly use familiar time–domain statistics, such as standard deviations and correlation coefficients, but also some frequency–domain statistics. For better overview, we separate our 42 variables into four blocks: nominal and financial variables, GDP–components, manufacturing and labor market variables, and foreign variables. Given that our data span very different eras in Swedish economic history, it is interesting to ask which stylized facts are robust across time. In addition to studying the whole sample period, we therefore compute moving statistics for 30–year periods from 1861–1891 to 1958–88. We also systematically compare the prewar period (1861–1913), the interwar period (1921–38) and the postwar period (1948–88).

With such a large data set as ours, we obviously face a trade–off between breadth and depth. Section 5 tries to establish some narrow facts by going deeper into some specific questions. The questions we choose to study are central to macroeconomic theory and debate. First, we look at the behavior of nominal prices and wages to see whether we can detect any signs of increased stickiness over time. Next, we study the comovements between money, output and prices and again ask whether those comovements are stable over time. We then look at the comovements between real wages, employment (unemployment), output and productivity and try to relate our findings to some of the main macroeconomic–labor market paradigms. We also study the comovements between domestic and foreign variables—foreign demand, domestic output, exports and relative prices in foreign trade, in particular—from the stepping stone of some common views in the Swedish macroeconomic discussion. Finally, we try to find evidence in our data for the popular belief that business cycles are asymmetric, and, in particular, that downturns in the cycle are faster than upturns.

In Section 6 we summarize our main findings. Based on these findings, we suggest some topics for further research on Swedish business cycles. We also attempt to evaluate our approach in comparison with other work and raise the difficult question whether the business–cycle fluctuations that we have identified are really important phenomena.

2. Data

Our purpose is to establish broad stylized facts of the Swedish business cycle since the 1860's. We are interested in real as well as nominal variables. Therefore, the data set contains yearly data on the available variables of macroeconomic interest. For data on most of the domestic real variables, we rely heavily on an earlier study by Englund, Persson and Svensson (1990). Most of the data series go back to 1861, a few series go back only to 1870, while the unemployment series only goes back to 1911. Specific sources for the data set are given in Appendix 1. The entire raw data set is published in Hassler, Lundvik, Persson and Söderlind (1992).

A major component of the data set is the national accounts block: GDP and manufacturing production, the aggregate demand components (public and private consumption, investment, exports, imports) as well as the GDP deflator and deflators for each of the demand components and for manufacturing production. The basic data sources for the historical national accounts stem from a major project undertaken in the 1930's at the Institute for Social Sciences at Stockholm University. The project covered the period from 1860 to 1930, and were published in Myrdal (1933), in Bagge, Lundberg and Svennilson (1933,1935) and in E. Lindahl, Dahlgren and Kock (1937). Dahlgren (1936, 1941) and O. Lindahl (1956) subsequently updated the national accounts data. Johansson (1967) presented consistent time series for the period 1861 – 1955. In 1950 the National Institute of Economic Research (konjunkturinstitutet) started publishing a modern national accounts series. Later on the Central Bureau of Statistics assumed responsibility for the national accounts. Obviously, data quality is not uniform across the whole period. The introduction of local crop investigations in 1870 and the more systematic collection of production data from the manufacturing sector in two rounds, 1896 and 1913, substantially improved quality. A fundamental improvement occurred in 1950 when the Central Bureau of Statistics started publishing the modern national accounts. The quality of the Swedish historical national accounts is generally regarded to be high in an international comparison. For instance, Backus and Kehoe (1989) judge the quality to be not quite as high as that of U.K. data but in parity with that of Canadian and Australian data.[1]

The original historical national accounts were only given in current prices. Krantz and Nilsson (1975) constructed price deflators for the demand components of GDP, by going back to the originally quantity series that were used when constructing the historical national accounts. They used these price indices to give a consistent GDP series at fixed prices from 1861 to 1970. Our study uses the historical data deflated by the price indexes from Krantz and Nilsson linked in 1950 with the modern national accounts. There are two problems with this linkage. One problem is how to treat inventory investment. Because the original historical data are basically constructed from the production side, they contain no information on inventories. Aggregate consumption and investment is determined as total production of consumption and investment goods minus the balance of trade in those goods. Inventory investments are thus split in unknown proportions between the historical series for consumption and investment, while the modern national accounts include inventory investment as a separate item. Absent any particular information on where inventory investments are hidden before 1950, we just link the consumption and investment series, which is likely to exaggregate their volatility in the early part of the period.[2]

The second problem is that the Krantz–Nilsson fixed–price series apply to GDP at

---

1 As pointed out in the recent work by Romer (1989), the historical data in many countries provide a poor measure of value added in service industries, which overestimates the variation in output. This problem is not likely to plauge the Swedish data we use, for reasons discussed in Englund, Persson and Svensson (1990). It may be important for some of the foreign GDP–data that enter our measure of foreign demand below, however.

2 Note that this procedure differs from that used by Krantz and Nilsson in their linking of pre– and post–1950 data. They start the linking on the destination side of the national product. There it is carried out for public consumption, for the private consumption categories of goods and services, and for the investment categories for machinery and buildings, respectively. These items are subsequently aggregated to for sub–totals for consumption and investment and a total for national product. (p.38). This means that pre–1950 items, which sum to GDP, are linked with post–1950 items, which do not sum to GDP.

factor cost, whereas the official national accounts only give GDP at market value in fixed prices. We handle this by deflating GDP at factor cost in current prices post 1950 by the implicit GDP deflator for GDP at market value. Given the relatively small share of indirect taxes in GDP, the resulting error is small.[3]

The only reasonably consistent data on wages and employment are limited to the manufacturing sector. The early data on wages and employment were also developed by the project at the Institute for Social Sciences in the 1930's and by Jungenfelt (1966). We can derive historical measures of total hours and total number of employees in manufacturing by dividing the total yearly wage bill by measures of average hourly earnings and average yearly earnings per employee. Using the series of manufacturing output and the series of hours, we can derive a measure of (average) labor productivity. Sectoral definitions for the historical production, wage and employment series accord well, since the data stem from the same project. In the early part of the period, the production and wage series may have been based on somewhat different samples of firms, however.[4] 1950 and later all data are from the Central Bureau of Statistics.

The unemployment series from 1911 to 1955 is based on statistics for unemployment among members in labor unions. In the early part of this period, there may be a problem of measurement error, since the share of unionized workers was relatively low. Furthermore there may be a problem of selection bias: because one of the benefits of union membership was unemployment insurance, union members may have had a larger than

---

[3] The way one handles both of these problems is of some quantitative importance. For the period 1950—1970 the Krantz and Nilsson data (their table 3.1) show an average growth rate of 3.37 per cent (with a standard deviation of 2.12 per cent). For the national accounts at market value in fixed 1968 prices the corresponding figures are 3.77 (1.55), and for our constructed series at factor cost 3.63 (1.42). We see that the Krantz and Nilsson procedure which pretends that there are no inventory investments leads to a considerable underestimation of the variability of GDP. The difference between the market value and factor cost series are minor for this period.

For the period 1970—1987 the official national accounts at fixed market values show an average growth of 2.00 per cent with standard deviation 1.46. Our series at factor cost show a slightly lower growth rate of 1.93 per cent but a considerably higher standard deviation of 1.96.

[4] An indication of different sampling is that we get a very high income share for labor during the first 30 years of the sample.

average probability of losing their jobs. After 1955 the source for unemployment is instead the number of unemployed registered at the national employment offices.

The basic financial data cover the money supply and nominal interest rates. The nominal money supply is a broad measure of money (M2), mainly from Jonung (1975). From these data and data on the price level (the GDP–deflator), we get a measure of the real money stock. There are two different nominal interest rates: the Swedish official discount rate, and the borrowing rate from the leading Swedish commercial bank. None of these is strictly a market equilibrium rate: the discount rate was a direct instrument for monetary policy, while the borrowing rate was regulated during some subperiods. We compute real rates of interest simply by deducting the inflation rate (based on the GDP–deflator) from the nominal rates.

Data for the current account up to 1950 are taken from L. Ohlsson (1969) and linked with data from the national accounts for the period thereafter. We formulate a measure of foreign demand by calculating a weighted average of GDP for Sweden's six leading trading partners, United Kingdom, Denmark, Norway, Germany, France, and United States. These countries received about 80 per cent of Swedish exports for most of the sample period. The source for foreign GDP–levels is Maddison (1982) before 1950 and Summers and Heston (1988) thereafter. The weight for each country is determined by the contemporaneous export share to the country (Ohlsson (1969) gives export shares for every 5 years since 1870). This measure of foreign demand is likely to be quite crude, in that it does not control for the specific (and changing) commodity composition of Swedish exports.

3. What is Business Cycles?

3.1 Business Cycles: A preliminary definition

There is no objective or universal definition of "business cycles". But since we set out to study business–cycle facts, we believe that it is important for us to be precise about exactly how *we* define business cycles. That is what we try to do in the present section. In addition we introduce most of the statistical concepts that we will use to document and characterize the facts in Sections 4 and 5.

We take a starting point in the celebrated definitions by Lucas (1977). Lucas defined the business cycle as:

"movements about trend in gross national product",

and the broader concept of business–cycle regularities as

"comovements of the deviations from trend in different aggregative time series".

One way or another, most modern studies of business cycles have adopted definitions along these broad lines. By focusing on the cyclical comovement between macroeconomic aggregates, this view is potentially quite different from the previous dominating paradigm—formulated in Burns and Mitchell (1946)—with its focus on reference cycles and on different phases in a given sequence of cycles.

But Lucas' definitions still contain far too many loose ends to be operational. In particular: If we are to study deviations from trend, how do we define the trend, in practice? And, if we are to study comovements between aggregative time series, how do we measure these comovements, in practice? The following two subsections try to answer these questions.

3.2 What is trend, cycle and noise?

Thinking about how to define the cyclical component, means confronting the classical statistical problem of representing a given time series, y say, as the sum of a trend component, a cyclical component, a seasonal component, and a noise component. Because we are dealing with yearly data, we can ignore seasonal, so schematically the possible decomposition is:

(3.1) $$y = trend + cycle + noise.$$

In the following we shall refer to a procedure to achieve this kind of decomposition as *filtering*.

Ideally, we would like to base our filtering on firm theoretical grounds. It is indeed possible to construct theoretical business–cycle models that gives some guidance on how to filter. But, unfortunately, these models often involve unbelievable assumptions. For instance, many real–business cycle models—following Kydland and Prescott (1982)—use a modified neoclassical growth model and express business cycles as fluctuations around a growth path where productivity grows at a constant exogenous rate. Taken literally, this approach would suggest filtering the data by just removing the same log–linear trend from each growing (real) variable in the model and no trend at all from each stationary variable in the model.[5]

But the assumption of a constant underlying productivity trend is hard to swallow, both from a theoretical and an empirical point of view. The new "endogenous growth theory" has led us to understand that the economy's underlying productivity trend could very well vary over time, for instance, as a result of government policies that affect the incentives to accumulate capital, human capital, or productive knowledge.[6] And—from our specific perspective—we know that secular productivity growth has varied quite a bit over the last 130 years. In the upper part of *Figure* 3.1a we have plotted the percentage

---

5 This point is also made in King, Plosser and Rebelo (1988a).

6 A formal and very interesting integration of the theories of growth and business cycles is starting to take place in the context of "endogenous growth models". See King, Plosser and Rebelo (1988b) for an early discussion, and King and Rebelo (1990) and Lundvik (1991) for recent applications. This interesting development seems to lead to serious questions regarding the fruitfulness of decomposing series into growth and cyclical components. It can also prospectively build a bridge between the theoretical and simulations–oriented literature on real business cycles and the empirical time series literature on "unit roots" and stochastic trends. For a further discussion see also Englund, Warne and Vredin (1991).

deviation of Swedish real *GDP* from a log–linear trend over our sample period: 1861 to 1988. The series has a major cycle: faster than average growth first during the industrialization in the late 19th century and then during the early post–war period and slower than average growth during the interwar period. What we normally think of as business cycles are not these kind of cycles however, but instead the more rapid fluctuations that gives the slow–moving curve in the figure its jagged appearance.

In practice, studies of business cycles typically go for a more flexible approach. Most researchers in the real–business cycle tradition have in fact chosen to remove a smooth, but variable trend from the data. Kydland and Prescott (1990) cite as one of their criteria for choosing a trend that:

> "The trend component for real GNP should be approximately the curve that students of business cycles and growth would draw through a time plot of this time series."

We are sympathetic to this criterion. But even if we accept it, we are still left with considerable degrees of freedom: just who do you chose as your "students of business cycles and growth"?

Thus, one cannot really escape to take an a priori stand. We take our stand in accordance with what we perceive to be the popular perception of business cycles among forecasters, policymakers and, maybe, text–book writers. In the language of Kydland and Prescott's criterion, we chose those practitioners to be the students of business cycles and growth. Common to these groups—we believe—is to think about business cycles as having an average length of about 5 years. This is the number Moore and Zarnowitz (1986) cite for the U.S, both before and after the second world war, and about the number Lindbeck (1975) cites for Sweden during the last century. According to both, the cycles were not of constant length but varied over time. Furthermore, official or semi–official forecasting bodies such as the *NBER* in the US and the *National Institute for Economic Research* in Sweden, typically think of cycles of roughly the same length.

Having taken this stand, we can sharpen Lucas' definitions in Section 3.1 somewhat and take business cycle regularities to mean *cyclical comovements, with a period of about 5 years, of deviations from trend in macroeconomic variables.* Is this definition a useful one? That is hard to determine on à priori grounds, or more colorfully: the proof of the pudding is in the eating. We return to a discussion about the usefulness of viewing business cycles in this particular way in Section 6 below. With our new definition in mind, we next turn to a discussion about the three different filters that we use in this study. Each of these filters produces time series which are dominated by cycles with an average length of about five years.

3.3 Three filters

Our first and preferred filter is a so called band–pass filter. To explain how it works, we make a slight digression on spectral analysis. Spectral analysis emphasizes precisely the cyclical properties of data and therefore provides a natural set of statistical tools for studying business cycles.[7]

A Fourier transform of a stationary time series y expresses the series as a sum of cyclical components of different frequencies ω. And a Fourier transform of the covariogram of y gives the *spectrum* of the series $S^y(\omega)$. The spectrum can be interpreted as a decomposition of the series' variance by frequency. Therefore, one can interpret the spectrum as a density function: the area under $S^y(\omega)$—the spectral mass—between any two frequencies, $\overline{\omega}$ and $\underline{\omega}$, gives the portion of the variance of y due to cyclical components in the frequency band $(\overline{\omega}, \underline{\omega})$.

The lower part of Figure 3.1a shows the spectrum for (the log of) real GDP less a log–linear–trend, the series discussed in Section 3.2. The log of the spectrum is plotted as a function of frequency, from 1 to 64 cycles per 128 years, the length of the sample period.

---

7 See Koopmans (1974) and Priestly (1981) for general discussions of spectral analysis. Sargent (1987) provides a condensed general discussion and an application to macroeconomics.

These frequencies correspond to cycles with lengths from 128 years down to 2 years. The spectrum in the figure has what Granger (1966) called the "typical spectral shape of an economic variable", namely most of the spectral power is concentrated at the low frequencies. Of course, this *frequency*–domain property of the series corresponds closely to the *time*–domain property that we already discussed: the series is dominated by major slow–moving cycles.

Band–Pass Filtering. Like Englund, Persson and Svensson (1990), we believe that the type of filter that closest corresponds to our definition of business cycles is a so called band–pass filter.[8] A band–pass filter operates in the frequency domain. In principle, it filters out all the cyclical components of a given series except those components within a chosen frequency band: the "pass band". In practice, it is not possible to shut out completely cyclical components outside of the pass band, unless one has an infinite time series. We refer the reader to Appendix 2 for a technical discussion of the properties of the band–pass filter and of how we apply it to a finite time series.

Keeping with our chosen view of business cycles as cyclical comovements around trend with a period of around 5 years, we choose a pass band *between 3 and 8 years.* In terms of the decomposition of y in equation (3.1), we treat components at the lowest frequencies—corresponding to cycles with a period of more than 8 years—as belonging to the *trend* of y. And we treat components at the very highest frequencies—corresponding to cycles with periods between 2 and 3 years—as belonging to the *noise* of y. What are the motivations for filtering out a noise component of the series? One motivation is that specific events, such as the large strikes, crop failures and wars during this long historical period, may reshuffle production and other variables between adjacent years. Such events will then show up as cycles close to two years in the data. Another motivation is that temporary measurement error will also show up as cycles at the highest frequencies.

---

8 Other applications of band–pass filters in the macroeconomic literature includes Stock and Watsons (1990) recent and exhaustive study of US post–war business cycles.

To see how the band–pass filter extracts the business cycle component, consider *Figure* 3.1b. In the upper part we plot (the log of) real GDP filtered with the band–pass filter against time. As in Figure 3.1a, this measure has the scale of percentage deviation from trend. The series now clearly corresponds much more to the practitioners' view of business cycles: counting the peaks and troughs, the number of cycles during the whole period is about 25, an average of about 5 years per cycle. In the lower part of the figure, we show the spectrum of the same series. Clearly, all the remaining spectral mass is at the intermediate frequencies. The dotted vertical lines in the figure mark the frequencies associated with cycles of 8 years and 3 years, respectively.[9]

Whittaker–Henderson filtering. Our second filter is the so called Whittaker–Henderson filter, introduced to macroeconomists by Hodrick and Prescott (1980). An important reason to consider this filter is to compare with other studies. Researchers in the real–business–cycle tradition have almost universally adopted this method of detrending. The Whittaker–Henderson filter operates in the *time* domain. It decomposes a given series into a trend component and a cyclical component by finding the solution to an optimization problem, where the trend component's smoothness is traded off against its ability to track the series well. How the trade–off is resolved depends on the value of the celebrated smoothness coefficient: "λ". Again we refer the reader to Appendix 2 for a technical discussion of the filter and its implementation.

For quarterly post–war data most researchers since Hodrick and Prescott have chosen to set $\lambda = 1600$. When we choose a value of λ for our yearly historical data, we follow the spirit of Kydland and Prescott's curve–drawing criterion above, maintaining our stated definition of business cycles. To get a total number of about 25 cycles for real GDP during our sample period, so that the cycles are about 5 years on average, we have to set a

9 Almost all the spectral mass outside the chosen frequency band derive frrom the fact that we have estimated the spectrum by taking a weighted average of the periodogram over adjacent frequencies. See Appendix 2 for a further discussion.

value of $\lambda = 10$. We then use this particular value of λ when filtering all the variables in our data set.

The resulting cyclical component from applying the Whittaker–Henderson filter to (the log of) real GDP is plotted in the upper part of Figure 3.1c. The series looks pretty similar to the band–pass filtered series. The spectrum plotted in the lower part of the figure reveals some differences though. In particular, the spectral mass is distributed across a broader band than for the band–pass filter. This is because the Whittaker–Henderson filter does not extract any of the highest frequencies. Leaving this "noise" in the series, more spectral mass from the lower frequencies has to be included to get cycles with an average length of 5 years.

First–Difference Filtering. The third and final filtering method we consider is the dominant method among business–cycle practitioners, namely to take first differences of time series. So it is interesting to include this method for the sake of comparison. We show the first–difference of (logged) real GDP, as well as its spectrum, in Figure 3.1d. The series in the upper part of the figure is largely similar to the other filtered series. But the spectrum in the lower part is quite different. We see that first–differences removes some of the spectral mass at the lowest frequencies, but not nearly as much as the other two filters. And first–differencing actually *magnifies* the "noise" at the very highest frequencies. Nevertheless, the cycles corresponding to the larger spectral mass at lower and higher frequencies tend to "net out", in that there are still about 25 major peaks and troughs in the filtered series.

The first–difference filter also differs from the other two filters in another respect, which is not immediately apparent from the figure. A first–differenced series is clearly *leading* the underlying non–differenced series in a cyclical sense, since the first difference will be highest (lowest) before the series reaches its cyclical peak (trough). In technical terms—and as we discuss further in Appendix 2—the first–difference filter induces a *phase–shift* on an original series, where the lead is about 1 year at the frequencies corresponding to 5–year cycles. The band–pass filter, on the other hand, induces no phase–shift and the Whittaker–Henderson filter induces a small phase shift only at the beginning and the end of a time series. In this respect, first–differenced series do not really give an accurate measure of deviation from trend and thus do not correspond perfectly with our à priori definitions of business cycles and business–cycle regularities.

Comparison of the filters. For easier comparison of the three filtering methods we have grafted the three series for real GDP on top of each other in *Figure* 3.2. The lead of the first–differenced series is evident from the plot. We also see that the first–differenced series is more volatile than the other two. But it is hard for the eye to detect any major difference between the band–pass filtered and the Whittaker–Henderson filtered series. However, from Figure 3.1, we know that the latter series has to have slightly higher variance than the former, since it has slightly more spectral mass under its spectrum. This is borne out when we compute standard measures of volatility in the time domain: the standard deviations of the three series are 3.0, 2.1, and 1.7 percent, respectively.

Broadly speaking, the three filters do not give a radically different picture of the cyclical development of real GDP. The results on business cycle regularities below are typically not too sensitive to the method of filtering. We will always report the results form band–pass filtered series, but note explicitly when the method of filtering seems to make a significant difference. As is clear from the discussion above, we should expect differences to arise when the cyclical behavior of a given time series—or combination of time series—is radically different in different frequency bands. From Figure 3.1 we see that this problem will occur when the long cycles (more than 8 years) have a different cyclical behavior then the business cycles (3–8 years).

3.4 What is Comovement?

If business–cycle regularities are cyclical comovements between macroeconomic variables, how do we measure these comovements? We use the present subsection to answer this question by presenting the relevant statistics in the time domain as well as in the frequency domain.

Time–Domain Statistics. There are obvious statistics we can use if studying our data in the time domain. It has become common practice in the real–business–cycle literature to measure the comovements by *cross–correlation coefficients* between different variables and an index of the cycle—typically GDP—at *different leads and lags.* We will use such cross–correlation coefficients extensively in the paper. As an example, consider *Table* 3.1. There we display the cross–correlation coefficients between real GDP and real private consumption and between real GDP and inflation, where private consumption and inflation are measured contemporaneously, as well as at one lag and lead (all series are band–pass filtered). Given the way we have defined cycles, it makes sense to report the correlation coefficients between GDP (or industrial production) and other macroeconomic variables over a 3–year span.

When describing the comovements, we will borrow some terminology from Blanchard and Watson (1986). We will say that a variable is *procyclical* (*countercyclical*) if it has predominantly *positive* (*negative*) and statistically significant correlation coefficients.[10] Otherwise we will call it *acyclical.* We will say that a variable displays *cyclical* (*non–cyclical*) *behavior* if if the correlation coefficients display (do not display) a pronounced peak. If such a peak occurs when the variable is lagged (leaded) relative to GDP, we will refer to it as a *leading* (*lagging*) variable. Thus based on Table 3.1, we would say that private consumption is a procyclical variable with strongly cyclical behavior. And inflation is a weakly countercyclical variable which non–cyclical or weakly leading behavior. The interpretation becomes more ambiguous if we detect both negative and positive correlation coefficients, in which case the variable can either be thought of as leading or lagging (depending on whether we interpret it as procyclical or countercyclical).

---

10 The next section discusses significance levels of correlation coefficients (and other statistical measures).

Frequency–Domain Statistics. When thinking about cyclical comovements, it is again natural and illuminating to study the data in the frequency domain. A frequency–domain measure of comovement between two variables, x and y, is *coherence*: $C^{xy}(\omega)$. Coherence can be interpreted as the absolute value of a frequency–specific correlation coefficient. The squared value of $C^{xy}(\omega)$ is like a measure of R^2: it gives the proportion of variance in either x or y that can be explained by regressing one variable (linearly) against the other at frequency ω. Coherence thus takes a value between 0 and 1. We will interpret a statistically significant coherence between a given variable and GDP (or industrial production) at business–cycle frequencies as a sign of cyclical comovements.

In *Figure* 3.3a we plot the squared coherence between GDP and private consumption and between GDP and inflation against frequency. As before, the vertical dotted lines delineate the frequency band between 3 and 8 years. These plots are based on the unfiltered series. The coherence at business cycle frequencies is much higher for private consumption. This, of course, reflects the higher correlation coefficients (in absolute value) for the filtered series in Table 3.1. The more pronounced cyclical *behavior* for private consumption is not evident from these pictures. In terms of frequency–domain statistics, the cyclical behavior results from the spectra of GDP and private consumption having local peaks at the same frequencies.

Coherence, by the nature of the measure, does not say anything about the sign of the relation between x and y. Neither does it say anything about a lead or lag in the relation. There is another frequency–domain statistic that reflects the lead–lag relation, however. At any frequency ω, the *phase* statistic of x with respect to y, $P^{xy}(\omega)$, measures the lead of x over y, in terms of the length of the cycle corresponding to ω. $P^{xy}(\omega)$ is thus measured between $-\pi$ and π (a full cycle being 2π), with the convention that a positive (negative) value means that x is leading (lagging) y.

A variable which has a phase with respect to GDP close to zero over business cycle frequencies is thus clearly procyclical. And a variable with a phase close to $-\pi$ or π is clearly countercyclical. For intermediate positive or negative values, we have the same problem of interpretation as when we encounter positive as well as negative cross–correlation coefficients in the time domain: the variable may be interpreted either as lagging or leading GDP.

In Figure 3.3b, we plot the phase of private consumption and of inflation with respect to GDP against frequency. The figure shows what we should expect from the discussion above and from the correlation coefficients in Table 3.1. Namely, private consumption, which we found to be procyclical, has a phase statistic close to zero over the business cycle frequencies, while inflation, which we found to be countercyclical, has a phase statistic close to π or $-\pi$.

4. Broad Facts

4.1 Introduction

This section presents some broad facts about the Swedish business cycles since 1861. To begin with, we study volatility and correlation measures for the whole 128–year period. But, we have many reasons to believe that the business–cycle patterns in the economy may have changed over this long period. Therefore, we will systematically compare the results for the whole sample with sub–samples for the "prewar period" 1861–1913, the "interwar period" 1921–1938 and the "postwar period" 1948–1988. We will also show figures with moving statistics: we use a window of ± 15 years and compute standard deviations and correlation coefficients recursively over time. For presentation purposes we chose to divide our series in four blocks: nominal and financial variables, aggregate GDP–components, the manufacturing sector, and foreign trade.

Before filtering, we transform most variables to logarithms. The only exceptions are the interest rates and the wage share, which are not transformed, and the current account and net exports, which we express as shares of GDP. In accordance with the discussion in section 3, most of the statistics we present are based on the band–pass filtered series, where cycles longer than 8 years and shorter than 3 years have been filtered out. At the end of this section, we will discuss to what extent the results are sensitive to the choice of filtering method. In Figure 4.1–5 the band–pass filtered series (solid lines) are plotted together with growth rates (dotted lines) against time. Looking at these diagrams, we realize that it may indeed be necessary to give a separate treatment to different periods and that the years during and immediately after the World Wars look very atypical.

Let us introduce the (large) set of tables and figures that we are going to refer to throughout the whole section. Table 4.1 summarizes most of the statistics for the entire sample (1861 (1871) – 1988). See Appendix 1 for exact sample lengths. The first two columns show volatility measures. For each variable, the standard deviation in Column 1 can be interpreted as the standard deviation in percent of the trend value of the variable. The relative standard deviation in Column 2 is simply the standard deviation divided by the standard deviation of a reference series. For most series, the reference is GDP, but for the variables in the manufacturing block it is instead manufacturing production.

The following three columns show correlations coefficients between the reference series at time t, and each other series at time t–1, t and t+1, respectively. All correlation coefficients that are significantly different from zero at the 10% level are highlighted in the table. As discussed at some length in Appendix 3, statistical inference on filtered data—and in particular on band–pass filtered data—is not completely straightforward. The significance tests underlying Table 4.1, and the other tables in Section 4, rely on corrected standard errors. As explained in the Appendix, the reported significance levels should still be treated with caution.

The last two columns summarize some cross–spectral statistics. The average (squared) coherence is an unweighted average over the business cycle frequencies (3 to 8 years) of the (squared) coherence $C^{xy}(w)$ between each series x and its reference series y. Since squared coherencies above 0.15 are significantly different from zero, (for our sample and estimation method) this value can also be applied to average coherencies, as a convenient rule–of–thumb. As explained in Section 3, the coherencies can be interpreted as correlation measures of the business *cycles*. The average time shift is a measure the average time shift between the reference series y, and each other series x, defined as the average over the business cycle frequencies of the phase statistic $P^{xy}(w)$ divided by frequency w. A positive value indicates that the *cycles* of series x lead the *cycles* of the reference series y with that many years.

Table 4.2 shows cross correlations, for the entire sample, between all variables (at time t) and Tables 4.3, 4.4 and 4.5 show cross correlations for the three subsamples. Tables 4.6 and 4.7 show standard deviations and correlations for subsamples. Again, correlation coefficients that are significant at the 10% level (based on corrected standard errors) are highlighted in these tables. Figures 4.6–10 show the change over time in standard deviations (solid lines) and relative standard deviations (dotted lines). For each plotted value, the standard deviation has been calculated over the ±15 nearest observations. Similarly, Figures 4.11–15 show the moving correlation coefficients between each variable and its reference series.

4.2 Nominal and financial variables

According to Table 4.1, nominal GDP, the GDP deflator, and inflation, all have standard deviations about double that of GDP. Together with the very low variability of nominal interest rates the latter implies a high variability of real rates, also around 2 times that of GDP. Most standard deviations show a clear hump centered around the inflation in the late 1910's and deflation in the early 1920's as seen in Figure 4.6. Many of them also seem to have a downward trend. As expected, there is a strong upward trend in the standard deviation of nominal interest rates, although staying at a very low level. The variability of real interest rates, however, seems to be dominated by the variability of inflation, giving a trend downwards combined with a clear hump around the wars. The variability in the nominal money supply shows a clear upward trend from the interwar period and onwards. At the same time, the correlation between the GDP–deflator and nominal money falls, as shown in Tables 4.3–5. Together, these facts more than offset the less variable GDP–deflator, so that real money becomes consistently more variable in the postwar period.

Turning next to Table 4.7, the correlations between GDP and most of the nominal and financial variables are strikingly unstable over time. As shown below, most of the results we find in the postwar period are either reversed or insignificant in the interwar and prewar periods. It is this lack of stability that explains the low average coherencies in Table 4.1.

Looking at the individual series, we find a distinct correlation pattern for the GDP deflator and inflation during the postwar period. The correlation between lagged inflation and current GDP is significantly negative, while the contemporaneous correlation is weakly positive and the correlation between leading inflation and current GDP is significantly positive. This is consistent with the common view that inflation follows GDP with a lag. Since inflation—by definition—leads the GDP–deflator the response of prices to GDP appears with an even further lag. In effect this tends to make the price level *countercyclical.* Kydland and Prescott (1990) stress the countercyclicality of the price level in their account of US postwar business cycle facts, as do Cooley and Hansen (1989). These characteristics seem to be something new in the Swedish business cycle: we cannot find the same pattern in any of the two earlier periods.

Nominal interest rates are strongly positively correlated with GDP one year before. Lagged inflation is, however, enough correlated with GDP to give a negative correlation between lagged real interest rates and GDP. Real rates therefore seem to lead rather than lag the cycle. Both the nominal and the real money supply show a clear leading procyclical behavior in the postwar period but no clear pattern the earlier periods. We find the change in the correlation pattern between money, prices and output interesting. It will be studied further in section 5.2 below.

4.3 Aggregate GDP components

The GDP components are, of course, at the core of the business cycle discussion. According to Table 4.1, we may divide the components into two subgroups in terms of their volatility: GDP, private consumption and public consumption have about the same standard deviation, while foreign trade and investment are 4–6 times as volatile. Danthine and Donaldson (1991) show that a low volatility for consumption and high volatility for investment and foreign trade is a common feature for developed Western Economies. A closer look in Table 4.1 reveals that private consumption is actually more volatile than GDP. This looks odd given the "consumption smoothing" feature of typical business–cycle models. Part of the explanation is probably that our consumption data include expenditures on consumer durables. However, we should also add that the typical consumption–smoothing argument focuses on income shocks. Once we add incentive effects of changes in atemporal and intertemporal relative prices, and the considerable volatility of those relative prices in our data, there is no unambiguous presumption that consumption should vary less than income in a small open economy which takes market prices as exogenous.

Figure 4.7 and Table 4.6 show that the volatility of the GDP components changes rather drastically over time. In general, the interwar period was much more volatile than the two other periods. For most series, with the exception of import, the prewar period is somewhat more volatile than the postwar period. Both these findings are in line with the results for several other developed countries obtained by Backus and Kehoe (1989). It is obvious that much of the volatility of foreign trade stems from a few years around the two World Wars. For instance, Figure 4.2f, shows that imports more than doubled in 1946. Nevertheless, foreign trade is more than twice as volatile as GDP even if we exclude these extremely volatile years. It is also interesting to note that the relative volatility of investment shows a clear downward trend, from 6 times as volatile as GDP around 1880 to 2 times at the end of the sample. In the case of investment, the markedly higher volatility in the prewar period probably reflects fluctuations in agricultural stocks being an important share of measured investment (compare the discussion about inventories in Section 2).

Even though the magnitude in the volatility of the GDP–components is very different across subperiods, their volatility ranking stays put over time. In fact, the relative standard deviations of private consumption, government consumption, and exports are virtually identical across subperiods. The relative volatility of imports and investment are somewhat less stable.

The volatility pattern for relative prices of consumption, investment, exports and imports is more stable. Relative export and import prices have virtually the same standard deviations over time, once we exclude the war years. The same is true for relative investment and consumption prices, the two exceptions being the more volatile relative price of consumption in the interwar period and the less volatile relative price of investment in the postwar period.

All GDP components are procyclical: that is, they have mostly positive and significant correlations coefficients with GDP. Furthermore, they all show a fairly marked cyclical behavior in the sense that some coefficients stand out. According to Table 4.1 public consumption leads the cycle (interestingly enough), while all other GDP components are basically contemporaneous with GDP. Figure 4.2 and Table 4.7 show that this pattern has changed little over time. The exceptions include public consumption which seems to lead the cycle in the prewar period but is acyclical in the postwar period, as well as imports and private consumption which have a greater tendency to lag the cycle in the postwar period.[11] It is surprising that the correlations have not changed more, given that the volatility has changed dramatically and that the correlation patterns between output and the nominal prices and money supply have shifted drastically over time.

One of the highest cross correlation in Table 4.2 is between consumption and imports. According to Table 4.3–5 the correlation between private consumption and imports is stable over the whole sample, except possibly for the volatile years around the World Wars. At the same time, the correlation between imports and exports is also very high.

For the postwar period, Table 4.7 reveals a strikingly high positive contemporaneous correlation between GDP and the relative prices of exports and imports. The difference between this and the almost zero contemporaneous correlation with the

---

11 This squares well with the findings of H. Ohlsson (1991), who studied the Swedish central government budgets and budget outcomes for the period 1970—1988. He finds very little cyclical behaviour, except for the labor market policy programmes.

relative prices on private consumption and investment is also conspicuous. The findings also indicate that export prices lag the cycle. Manufacturing prices as well as consumer prices, on the other hand seem to lead.

As in the case of the deflator and nominal GDP, most of these facts are only associated with the post–war business cycle. Only in the case of the lagging export prices is it possible to detect a weak similar pattern before the wars.

What we take as most interesting conclusion from this subsection is one particular stylized fact: despite drastic changes in the volatility of the GDP–components over time, their relative volatility, as well as their comovements have been surprisingly stable. The stability in these business cycle regularities is analyzed and discussed at greater length in Englund, Persson and Svensson (1990).

4.4 Manufacturing and labor market variables

The manufacturing sector has traditionally been regarded as very cyclical. According to Table 4.1 this notion contains some truth, since manufacturing production (value added) is about twice as volatile as GDP. The rest of the variables in this block, which all—except unemployment—are specific to the manufacturing sector, are henceforth compared with manufacturing output, rather than with GDP. Most of the variables are about as volatile as manufacturing output, with the exceptions of hours/employee and unemployment which are considerably less volatile. This means that fluctuations in labor input (hours) stem more from changes in the number of employees, than from changes in the workweek. Kydland and Prescott (1990) stressed a similarly low volatility of hours/employee for postwar US quarterly data.

The volatility patterns have changed over time, as shown in Table 4.6 and Figure 4.8–9. A few things are worth noting. First, the relative volatility of manufacturing production to that of GDP shows a marked peak around 1890 and has decreased substantially ever since. The 30 years centered around 1890 coincides with the beginning of the Swedish industrialization, when manufacturing constituted only a small fraction of GDP. Second, the relative volatility of productivity and the wage share took a sudden dip around the second World War. Finally, the relative volatility of unemployment has decreased dramatically since the 1920's. This could possibly reflect measurement problems in the early part of the unemployment series (compare Section 2), and/or the active labor market or stabilization policies that have been pursued since the second World War.

According to Table 4.1 the cycles for manufacturing production are highly synchronized with the cycles for GDP. For the rest of the variables in this block, we study correlations with manufacturing output, rather than with GDP. Hours/employee and unemployment are, surprisingly, acyclical variables compared with manufacturing output, while the wage share is clearly countercyclical. The nominal wage rate and the nominal wage cost are weakly procyclical, with a tendency to lead the cycle. The real wage rate and real wage costs is somewhat more procyclical. Hours, employees and productivity are all clearly procyclical.

These correlations have been far from stable over time. Table 4.7 and Figure 4.13b show that manufacturing production was even slightly countercyclical before 1890, but since 1910 it is strongly procyclical and contemporaneous. The real wage was procyclical before 1930 but became markedly countercyclical after the second World War. Hours and employees were leading the cycle before the first World War and close to lagging after the second World War, while the opposite holds for productivity. Finally, while unemployment was virtually acyclical between the wars, it is clearly counter cyclical after the second World War.

Among the cross correlations in Table 4.2 we find, as expected, that hours and the number of employees are very correlated. More interesting, both hours and employees are *negatively* correlated with productivity, as well as with real wages. Danthine and Donaldson (1991) find that the correlations between real wages and employment and between productivity and employment vary substantially across countries. According to Table 4.3–5, the correlation between employment and productivity was markedly negative before and virtually zero after the second World War. But the negative correlation between employment and real wages is stable over time. Furthermore, the correlation between unemployment and real wages is significantly positive. These correlations clearly challenge the conventional wisdom, expressed in Blanchard and Fischer (1989), that the real wage or the return to labor is acyclical, or maybe weakly procyclical. We will return to these last findings in Section 5.3 below.

4.5 Foreign and domestic cycles

According to Table 4.1 the business cycles in United Kingdom, Denmark, Norway, Germany, France and the US have been more volatile than in Sweden. According to Figure 4.10 and Table 4.6 this holds for all subperiods except the prewar period. Note, however, that the data for the prewar period might be of relatively low quality for some of the countries—see Section 2. The volatility in the current account and the terms of trade relative to GDP in Figure 4.9 is about the same across subperiods.

Over the entire sample, the current account and net exports are, surprisingly enough, acyclical. Swedish GDP has been fairly correlated with foreign demand, with a tendency for foreign demand to lead. GDP in Denmark, Norway and the US are more or less contemporaneous with the Swedish GDP, while Germany seems to lead. These cyclical patterns have shifted over time. Table 4.7 and Figure 4.14 show that the current account and net exports were clearly countercyclical most of the time, except for the interwar period when it was procyclical. Furthermore, Swedish GDP was clearly correlated with foreign demand only between the wars. In the postwar period it was virtually uncorrelated with all other countries. In the postwar period the terms of trade seem to strongly lag the cycle, while there is no clear pattern in other periods.

The current account and net exports are, according to Table 4.2, virtually uncorrelated with foreign demand. A closer study of the sub–samples in Table 4.3–5 shows that the current account and net exports were actually negatively correlated with foreign demand in the prewar period. But these correlations have increased over time and are strongly positive in the postwar period. It is hard to detect any clear cut world or even European business cycle, except for the interwar period. This is probably the result of the large and fairly well synchronized recessions during the 1920's and early 1930's. These last results are in line with the findings by Backus and Kehoe (1989).

To us, the most interesting result in this subsection is that the widespread idea that Swedish business cycles are driven by foreign demand seems to have so little support in data. We will return to this issue in Section 5.4 below.

4.6 Comparison of different filtering methods

This section aims at shedding some light on the question how dependent the results are on the choice of filter. The answer is: in general, not much! Table 4.8 shows, for three different filtering methods, the relative standard deviations (that is the standard deviation relative to the standard deviation of either GDP or manufacturing production) and the contemporaneous correlations with either GDP or manufacturing production. The three filters are those that we discussed in Section 3, namely the band–pass filter, the first–difference filter and the Whittaker–Henderson filter.[12]

It was noted in Section 3 that the Whittaker–Henderson filter does not filter out the short cycles as our band–pass filter do, and that the first–difference filter actually amplifies the short cycles. Furthermore, more long cycles passes through the Whittaker–Henderson and the first–difference filters than through the band pass filter. Hence, it is expected that the standard deviations should differ across filtering methods. This is indeed so. For instance, real GDP has a standard deviation of 1.7 percent when filtered by our band pass

12 The significance tests underlying the highlighted correlation coefficents in the table, again rely on corrected standard errors.

filter, while the first–difference difference and Whittaker–Henderson filter gives 3.0 and 2.1 percent, respectively. But, the relative standard deviations in Table 4.8 are *very* similar. The contemporaneous correlations are similar too. Out of 126 possible comparisons between the correlations (3 methods and 42 variables), we find only 4 cases of a correlation coefficient above 0.15 in absolute value changing sign.

It is quite a monumental task to investigate whether the correlations with reference series at leads and lags and the cross–correlations are similar across filtering methods. No such attempt is made here, but when highlighting specific narrow facts in the next section, we document whether these facts are robust to the filtering technique.

5. Narrow Facts

5.1 Nominal prices and wages

If we compare the standard deviations of nominal prices and wages in different subperiods, as documented in Table 4.6 and Figures 4.5 and 4.7, we find a striking similarity. Not only is the relative ranking preserved—volatility being highest in the interwar period and lowest in the postwar period—but the percentage standard deviation in wages is very close to the percentage standard deviation in prices in each subperiod. This finding is robust across filtering methods. Looking at the relative standard deviations, however, we find a much weaker pattern. Indeed, the typical pattern across filtering methods is that the relative standard deviations are about the same in the postwar and interwar period, but lower in the prewar period. (Note, however, that the reference series for prices in GDP, while for wages it is manufacturing production.)

Next, look at the correlation coefficients in Table 4.7 and Figures 4.11 and 4.13. Both prices and wages seem to have weak cyclical patterns in the more volatile prewar and interwar periods. But in the postwar period prices and wages are both clearly lagging the cycle: upturns seem to have a pronounced effect on prices and wages, but only with a lag of one or two years. (The longer lag is evident from the correlation coefficients between inflation and real GDP.) Furthermore, the moving correlation coefficients in Figures 4.11 and 4.13 suggest that the tendency for lagged responses becomes more pronounced over the postwar period itself. These broad facts are again robust with respect to how we filter out the cyclical component.

We may add to this observation the fact that neither prices nor wages have a trend in the two first subperiods, while they both have a steady upward trend in the postwar period. These upward trends plus the lag in the response of prices and wages to cyclical fluctuations may give weak support to the common claim that prices and wages have become more "sticky" in the postwar period. The constancy of relative standard deviations in prices and wages seem to run counter to the idea of increased stickiness, however.

Historical studies of the US by Sachs (1980), Gordon (1980), and others have sought to document greater wage and price stickiness in the postwar period by a Phillips–curve approach. Both Sachs and Gordon find more price and wage inertia in the postwar period.

If we identify wage and price stickiness with persistence in wages and prices, a simple way to try and measure the concept statistically is to estimate AR– or VAR–processes for prices and wages. We have made preliminary attempts in this direction, following the same approach as Taylor (1986). The results are mixed depending on the filtering method. VAR's estimated with first–differenced data indeed yield results that support more postwar inertia: the sum of coefficients in the lag polynominals for prices and wages in the price and wages equations, respectively, are significantly higher in the postwar period than in earlier periods. But the results are considerably weaker with Whittaker–Henderson filtered data, and they disappear altogether with band–pass filtered data. We conclude from these preliminary attempts that there is, if anything, only weak evidence for more stickiness in wages and prices in the postwar period.

5.2 Money, prices and output

In Section 4.1 we noted a somewhat atypical pattern in the variability in nominal money and nominal interest rates over time. Nominal money was the only variable in our sample with its lowest variability in the interwar period. The variability in nominal interest rates is also much lower—relative to the other variables in the sample. With regard to cyclicality, we noted that nominal money in the postwar period became a leading rather than a lagging variable relative to real GDP. The nominal interest rate has a postwar cyclical pattern close to the inflation rate: increasing interest rates lead downturns in output and lag upturns in output.

The contemporaneous correlation coefficients between money and real GDP increase over time: they are 0.24, 0.09, and 0.62, respectively, in the three subperiods of the sample.

The contemporaneous correlation coefficients between money and prices in Tables 4.3–5, on the other hand, show a reverse pattern: they are 0.65, 0.15, and –0.15, respectively. Taken together, these changes suggest a gradual decoupling of money and prices and a gradual coupling of money and real GDP over time. An interesting hypothesis—that the simple correlation coefficients can say little about—is that the stronger comovement between money and output and the weaker comovement of money and prices is connected with the tendency for prices and wages to lag the cycle in the postwar period.

The links between money, output and prices is, of course, at the very heart of most macroeconomic theories. To throw some further light on these links in our sample, we take a step beyond the unconditional statistics we have dealt with so far. In particular, we carry out some simple tests regarding the statistical properties of money vis–a–vis output and money vis–a–vis prices. Since the seminal work by Sims (1980), a large number of researchers have investigated whether money "Granger–causes" real GDP, mostly for US data. Stock and Watson (1989) nicely discuss, extend and an interpret the results in this literature.

Consider the following equation for real GDP taken out of a multivariate VAR (Vector Auto Regression) system:

$$y_t = \beta^m(L)m_{t-1} + \beta^y(L)y_{t-1} + \beta^z(L)z_{t-1} + \epsilon_t. \tag{5.1}$$

In (5.1) y is real GDP, m is nominal money, and z is a vector of other variables, such as an interest rate and the inflation rate, that may help predict y. A Granger–causality test is an F–test of the null–hypothesis that all the coefficients in the lag polynomial $\beta^m(L)$ are zero. A (weaker) "neutrality test" is a t–test of the null–hypothesis that the sum of these polynomial coefficients $\beta^m(1) = \Sigma_1^I \beta_i^m$, I being the order of the vector autoregression, is equal to zero. These tests thus focus on the *marginal* predictive power of money. Do changes in money help predict future output, once we control for the pure autoregressive part of output and possibly for the predictive power of other variables?

In *Table* 5.1 we report F–statistics and p–values from Granger–causality tests for first–differenced data, bivariate and multivariate formulations, and different sample periods. And in *Table* 5.2 we report estimated $\beta^m(1)$–coefficients and t–statistics from neutrality tests for the same data, formulations and sample periods. All the multivariate formulations have the lagged nominal interest rates and inflation rates on the right–hand side of (5.1), in addition to the lagged money stocks and outputs included in the bivariate formulations. All regressions were estimated by OLS and include 3 lags of each variable (except some regressions for the shorter interwar period, where we use 2 lags to save on degrees of freedom). They include a constant plus a linear time trend if appropriate.[13]

For the whole sample, we can neither reject neutrality nor the absence of Granger causality. The picture looks different, when we break the sample into subperiods. We obtain the strongest results for the volatile interwar period, where—as for the whole period—we cannot reject neutrality and absence of causality. For the postwar period the results are almost as strong. Here we instead find evidence for causality. And, at least in the bivariate case we can reject neutrality. Note, however, higher money seems to drive future output *down*. In the prewar period, finally, the results are less robust in that we typically reject causality but find some (marginal) evidence against neutrality. As an aside, we note that the results for the postwar period confirm a consistant finding in US postwar data, emphasized by Blinder and Bernanke (1991) and Stock and Watson (1990), namely that increases in nominal interest rates predict declines in output.

If we estimate the same equation(s) on either band–pass filtered or Whittaker–Henderson filtered data, the results look similar. We choose not to emphasize these results, however. In addition to the difficulties discussed in Appendix 3, there are potentially serious problems with conducting Granger–causality tests on time series that have been passed through a common *two–sided* filter. Essentially, two–sided filtering may

13 Some of the first–differences series have trends in some subperiods. It is then nesessary to include a trend in the regressions to use uncorrected standard errors: see Stock and Watson (1989) for a discussion.

alter one–sided projections of a given series on another and thereby render inconsistent estimates of projection equations, such as (5.1).[14]

We also look at the relation between money and prices by investigating the following regression for prices:

$$p_t = \gamma^m(L)m_{t-1} + \gamma^p(L)p_{t-1} + \gamma^z(L)z_{t-1} + \mu_t. \tag{5.2}$$

In (5.2) p is the GDP–deflator, and z contains the nominal interest rate and real GDP. As before, we estimate (5.2) on first–differenced data by OLS with three lags of each variable, a constant and possibly a time trend. We test the null–hypothesis $\gamma^m(L) = 0$. *Table* 5.3 reports F–statistics and p–values for different formulations and subsamples.

For the whole period we find evidence for causality. The results seem largely to be driven by the interwar period, where we find strong evidence for causality. For the postwar period we do not find evidence for causality. For the prewar period, finally, the results also tend to reject causality, although only marginally so. Subject to the qualification above, results based on data filtered by our alternative filters give similar results.

We have also looked for causality in the other direction: that is, from either prices or output on money. We don't find significant predictive power from either prices or output in any of the subperiods, but we do find predictive power from prices for the whole sample period.

Taken together, the results in Tables 5.1–3 provide further evidence for the hypothesis of a stronger link between money and output and a weaker link between money and prices in the postwar period, as opposed to earlier periods, the interwar period in particular. One could think of many possible explanations ranging from different regimes in monetary and exchange rate policy to innovations in the financial sector. More work is needed to investigate the hypothesis and likely explanations, however.

---

14 See Sargent (1987, ch. XI) on this point. Singleton (1988) discusses some general problems of inference on filtered data.

5.3 The labor market

This section studies two issues related to the cyclical properties of the Swedish labor market. First: by what means does output vary over the business cycle? Does labor hoarding or other kinds of variable capacity utilization play an important role? Second: how do real wages behave over the cycle?

First, let us deal with the question about labor hoarding and capacity utilization. As documented in Tables 4.7 and Figure 5.1, manufacturing output and hours are positively correlated in all three subperiods (The correlation coefficients being: 0.17, 0.42 and 0.64, respectively.) But the correlation between output and productivity is even higher (0.76, 0.65 and 0.69), which actually makes the correlation between hours and productivity negative (–0.48, –0.41 and –0.12). Table 4.6 also reveals that output varies more than hours. None of these facts is very sensitive to the choice of filter.

How could they be explained? In a simple neoclassical model, productivity is countercyclical—or equivalently hours vary relatively more over the cycle than output—because of diminishing marginal returns. Evidently, our data clearly rejects this model, in accordance with most international findings: for instance, Hultgren (1960), Brechling (1965), Nadiri and Rosen (1973), and Sims (1974). Different explanations have been suggested as to why the logic of the simple neoclassical model breaks down. *Labor hoarding*, or any other type of variable capacity utilization, leads to a positive correlation between productivity and output, while the correlation between productivity and hours is ambiguous and depends on the degree of labor hoarding. The same pattern could also be generated by exogenous *productivity shocks* to a neoclassical production function, in the spirit of Kydland and Prescott (1982), provided the model includes variable capacity utilization of another factor than labor, as in Greenwood, Hercowitz and Huffman (1988).

Next, let us study how real wages behave over the cycle. As documented in Table 4.3–5, and Figure 5.1, the correlations between real wages and labor input (hours and number of employees) are negative in all three subperiods (1861–1913, 1921–1938 and

1948–1988). For hours and real wages, the correlations are –0.19, –0.70 and –0.48, and for employees and real wages they are similar but of somewhat lower magnitude. This is counter to the conventional wisdom of most economists. In a classical study, Dunlop (1938) found that real wages are somewhat procyclical for the United Kingdom. And Blanchard and Fisher (1989) indeed take acyclical or slightly procyclical real wages to be a stable stylized fact.

Geary and Kennan (1982) actually found that real wages and employment are independent for a number of OECD countries (Sweden was not part of their study). We have applied their basic methodology, which amounts to a significance test for the S–statistic, calculated as

$$S = n\sum_{k=-1}^{1} r(k)^2 \quad , \tag{5.3}$$

where $r(k)$ is the estimated correlation coefficient between a measure of current real wages and a measure of hours lagged k times, and where n is the sample length. We carried out the tests for different filtering methods and for different measures of real wages and hours. First, we simply used the cyclical component from each of our filtering methods. Next, we followed Geary and Kennan, and used the innovations from estimated univariate AR(1) and AR(2)–processes (which also include a time trend) to compute the correlation coefficients $r(k)$ in (5.3).

Table 5.4 reports the S–statistics and marginal significance levels (p–values) for different filtering methods, different subperiods and different measures of real wages and hours. The S–statistic is asymptotically distributed as $\chi^2(3)$. When computing it, we correct the standard errors to allow for autoregression.[15] In most cases, we reject

---

[15] Under the null–hypothesis of independence and absent serial correlation, $r(k)$ is distributed nomally with variance $1/n$, n being the number of observations. Dividing $r(k)$ with its standard deviation, squaring, and summing over k, we get our S: a χ^2–distributed variable with k degrees of freedom. If we allow for autoregression, the variance of $r(k)$ (under the same null) is instead

$$\Sigma\, \rho_1(k)\rho_2(k)\,/n \quad ,$$

independence decisively. The only major exception is when the $r(k)$'s are computed from first–differenced post–war data.

Our conclusion from the correlations and the tests is that the Swedish labor market seems to function quite differently from many other labor markets. This conclusion is further strengthened by the fact that the correlation between real wages and unemployment is positive for both the interwar (0.77) and the postwar (0.49) periods (unemployment data are not available for the prewar period). Again, these findings are not sensitive to the choice of filter.

How can we interpret the Swedish correlation pattern in terms of macroeconomic theory? Below we discuss four well–known theories, which we label classical, Keynesian, efficiency wages, and trade unions, in order to investigate how they would explain negative correlation between real wages and labor input.

In a *classical* model with a traditional clearing labor market, we can think of the correlation between real wages and labor input as depending on whether "demand" or "supply shocks" dominate in the labor market. If the supply shocks are more important than the demand shocks, the correlation is negative. In terms of a classical model, our data thus suggest that most business–cycle fluctuations come from disturbances that shift labor supply.

The efficiency–wage model comes in many guises. The model of Shapiro and Stiglitz (1984) motivates the notion of efficiency wages by assuming that firms cannot perfectly observe the effort of workers. Lower unemployment requires higher real wages in order to prevent workers from shirking, implying that real wages and labor input should be positively correlated, unless there are strong systematic cyclical shifts in the incentive constraint. Absent such implausible shifts, this model is rejected by data.

In *The General Theory*, Keynes assumes a non–clearing labor market, where

---

where $\rho_i(k)$ is the kth autokorrelation coefficient for series i. The tests rely on estimates of ρ_i. See Brockwell and Davis (1991).

exogenous nominal wages (and market–clearing prices) determine the real wage along the downward–sloping demand schedule for labor. Hence, the correlation between real wages and labor input is negative. This kind of Keynesian model, with autonomous wage shocks is not rejected by data.[16]

In a simple rights–to–manage *trade union model*, the union determines the real wage and the firm chooses employment. Hence, real wages and employment are again determined along the downward sloping demand schedule for labor. The correlation between real wages and labor input is negative, as long as shocks to union preferences dominate disturbances that shift the demand curve for labor. In terms of the trade union model, our data thus suggest that independent wage shocks have been driving employment.

The discussion so far has concerned the relation between real wages and labor input. But since labor input is far from perfectly correlated with output, and moreover, the correlation has changed over time, the relation between real wages and output is more complicated. As documented in Tables 4.8–10, the correlation between real wages and output is positive during the prewar and interwar periods, (0.52 and 0.23) respectively, and negative in the postwar period, (–0.35). The correlation between the real wage and productivity is positive for the first two periods, (0.56 and 0.81), and zero, (0.03), for the last period. The low postwar correlation is somewhat puzzling, given our appeal to a demand curve for labor in our discussion of the negative comovements between real wages and employment. But the presence of labor hoarding may, of course, magnify any existing wedge between the marginal and average product of labor.[17]

5.4 Influences from abroad

---

16 In the light of the findigs by Dunlop (1938), Keynes (1939) came to doubt his own assumption. Had he been more aware of the Swedish situation, he might have been spared this inconvenience.

17 Another candidate for explaining the low correlation between real wages and productivity in the postwar period is the theory of implicit labor contracts, as in Azariadis (1975). That explanation is not all that plausible, however, since the volatility of real wages exceeds the volatility of productivity in the postwar period, while the opposite is true in the prewar and interwar periods.

Sweden is a small open economy and as such is often believed to be largely influenced by shocks originating abroad and by shocks that are common to many of the countries she trades with. More specifically, it is a common view among economists in Sweden that Swedish business cycles are, to a large extent, driven by cycles in foreign demand (see, for instance, Lindbeck (1975)). But, in Section 4 we found very little support for this notion. Therefore, we devote the first part of this section to a closer look on this matter. Another idea which has gained more and more support in Sweden during the last decades is the notion of fluctuations caused by domestic "cost crises". According to this view, high production costs caused by wage shocks in Sweden reduce production due to international competition. In the second part of this section we try to shed some light on this issue by looking for a statistical link between "cost crises" and output. Finally, we investigate the much–discussed relation between terms of trade and current account.

In Section 4.5 we found that generally Swedish output and our measure of foreign demand were only weakly correlated for band–pass filtered data. The notable exception was the interwar period, when most western economies seem to have experienced well synchronized recessions. In Section 4.6 we noted that most of our results are not sensitive to the choice of filtering method. But, it turns out that the relation between Swedish and foreign business cycles is one of the (few) exceptions. This is illustrated in Table 5.5a, which shows the correlations between foreign demand and Swedish output, exports and manufacturing output, respectively, for different subperiods and filtering methods.[18] The previous findings of a high correlation between foreign demand and Swedish output during the interwar period is robust with respect to the filtering method. But this is not true for the two other periods. Specifically, for the postwar period the correlation coefficient based

---

18 In Table 5.5, the postwar period is taken to start in 1950, rather than in 1948 as before. The reason is that both exports and output in some of the foreign countries changed so much in the late forties (see Figure 4.4) that these few observations dominate the correlation pattern for the period between 1950 and 1988. We believe that the exclusion of 1948—1949 provides a more representative description of the postwar period as a whole. But none of our major conclusions would be altered if we included these two years.

on band–pass filtered data is insignificant (0.10), while it is relatively high (0.39) for first–differenced data.

One way to understand this discrepancy is to study the coherence between foreign demand and Swedish output. We recall from Section 3 that coherence can be interpreted as a correlation measure between cycles of a certain length in two series. Figure 5.2 shows estimated coherencies for the three subperiods.[19] As in Section 3, our preferred business cycle band, 3 to 8 years (approximately 43 to 16 cycles per 128 years), is marked by vertical dotted lines in the figure. Clearly, the coherencies in the interwar period and the two other periods have very different spectral shapes. Whereas the interwar period has high coherencies for a wide band of cycles, including the business cycle frequencies, the two other periods have zero coherencies almost everywhere, except for the very long cycles. For the latter periods, a filter that passes much of the long cycles should therefore give higher correlations. As mentioned in Section 3, and as discussed in some detail in Appendix 2, the first–difference filter passes a lot, the Whittaker–Henderson less, and the band–pass filter very little of the long cycles. Our conclusion is thus that the higher correlation for the first–differenced filtered data is an effect of long–run co–movements of foreign and Swedish output, rather than of co–movement of business cycles (as we have defined them). One may ask why the correlation coefficients for the prewar period are fairly small, irrespective of the filtering method. According to Figure 5.2, the answer is simply that the coherencies for the prewar period are small at all frequencies. In general, this result carries over to the correlation between Swedish output and the output of each of the countries in our data set (United Kingdom, Denmark, Norway, Germany, France and United States).

If we instead focus on the comovements between foreign demand and Swedish exports or Swedish manufacturing output in Table 5.5a and Figure 5.3–5.4, we still see consistently low correlations/coherencies for the prewar period and very high

19 The coherences are estimated using a weighted covariogram estimator with tent shaped weights for the closest ± 4 covariogram estimates.

correlations/coherencies for the interwar period. But two important differences are worth noting. First, correlations and the coherencies are in general higher than between foreign demand and Swedish GDP. Second, the coherence for the postwar period on business cycle frequencies are much higher, especially for cycles between 3 and 5 years. Consequently, the correlation for the postwar period are fairly similar across filter methods. In this sense, Swedish exports and manufacturing output covaries to a greater extent with the foreign business cycle, while Swedish GDP is more insulted.

It is also of interest which of Sweden's trading partners have been most important for the business–cycle fluctuations in exports. Therefore, the correlations for band–pass filtered data of Swedish exports and output in a number of countries are shown in Table 5.5b. We find some evidence of British output to be positively correlated with Swedish exports during the prewar period (and German output to be negatively (!) correlated). Output in all countries except Germany is closely correlated with Swedish exports during the interwar period, while Britain, Denmark and France show the highest correlations during the postwar period.

Is there any truth in the notion that domestic "cost crises" have caused recessions by reducing the competitiveness of the Swedish economy? The "cost crises" are supposed to be triggered by shocks to wage costs induced by aggressive trade unions, an "overheated" labor market, or by hikes in labor taxes. In most conceivable theoretical models, such negative supply shocks would tend to reduce Swedish exports and production, regardless of whether Swedish firms are price–takers or price–setters. It is of great theoretical and practical interest to confront this notion with data. To do this in a thorough way is a monumental task, which we leave for future research.

What we want to do here is something much more preliminary, namely to see whether real wage costs Granger–cause exports; that is, we want to see whether information on real wage costs can improve export forecasts. To this end, we have estimated a small VAR system using first–differenced data. The reduced form for the export equation is

$$x_t = \varphi^x(L)x_{t-1} + \varphi^z(L)z_{t-1} + \varphi^w(L)w_{t-1} + v_t, \tag{5.4}$$

where x is Swedish exports, where z contains a constant, a time trend, foreign demand, Swedish output and the relative price of exports, and where w is the real wage cost (wages plus payroll taxes) in the manufacturing sector. The lag polynomials $\varphi^x(L)$, $\varphi^z(L)$ and $\varphi^w(L)$ are all order two. Table 5.6 shows the F–values for $\varphi^w(L) = 0$ and the corresponding marginal probabilities, as well as the coefficients in $\varphi^w(L)$, for each of our three subperiods. There is no evidence of marginal forecasting power of the real wage cost variable.

This simple exercise does not give any support for the popular notion of cycles in exports induced by "cost crises". It can be noted that this conclusion is not sensitive to the exclusion of the relative price of exports. Further circumstantial evidence is gained by assuming that Swedish exporters have some market power, that is, that they are facing a downward sloping demand curve. This is, after all, what the practitioners assume all the time when they estimate "export equations". Within a simple demand and supply framework, we would expect the correlation between exports and export prices to be positive if the fluctuations in exports are driven mainly by demand shocks and negative if they are driven mainly by supply shocks. In Table 5.5b we see that this correlation is negative during the prewar period, almost zero during the interwar period and positive during the postwar period. The data thus seem consistent with the hypothesis that Swedish exports were more dependent on supply shocks in the prewar period and more dependent on demand shocks during the postwar period. This finding also seems to square well with our earlier finding that Swedish exports is more dependent on foreign business cycles during the postwar than the prewar period, but leaves the interwar period unexplained.

How reasonable is it to believe that Swedish exporters have any market power? The answer is not obvious for aggregate exports since Sweden exports such a vast range of goods. Moreover, the composition of Swedish exports has changed dramatically during our long sample, from being concentrated in primary commodities like wood and steel to a much more varied blend including a large portion of manufactured goods. This change in composition vaguely suggests that the market power of Swedish exporters might have increased over time. Is that vague idea supported by our data? Once again, we have to settle with preliminary evidence in the form of Granger–causality: that is, do exports improve upon a VAR–forecast of the relative price of exports? The reduced form equation for the relative price of exports, taken from the VAR system underlying (5.4) is

$$px_t = \psi^{px}(L)px_{t-1} + \psi^{z}(L)z_{t-1} + \psi^{x}(L)x_{t-1} + u_t, \tag{5.5}$$

where px is the relative price of exports, x is exports and z contains all the other variables mentioned in conjunction with (5.4). The F–test and marginal probability for $\psi^{x}(L) = 0$, as well as the coefficients in $\psi^{x}(L)$ are shown in Table 5.7. During the prewar period we find no evidence of any marginal predictive power of exports. For the postwar period $\psi^{x}(L)$ is significantly different from zero. These results suggest a link between export quantities and export price which has increased in strength over time. Obviously, this is not inconsistent with our conjecture of an increased market power, although a much more thorough study is warranted in order to settle the issue.

Finally, Table 5.8 gives some correlations between the current account on the one hand and terms of trade and output on the other hand. During the prewar and postwar periods both terms of trade and output is negatively correlated with the current account, while the opposite holds for the interwar period.[20]

5.5 Asymmetry in Swedish Business Cycles

This section is an attempt to study possible asymmetries in the Swedish business cycles. The conventional wisdom says that downturns are faster than upturns. Is this true for

20 A much more extensive, theoretical and empirical, study of the comovement in the terms of trade and domestic variables is found in Lundvik (1990).

Swedish yearly data? The notion of asymmetry has a long history. For instance, Keynes (1936, p. 413) stated "There is, however, another characteristic of what we call the Trade Cycle which our explanation must cover the fact that the substitution of a downward tendency often takes place suddenly and violently, whereas there is, as a rule, no sharp turning–point when an upward is substituted for a downward tendency."

During the 1980's the existence of asymmetries has been studied by, among others, DeLong and Summers (1986). DeLong and Summers used quarterly and annual data for national income, industrial production and unemployment rates for several OECD countries. They found very little evidence of asymmetries in these data, except for the US unemployment rate. Moreover, a similar study by Westlund and Öhlen (1989) of Swedish quarterly data for industrial production and unemployment covering the period 1960:I to 1988:I found no significant asymmetries.

This study takes the same approach as DeLong and Summers (1986), namely to study the skewness coefficient (the third centered moment divided by the cube of the standard deviation)

$$\alpha_3 = \frac{\sum_i (x_i - \bar{x})^3}{\left[\sum_i (x_i - \bar{x})^2 \right]^{3/2}}, \tag{5.6}$$

where x is a stationary time series, $\bar{x}$ its the sample mean and $\hat{a}_3$ is the estimated skewness coefficient. For a procyclical variable the kind of asymmetry discussed above is expected to result in negative skewness ($\hat{a}_3<0$) for the *growth rate*, since the fewer but larger negative (with the mean $\bar{x}$ subtracted) growth rates dominates over the more numerous but smaller positive growth rates, due to the power of three in (5.6). Analogously, the growth rate of an asymmetric and countercyclical variable is likely to give a positive skewness coefficient. Under the null hypothesis of no skewness, the estimate $\hat{a}_3$ is asymptotically normally distributed with mean zero and variance 6/N, where N is the sample size – *provided* the observations are independent. But, our data are rather characterized by autoregression. Following DeLong and Summers, we instead obtain estimates of the variance by means of Monte Carlo experiments. For each series and sample, we fit an AR(2) process, for which there should be no skewness. This AR(2) process is simulated 250 times, giving 250 estimates of the skewness coefficient. Then, we calculate the variance of these 250 estimates. Finally, we use the larger of this variance and 6/N in the significance tests below.

Table 5.9 shows the skewness measure for the entire sample 1861 (1871) – 1988, as well as for the subsamples 1861 (1871) – 1913, 1921 – 1938 and 1948 – 1988. A black cell indicates that the coefficient is significantly different from zero at the 5 percent significance level. As a complement, the table also shows the median for each series and sample. The mean of each series is normalized to zero for each sample and the median is divided by the interquartile range (the difference between the third and first quartile) in order to make the figures comparable across variables. A positive median indicates that more than half the observations is above the mean and the magnitude is an indication of of how much they are above the mean. Generally, one would expect a significant skewness measure and the median to have opposite signs. If this is not the case, one may suspect that the significant skewness is due to some extreme observation, which casts doubts on the validity of the test.

For the entire sample, half of the series—including series like GDP and private consumption—show significant skewness. But, for many series, most notably some relative prices, interest rates and imports, the skewness is *positive*. This indicates that upturns are fewer but larger than downturns. At the same time, the medians are fairly close to zero. Therefore, we may indeed suspect that much of the skewness stems from some extreme values, for instance, in conjunction with the World Wars. Furthermore, it is possible that the degree of asymmetry has changed over time. For both of these reasons, it is instructive to study the subsamples, which exclude the years around the wars. In the prewar period only three series show significant skewness, namely nominal and real money, which show positive skewness, and hours, which shows negative skewness. On the other hand, a large degree of asymmetry seems to characterize the interwar period, since half of the series have significant skewness and often medians far from zero. For instance, GDP shows the expected negative skewness and positive median, while unemployment shows the equally expected positive skewness and negative median. Finally, a large number of variables are skewed in the postwar period. But, the skewness is almost isolated to relative prices and nominal variables, which show mostly positive skewness. This is probably due to the "Korea inflation" in the early 1950's. The only real variables with significant skewness during the post war period are hours/employee and German and French GDP.

The conclusion from this subsection is that asymmetries for real variables seem to have characterized the crisis–torn interwar period, but we find no evidence of such asymmetries, neither during the prewar period nor during the postwar period.

6. Concluding Comments

6.1 Summary and suggestions for further work

We have tried to document a number of broad facts regarding the Swedish business cycle during the last 130 years. Some of the facts we present in Section 4 conform well with the corresponding business–cycle facts for other countries and other time periods. We find such conformity when it comes to the correlations between, and relative volatility of, GDP and its main demand components. What we find particularly interesting is that these broad facts stay roughly constant over the whole sample period, despite large differences in the absolute volatility of most series across subperiods. In general, the business–cycle facts for most real variables is stable over time. This stands in stark contrast to the business–cycle facts for nominal variables, where it is very hard to find any stable pattern.

We have also tried to document a number of narrow facts regarding Swedish business cycles. Some of the facts we present in Section 5 are interesting enough to merit further and closer study. One example is the changing relation between money, prices and output. In this case, one may ask whether our finding of a gradual decoupling of money and prices and a gradual coupling of money and output at business–cycle frequencies is robust and, if so, whether it is due to changes in the policy regime or in financial structure. Another interesting fact is the strong countercyclicality of the real wage, which seems to distinguish the Swedish labor market from that of most other countries. If it holds up to further empirical scrutiny, this finding is suggestive about which mechanisms should be emphasized in theoretical models of the interaction between the labor market and the macro economy.

Although we found Swedish exports and manufacturing production to be correlated with foreign demand in the post–war period, we found no such link between Swedish GDP and our crude measure of foreign demand. Nevertheless, it is a common view in Sweden that domestic business cycles are largely driven by foreign demand. We find strong evidence of such a link only in the interwar period. The dramatic events during the interwar period thus still seem to dominate current thinking. A similar example is the common idea of an asymmetry in the business cycle, in the sense of downturns being faster than upturns. But we find no evidence for the conventional view in this case either, except in the interwar period.[21] One may ask: how much longer will the great depression haunt our minds?

6.2 Is the business cycle important?

Our general definition of business cycles in Section 3 stresses comovements around trend of important macroeconomic variables. The results in the paper rely on our operational definition, which amounts to filtering each original time series by either of three filters so as to emphasize fluctuations at the particular frequency band corresponding to cycles between 3 and 8 years. Does this operational definition make sense?

From an empirical view—as Klaus Neusser points out in his comments—singling out certain frequencies in this way is highly questionable unless the resulting "cyclical component" is assumed to be driven by a different stochastic process than the remaining "growth component". Of course, it is only a similar implicit assumption that warrants the traditional theoretical distinction between growth and business cycle theories. Such an "identifying assumption" can certainly be criticized, particularly in light of the mounting evidence that many important macroeconomic variables may follow stochastic trends.

We have two, mostly pragmatic, arguments in favor of doing what we do. The first argument has to do with our belief that documenting stylized facts is an important inductive stage in macroeconomic research. As we mentioned in Section 3, some very interesting theoretical research on the interrelation between business cycles and growth is

---

21 Kydland and Prescott (1990) note a similar phenomemon, namely the lack of evidence for a procyclical price level in US postwar data that runs counter to a conventional wisdom. In that case, too, the conventional wisdom is consistent with (US) interwar data. (In Section 4, by contrast, we found no evidence of a procyclical Swedish price level even in the interwar period.)

starting to appear. But this research is still quite far from laying a firm foundation for empirical work. If we want to establish stylized facts to guide theorizing, the reason for singling out fluctuations at the business–cycle frequencies, is thus that existing business–cycle theory—both in its neo–classical and in its neo–keynesian incarnations—effectively does the same thing. This argument is, of course, nothing but the well–known story about looking for the key under the street–lamp.

The other argument has to do with the popular and policy–oriented macroeconomic discussion. Much of this discussion revolves around cyclical variables without strong trends, such as the unemployment rate, the inflation rate and the current account. If these variables have strong cyclical components that are well correlated with fluctuations in other (trending) variables, our operational approach does not seem too far from our general definition of business cycles which stresses cyclical comovements between macroeconomic variables.

This latter argument can also be made empirically. For each series in our data set we ask whether the business–cycle frequencies, as we have defined them, contain a substantial portion of the variance in the series. Table 6.1 displays for each series, the *share* of the variance over the whole sample that can be attributed to cycles between 3 and 8 years. (Before calculating the spectrum for each time series we subtracted a log–linear trend.) For many variables, including GDP, the share is below 10 %, suggesting that they are trending variables subject to permanent shocks. But for certain variables that indeed include the unemployment rate, the inflation rate and the current account, the share is above 20%, suggesting that they contain a substantial cyclical component. And our earlier findings show significant comovements between these variables on the one hand, and GDP and other trending variables on the other.

The positive question whether the business cycle is important, is often connected with the normative question whether business–cycle fluctuations should be a cause for policy concern. The latter is a difficult question, where economists have a wide range of views. Of course, there is nothing in our results that enables us to judge the *absolute* importance of Swedish business cycles. But we can at least say something preliminary about how the *relative* importance of business cycles has changed over time. Figure 6.1 suggests that this change may have been considerable. The figure is constructed by estimating an unweighted periodogram (see Appendix 2 for details) of GDP, for a window of 51 observations. We then plot the share of the variance explained by business cycles (the frequency band corresponding to 3 to 8 year cycles), with the date centered on the middle observation in the window. The figure clearly spells out how the importance of the business cycle peaks around World War I and how it has declined steadily over time. Maybe this is another instance of the general phenomenon mentioned at the end of Section 6.1: dramatic historical events tend to color the research agenda and shape the policy perspectives for many decades.

References

Azariadis, C. (1975), "Implicit Contracts and Underemployment Equilibria", *Journal of Political Economy* 83, 1183–1202.

Backus, D.K. and P.J. Kehoe (1989), "International Evidence on the Historical properties of Business Cycles", Federal Reserve Bank of Minneapolis, Research Department Working Paper 402R, forthcoming in the *American Economic Review.*

Bagge, G., E. Lundberg and I. Svennilson, (1933), (1935), *Wages in Sweden 1860–1930, vol.* I–II, London.

Blackburn, K. and M.O. Ravn (1990), "Business Cycles in the UK: Facts and Fictions", Mimeo, University of Southampton.

Bernanke, B. and A.Blinder (1990), "The Federal Funds Rate and the Channels of Monetary Transmission", Working Paper No. 3487, *NBER.*

Blanchard, O. and S. Fischer, (1989), *Lectures on Macroeconomics,* MIT Press.

Blanchard, O. and M.W. Watson (1986), "Are Business Cycles All Alike?", In Robert Gordon (ed.), *The American Business Cycle,* University of Chicago Press.

Brander, P. and K. Neusser (1990), "Business Cycles in Open Economies: Stylized Facts for Austria and Germany", Working Paper No. 40, Österreichisches Institute für Wirtschaftsforschung.

Brechling, F.P.R. (1965), "The Relation Between Output and Employment in British Manufacturing Industries", *Review of Economic Studies* 32, 187–216.

Brockwell P.J and R.A. Davis, (1991), *Time Series: Theory and Methods,* Springer–Verlag, New York.

Burns A.F. and W.C. Mitchell, (1946), *Measuring Business Cycles,* New York: NBER.

Cooley T.F. and G. Hansen (1989), "The Inflation Tax in a Real Business Cycle Model", *American Economic Review* 79, 733–748.

Correia, I.H., J.C. Neves and S. Rebelo (1990), "Business Cycles in Portugal": Theory and Evidence", Mimeo, Banco de Portugal.

Dahlgren, E., (1936), *Produktionsstatistisk uppskattning av Sveriges nationalinkomst* 1930–1934 (*An Estimate of Swedish National Income According to Statistics of Production*), Statens Offentliga Utredningar 1936:18, Appendix 1, Stockholm.

Dahlgren, E. (1941), "PM med vissa beräkningar angående nationalinkomstens storlek" (Some Calculations of the National Income), in *Statsverkspropositionen* (the Government's Budget Proposal) 1941, Stockholm.

Danthine, J.–P. and J.B. Donaldson (1991), "Methodological and Empirical Issues in Real Business Cycle Theory", Cahier No. 9102, DEEP, Lausanne.

Danthine, J.–P. and M. Girardin (1989), "Business Cycles in Switzerland: A Comparative Study", *European Economic Review* 33, 31–50.

DeLong, B. and L.H. Summers (1986), "Are Business Cycles Symmetrical?", In Robert Gordon (ed.), *The American Business Cycle*, University of Chicago Press.

Dunlop, John, (1938), "The Movement of Real and Money Wage Rates", *Economic Journal*, 413–434.

Engle, R.F., (1974), "Band Spectrum Regression", *International Economic Review* 15, 1–11.

Englund, P., T. Persson and L.E.O. Svensson (1990), "Swedish Business Cycles: 1861–1988", Working Paper No. 275, Rochester Center for Economic Research.

Englund, P., A.Vredin and A. Warne (1991), "Macroeconomic Shocks in Sweden", In This Volume.

Geary P.T. and J. Kennan (1982), "The Employment–Real Wage Relationship: An International Study", *Journal of Political Economy* 90, 854–871.

Gordon, J.R. (1980), "A Consistent Characterization of a Near–Century of Price Behavior", *The American Economic Review* 70, 243–249.

Granger, C.W.J. (1966), "The Typical Spectral Shape of an Economic Variable", *Econometrica* 34, 150–161.

Greenwood, J., Z. Hercowitz and G. Huffman (1988), "Investment, Capacity Utilization and the Real Business Cycle", *The American Economic Review* 78, 402–417.

Hassler, J., P. Lundvik, T. Persson, and P. Söderlind, (1992), *The Swedish Business Cycle: Stylized Facts Over 30 Years*, Monograph No. 20, Institute for International Economic Studies.

Hodrick, R.J. and E.C. Prescott (1980), "Post–War U.S. Business Cycles: An Empirical Investigation", Working Paper No. 451, Carnegie–Mellon University.

Hultgren, T., (1960), "Changes in Labor Cost During Cycles in Production and Business", Occasional Paper 74, NBER

Johansson, Ö., (1967), *The Gross Domestic Product of Sweden and its Composition 1861–1955*, Stockholm Economic Studies VIII.

Jonung, J.L.B., (1975), *Studies in the Monetary History of Sweden*, Dissertation in Economics, UCLA.

Jungenfelt, K.G., (1966), *Löneandelen och den ekonomiska utvecklingen* (The Wage share and Economic Development), Uppsala 1966.

Keynes, J.M., (1936), The General Theory of Employment, Interest and Money, London: Macmillan.

Keynes, J.M. (1939), "Relative Movements in Real Wages and Output", *Economic Journal*, 34–51.

King, R.G., C.I. Plosser and S. Rebelo (1988a), "Production, Growth and Business Cycles: I. The Basic Neoclassical Model", *Journal of Monetary Economics* 21, 195–232.

King, R.G., C.I. Plosser and S. Rebelo (1988b), "Production, Growth and Business Cycles: II. New Directions", *Journal of Monetary Economics* 21, 309–341.

King, R.G. and S. Rebelo (1990), "Low Frequency Filtering and Real Business Cycles", mimeo, University of Rochester.

Koopmans, L.H. (1974), *The Spectral Analysis of Time Series*, Academic Press.

Krantz, O. and C.–A. Nilsson, (1975), *Swedish National product 1861–1970*, Lund

Kydland, F. and E.C. Prescott (1982), "Time to Build and Aggregate Fluctuations", *Econometrica* 50, 1345–1370.

Kydland, F. and E.C. Prescott (1990), "Business Cycles: Real Facts and Monetary Myth", *Quarterly Review*, Federal Reserve Bank of Minneapolis

Lindahl, E., E. Dahlgren and K. Kock, (1937), *National Income of Sweden* 1861–1930, *vol.* I–II, London.

Lindahl, O. (1956), Sveriges nationalprodukt 1861–1951, Meddelanden från konjunkturinstitutet serie B:20, National Institute for Economic Research, Stockholm.

Lindbeck, A., (1975), *Swedish Economic Policy,* The MacMillan Press Ltd.

Lucas, R.E. Jr. (1977), "Understanding Business Cycles", *Carnegie–Rochester Conference series* 5.

Lundvik, P. (1990), "Business Cycle in a Small Open Economy: Sweden 1871–1987", Mimeo, Institute for International Economic Studies.

Lundvik, P. (1991), "Human Capital Accumulation and the Real Business Cycle", Mimeo, Institute for International Economic Studies.

Maddison, A., (1982), *Phases of Capitalist Development,* Oxford University Press.

Moore, G.H. and V. Zarnowitz (1986), "The Development and Role of the National Bureau of Economic Research's Business Cycle Chronologies", In Robert Gordon (ed.), *The American Business Cycle,* University of Chicago Press.

Myrdal, G., (1933), *The Cost of Living in Sweden 1830–1930*, London

Nadiri, Ishaq, and Sherwin Rosen, (1973), *A Disequilibrium Model of Demand for Factors of Production,* New York: Columbia University Press

Newey, W. and West, K. (1987), "A Simple, Positive–Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix", *Econometrica* 55, 703–708.

Ohlsson, H. (1991), "Har den svenska finanspolitiken varit kontracyklisk?" (Has Swedish Fiscal Policy been Countercyclical?), Mimeo, Uppsala University.

Ohlsson, L., (1969), *Utrikeshandeln och den ekonomiska tillväxten i Sverige 1871–1966*, Industriens Utredningsinstitut, Almquist & Wiksell, Stockholm.

Priestly, M.B., (1981), *Spectral Analysis and Time Series*, Academic Press.

Romer, C.D. (1981), "The Prewar Business Cycle Reconsidered: New Estimates of Gross National Product 1869–1908", *Journal of Political Economy* 97, 1–37.

Sachs, J. (1980), "The Changing Cyclical behavior of Wages and Prices", *The American Economic Review.*

Sargent, T. J., (1987), *Macroeconomic Theory*, Academic Press.

Shapiro, C. and J. Stiglitz (1984), "Equilibrium Unemployment as a Discipline Device", *American Economic Review* 74, 433–444.

Silenstam, P., (1970), *Arbetskraftsutbudets utveckling i Swerige 1870–1965*, Industriens Utredningsinstitut.

Sims, C. (1974), "Output and Labor Input in Manufacturing", *Brookings Papers on Economic Activity* 3, 695–735.

Sims, C. (1980), "Comparison of Interwar and Postwar Business Cycles: Monetarism Reconsidered", *The American Economic Review* 70, 250–257.

Singleton, K.J. (1988), "Econometric Issues in the Analysis of Equilibrium Business Cycle Models", *Journals of Monetary Economics* 21, 361–386.

Stock, J.H. and M.W. Watson (1989), "Interpreting the Evidence on Money–Income Causality", *Journal of Econometrics* 40, 161–182.

Stock, J.H. and M.W. Watson (1990), "Business Cycle properties of Selected U.S. Economic Time Series, 1959–1988", Working Paper No. 3376, *NBER*

Summers, R. and A. Heston (1988), "A New Set of International Comparisons of Real Product and Price Levels: Estimates for 130 Countries", *The Review of Income and Wealth* 34, 1–75.

Taylor J. (1986), "Improvements in Macroeconomic Stability: The Role of Wages and Prices", In Robert Gordon (ed.), *The American Business Cycle*, University of Chicago Press.

Westlund, A.H.and S. Öhlen (1988), "On Testing for Cyclical Symmetry in Some Swedish Economic Time Series", Research Report, Statistics Sweden.

Whittle, P., (1983), *Prediction and Regulation*, 2nd edition, University of Minnesota Press: Minneapolis.

Appendix 1
Data Sources and Definitions

This appendix gives exact sources for our data and exact definitions of the variables in our study.

GDP Deflator (Py)
Nominal GDP/Output defined as below.

Inflation (Inf)
First differences of logarithms of the GDP Deflator.

Nominal GDP (Ynom)
GDP in current factor prices

Sources:

1861–1949	Krantz and Nilsson (1975), Table 1.2 col 4
1950–1969	Statistics Sweden, N10 SM8901, Appendix 2–3, Table 3.1, GDP in factor values.
1970–1988	Statistics Sweden , N10 SM8901, Table H1, GDP in factor values.

Money Stock (M2)
Central Bank and private bank (until 1903) notes held by the public plus demand and time deposits at Commercial Banks

Sources:

1871–1971	Jonung (1975), Appendix A.
1972–1988	Statistical Yearbook, Central Bank of Sweden.

Real Money Stock (M2/Py)
Money Stock divided by the GDP deflator.

Discount Rate (R)
Central Bank Discount Rate

Source:

1861–1988	Statistical Yearbook, Central Bank of Sweden.

Interest rate (R2)
Lowest offered interest rate for loans at the commercial bank Skandinaviska Enskilda Banken and its ancestors.

Sources:

1867–1911	Sammandrag av solidariska enskilda bankers samt aktiebankernas och kreditaktiebolagens uppgifter,quarterly publication, Statistics Sweden.
1912–1967	Statistiska meddelanden serie E, Uppgifter om bankerna, monthly publication, Statistics Sweden.
1968–1983	Bankerna, monthly publication, Statistics Sweden.
1984–1986	Affärsbankerna, monthly publication, Statistics Sweden.
1987–1988	Approximate figure given by Sven Lindström at SE–banken. Rates decided upon locally.

Real Discount Rate (R–Inf)
Official Discount Rate minus inflation.

Real Interest Rate (R2–Inf)
Interest Rate minus inflation.

GDP (Y)
Gross Domestic Product in 1985 fixed factor values. From 1950 GDP at current factor values is deflated by the implicit deflator for GDP at market values.

Sources:

1861–1949	Krantz and Nilsson (1975), Table 3.1
1950–1979	Statistics Sweden, N10 SM8901, Appendix 2–3, Tables 3.1 and 3.2
1980–1988	Statistics Sweden, N10 SM8901, Tables H:1 and H:2

Private Consumption (C)
Private consumption of goods and services at fixed 1985 prices.

Sources:

1861–1949	Krantz and Nilsson (1975), Table 2.3.1.
1950–1979	Statistics Sweden, N10 SM8901, Appendix 2–3, Table 3:2
1980–1988	Statistics Sweden, N10 SM8901, H2.

Public Consumption (G)
Public consumption of goods and services, state and municipalities deflated with the GDP deflator.

Sources:

1861–1949	Krantz and Nilsson (1975), Table 1.1.
1950–1979	Statistics Sweden, N10 SM8901, Appendix 2–3, Table 3:1
1980–1988	Statistics Sweden, N10 SM8901, H1.

Investments (I)
Gross domestic capital formation in fixed 1985 prices.

Sources:

1861–1949	Krantz and Nilsson (1975), Table 2.2.1.
1950–1979	Statistics Sweden, N10 SM8901, Appendix 2–3, Table 3:2, row 5.
1980–1988	Statistics Sweden, N10 SM8901, Table H2.

Exports (X)
Exports of goods and services in fixed 1985 prices.

Sources:

1861–1949	Johansson (1967), Table 50 col.14
1950–1979	Statistics Sweden, N10 SM 8901, Appendix 2–3, Table 3:2
1980–1988	Statistics Sweden, N10 SM 8901, Table H2

Imports (M)
Imports of goods and services in fixed 1985 prices.

Sources:

1861–1949	Johansson (1967), Table 52 col.14
1950–1979	Statistics Sweden, N10 SM 8901, Appendix 2–3, Table 3:2

1980–1988	Statistics Sweden, N10 SM 8901, Table H2

Relative Price Private Consumption (Pc/Py)
Private consumption at current prices divided by Private consumption at fixed prices and the GDP deflator

Sources for private consumption at current prices:

1861–1949	Krantz and Nilsson (1975), Table 1.1
1950–1979	Statistics Sweden, N10 SM8901, Appendix 2–3, Table 3:1
1980–1988	Statistics Sweden, N10 SM8901, H1.

Relative Price Investments (Pi/Py)
Gross fixed capital formation at current prices divided by gross fixed capital formation at fixed prices and the GDP deflator

Sources for fixed capital formation at current prices:

1861–1949	Krantz and Nilsson (1975), Table 1.1
1950–1979	Statistics Sweden, N10 SM8901, Appendix 2–3, Table 3:1
1980–1988	Statistics Sweden, N10 SM8901, H1.

Relative Export Prices (Px/Py)
Exports of goods and services at current prices divided by gross exports at fixed prices and the GDP deflator.

Sources for exports at current prices:

1861–1949	Johansson (1967), Table 49 col.14
1950–1979	Statistics Sweden, N10 SM 8901, Appendix 2–3, Table 3:1
1980–1988	Statistics Sweden, N10 SM 8901, Table H:1

Relative Import Prices (Px/Py)
Imports of goods and services at current prices divided by gross imports at fixed prices and the GDP deflator.

Sources for imports at current prices:

1861–1949	Johansson (1967), Table 51 col.14
1950–1979	Statistics Sweden, N10 SM 8901, Appendix 2–3, Table 3:1
1980–1988	Statistics Sweden, N10 SM 8901, Table H:1

Manufacturing Production (Yman)
Value added in manufacturing and mining in fixed 1985 producer prices.

Sources:

1861–1949	Krantz and Nilsson (1975), Table 3.2.1
1950–1962	Statistics Sweden, SM N 1975:98, Table 2A
1963–1969	Statistics Sweden, SM N 1981:2.5, Appendix 4, Table 2A
1970–1988	Statistics Sweden, N10 SM8901, Table H:4

Relative Price Manufacturing Production (Pman/Py)
Value added in manufacturing and mining at current producer prices divided by value added in fixed producer prices and the GDP deflator.

Sources for value added in current producer prices :

1861–1949	Krantz and Nilsson (1975), Table 1.3

1950–1962	Statistics Sweden, SM N 1975:98, Table 1A
1963–1969	Statistics Sweden, SM N 1981:2.5, Appendix 4, Table 1A
1970–1988	Statistics Sweden, N10 SM8901, Table H:3

Wage rate
Wage in current SEK per 100 hours for workers in manufacturing and mining.

Sources:

1861–1913	Bagge et al. (1935), Table 26, Column "Social Science Institute"
1914–1919	Bagge et al. (1935), Table 26, Column "Social Board"
1920–1929	Statistics Sweden, Lönestatistisk årsbok 1929, Table 8
1930–1934	Statistics Sweden, Lönestatistisk årsbok 1938, Table 24
1935–1938	Statistics Sweden, Lönestatistisk årsbok 1940, Table 28
1939–1984	Statistics Sweden, Löner 1984, p 58, Table D
1985–1986	Statistics Sweden, Löner och sysselsättning inom privat sektor 1988, p 44, Table D

Real Wage (W/Pman)
Wage rate deflated with manufacturing prices.

Real Consumer Wage (W/Pc)
Wage rate deflated with private consumption prices.

Wage Cost (Wc)
Total wage bill in current values to workers in manufacturing and mining divided by total number of hours worked by workers.

Source for total wage bill:

1870–1949	Jungenfelt (1966), p 122 col 5.
1950–1962	Statistics Sweden, Nr N 1975:98, Appendix 98, Table 4AA
1963–1969	Statistics Sweden, Nr N 1978:8.4, Appendix 5, Table 14.
1970–1979	Statistics Sweden, N10 SM8601, Appendix 5, Table 5:11
1980–1988	Statistics Sweden, N10 SM8901, Appendix 5, Table 5:11

Real Wage Cost (Wc/Pman)
Wage cost deflated by manufacturing prices.

Worked Hours in Manufacturing (H)
Total number of worked hours by employees in manufacturing and mining. Between 1870 and 1949 constructed by dividing total wage bill (see wage cost) and wage rate defined as above. Between 1950 and 1959 hours by entrepreneurs ("företagare") is included.

Sources:

1950–1959	Statistics Sweden, Nr N 1975:98, Appendix 5, Table 98
1960–1962	Statistics Sweden, Nr N 1975:98, Appendix 5, Table 92
1963–1969	Statistics Sweden, N 1978:8.4, Appendix 5, Table 92
1970–1979	Statistics Sweden, N10 SM8601, Appendix 5, Table 5:8
1980–1988	Statistics Sweden, N10 SM8901, Appendix 5, Table 5:8

Workers (N)
Average number of workers in manufacturing and mining.

Sources:

1861–1919	Bagge et al. (1935), Table 187

1920–1986	Industri, yearly publication from Kommerskollegium, later Statistics Sweden. Workers ("arbetare and "övriga arbetare") in industrial groups 1–8, 1952–1986 groups 1–11 due to reclassification.

Hours per Worker
Worked hours in manufacturing and mining divided by average number of workers.

Productivity (Pr)
Labor productivity in manufacturing and mining. Value added in manufacturing and mining in fixed 1985 producer prices divided by total number of worked hours.

Wage share (Wshare)
Total wage bill (see wage cost) divided by value added in manufacturing and mining in current prices.

Unemployment (U)
Yearly average of number of unemployed reported to unemployment insurance. ("Arbetslöshetskassor")

Sources:

1911–1956	Silenstam (1970)
1956–1969	Historical Statistics, Arbetsmarknadsstyrelsen, Swedish Labor Market Board.
1970–1988	Arbetsmarknadsstyrelsen, Swedish Labor Market Board.

Current Account (CA)
Current Account in current values.

Sources:

1871–1949	Ohlsson (1969), Table B:1
1950–1962	Statistics Sweden, N 1975:98, Appendix 3, Table 5
1963–1969	Statistics Sweden, N 1981:2.5
1970–1974	Statistics Sweden, N10 SM8601
1975–1988	Statistics Sweden, N10 SM8901, Table VIII,row 8

Net Exports (Nx)
Exports minus imports deflated with GDP deflator.

Terms of Trade (Tot)
Relative export price divided by relative import price.

Foreign Demand (Fy)
Aggregated weighted GDP in Great Britain, Denmark, Norway, (West) Germany, France and United States. Weights calculated as follows: Unfiltered weights are defined as:

$$\alpha_i = w_i X / Y_i Px$$

where subscript $_i$ denotes the countries mentioned above. w_i denotes the share of Swedish exports going to country i, Y_i real GDP in country i and Px is export prices. For years without observations on w_i, linerar interpolations are made. A Whittaker–Hendersson filter with λ=6400 is then applied to α_i and the trend component $\overline{\alpha}_i$ (normalized to sum to one) is used as the weight so that:

$$Fy = \Sigma \tilde{\alpha}_i Y_i$$

Source for w_i:

1871–1964	Ohlsson (1969), Table B:9
1965–1988	*Statistisk Årsbok*, Statistics Sweden

Output Great Britain (Uk)
GDP of Great Britain in fixed values.

Sources:

1870–1949	Maddison (1982), Table A6–A8
1950–1985	Summers and Heston (1988)
1986–1988	OECD, National Accounts

Output Denmark (Dk)
As for Uk.

Output Norway (No)
As for Uk.

Output Germany (Ge)
As for Uk.

Output France (Fr)
As for Uk.

Output United States (Us)
As for Uk.

Appendix 2
Filters and frequency domain statistics

This appendix presents and discusses more formally the filters we apply in order to extract cyclical components of the raw data series, and discusses in some detail how we estimate the frequency domain statistics.

A2.1 The transfer function and phase

In this section we will define and analyze filters in terms of their effect on cyclical behavior. A univariate time invariant linear filter transforms the time series x (input) to the new series y (output) by forming a weighted moving average using the weights v :

(A2.1) $$y_t = \sum_{s=-\infty}^{\infty} v_s\, x_{t-s}.$$

The *transfer function* for the filter is the Fourier transform of the weights

(A2.2) $$B(\omega) = \sum_{s=-\infty}^{\infty} v_s \exp(-i\omega s),$$

where $\exp(-i\omega s) = cos(\omega s) - i^{*}sin(\omega s)$ is the complex exponential function (this is like replacing x_{t-s} with $\exp(-i\omega s)$ in (A2.1)). The frequency $\omega \in [-\pi,\pi]$, but spectra are symmetric around zero.

The reason why the transfer function is interesting is that the spectrum for y, $S^{y}(\omega)$, is given by

(A2.3) $$S^{y}(\omega) = |B(\omega)|^2\, S^{x}(\omega),$$

where $S^{x}(\omega)$ is the spectrum for x and $|\ |$ denotes the modulus of the complex function $B(\omega)$, that is, if $B(\omega) = q + ip$ then $|B(\omega)|^2 = q^2 + p^2$.

The transfer function can equivalently be expressed as

(A2.4) $$B(\omega) = |B(\omega)|\ \exp[-iP^{xy}(\omega)],$$

where $P^{xy}(\omega)$ is the *phase* and the magnitude $|B(\omega)|$ is often called the *gain*. The phase is defined by

(A2.5) $$P^{xy}(\omega) = argB(\omega) = tan^{-1}\{Im[B(\omega)]/Re[B(\omega)]\},$$

where *Im* and *Re* are operators that pick out the imaginary and real part of the complex number, respectively. One way of interpreting the phase is to note that

(A2.6) $$\tau(\omega) = P^{xy}(\omega)/\omega$$

is a measure of the phase shift at frequency ω in terms of time (which is measured in years in the present paper). The convention is that when $\tau(\omega) < 0$, then on average y (output) is lagged relative to x (input).

A2.2 Definitions of the filters

This subsection provides formal definitions for the three filters that we use in the paper. The computational procedures are described in a subsequent section.

The *Band–pass* filter (denoted BA) operates in the frequency domain. We use a filter with the transfer function

(A2.7) $$B^{BA}(\omega) = \begin{cases} 1 \text{ if } 2\pi/3 \geq |\omega| \text{ and } |\omega| \geq 2\pi/8 \\ 0 \text{ otherwise} \end{cases},$$

which means that cycles with a period between 3 and 8 years passes through the filter untouched, but all other cycles are completely removed.

The *Whittaker–Henderson* filter type A, introduced to economists by Hodrick and Prescott (1980) and described in some detail by Danthine and Girardin (1989), is given by the solution to the following optimization problem:

Split the series x into a cyclical component y and a trend g (where, of course, $x_t = y_t + g_t$) so as to minimize

(A2.8) $$\sum_{t=1}^{n} y_t^2 + \lambda \sum_{t=3}^{n} [(g_t - g_{t-1}) + (g_{t-1} - g_{t-2})]^2$$

Hence, the trend's tracking of the x series (giving small y^2) is traded off against the smoothness of the trend (giving small $[(g_t - g_{t-1}) + (g_{t-1} - g_{t-2})]^2$). We have chosen $\lambda = 10$, which implies that the trend tracks the original series fairly closely, in order to get an average cycle length of approximately 5 years for the cyclical component (y) of the GDP series.

The *first difference* filter is simply $y_t = x_t - x_{t-1}$, which corresponds approximately to growth rates for all series that are expressed in logarithms.

A2.3 Computational procedures for the filters

This section describes the actual computational procedures that we apply. All calculations are made in the GAUSS programming language. Let us assume that we have n observations of the time series x (input) $x_0, x_1, \ldots, x_{n-1}$.

The band–pass filter is implemented in four steps. First, in order to reduce the wrap–around effect (see below) the x series is prefiltered with a Whittaker–Henderson filter with λ=2500 and padded with zeros to four times its original length. If needed, it is further padded with zeros to get a number of elements T equal to a power of 2. Second, a Fast (finite) Fourier Transform (FFT) is applied, to form the random spectral measure

(A2.9) $$Z(\omega_j) = (1/T)\sum_{t=0}^{T-1} x_t \exp(-i t \omega_j), \quad \omega_j = 2\pi j/T \text{ where } j=0,1,2,\ldots,T-1.$$

The frequency runs from 0 to $2\pi(T-1)/T$, but since the spectral measure is periodic with a period of 2π, the values for $\pi \leq \omega < 2\pi$ equals the values for $-\pi \leq \omega < 0$. Third, the spectral measure is multiplied with the transfer function $B^{BA}(\omega)$ from (A2.7), with the definition changed in accordance with the frequency domain of the FFT

(A2.10) $$B^{BA}(\omega) = \begin{cases} 1 & \text{if } 2\pi/8 \leq \omega \leq 2\pi/3 \text{ or } 2\pi(1-1/3) \leq \omega \leq 2\pi(1-1/8) \\ 0 & \text{otherwise} \end{cases}.$$

Fourth, the inverse FFT is calculated as

(A2.11) $$y_t = \sum_{j=0}^{T-1} Z(\omega_j) B^{BA}(\omega_j) \exp(i t \omega_j), \quad \text{where } \omega_j = 2\pi j/T,$$

and the n first observations are picked out. The result of these operations constitutes our filtered series.

The Whittaker–Henderson type A filter operates in the time domain and is simple to use. Danthine and Girardin (1989) shows that the filter can be computed as

(A2.11a) $$y_t = [I - (I+\lambda \Gamma'\Gamma)^{-1}]\, x_t,$$

where I is the $n \times n$ identity matrix and Γ the $n \times n$ toeplitz matrix

(A2.11b) $$\Gamma = \begin{bmatrix} 1 & -2 & 1 & 0 & 0 & \dots & 0 & 0 & 0 \\ 0 & 1 & -2 & 1 & 0 & \dots & 0 & 0 & 0 \\ 0 & 0 & 1 & -2 & 1 & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & & & & \vdots \\ 0 & 0 & 0 & 0 & 0 & \dots & 1 & -2 & 1 \end{bmatrix}.$$

The first–difference filter is simply

(A2.12) $$y_t = x_t - x_{t-1}, \qquad t \in [1, n-1],$$

which of course means that one observation at the beginning of the sample is lost.

A2.4 Characteristics of the filters

This section discusses the characteristics of the filters in terms of their transfer and phase functions. Special attention is paid to the effect of the finite sample length.

Figure A2.1a–c shows in the upper panel the the gain functions $(|B(\omega)|)$ of the three filters, and in the lower panel the phase functions. The x–axis is expressed in frequencies (ω) which run from zero to π. For convenience, cycle lengths of 16, 8, 3, and 2 years are marked with vertical dotted lines. Note that the cycle length in years and the frequencies (ω) are related according to

(A2.13) $$\text{years/cycle} = 2\pi/\omega.$$

In Figure A2.1a the gain for the ideal (asymptotic) *band pass* filter (A2.7) is plotted as the thick solid curve. This filter obviously keeps all cycles between 3 and 8 years but shuts out all others cycles. Unfortunately, this filter is not realizable for a finite sample. The reason is easy to see if the band pass filter is transformed to the time domain by applying the inverse Fourier Transform. It can be to shown that the theoretical (asymptotic) weights in the time domain v_s in (A2.1) for the band pass filter (A2.7) are

$$v_s = \begin{cases} [\, sin(s2\pi/3) - sin(s2\pi/8)\,]/(s\pi) & s=\pm1,\pm2,\ldots \\ [\, sin(2\pi/3) - sin(2\pi/8)\,]/\pi & s=0 \end{cases}.$$

These weights decline fairly slowly as $|s|$ increases, which is at the root of the problem. With a finite sample, some of the v_s are disregarded implying that the cycles to some extent are blurred with each other, a phenomenon usually called leakage. How does the the gain function actually look like for our sample length? In order to understand that, we have to deal with the question about how the FFT that we use for calculations treats a time series. As a matter of fact, it treats the series as periodic and assumes the the last observation is identical to the observation preceding the first observation. This "wrap–around" can seriously distort the time series. Therefore, we try to eliminate the wrap–around by padding the time series with a lot of zeros. All this means that the finite sample problem is indeed present.

In Figure A2.1a we have plotted, along with the ideal gain function discussed above, the actual gain function for observation t=64 (thin solid line) and t=1 (dotted line) in a sample of length 128. Obviously, for t=64, the finite sample problem is insignificant, but for t=1 (and also for t=128 which is identical to t=1) the leakage is considerable. It can be shown that for t=5, the leakage is dramatically smaller than for t=1. Furthermore, for the observations at the beginning (end) of the sample, only weights v_s for $s<0$ ($s>0$) has any effect. This will introduce a phase shift for these observations. Even if the ideal band–pass filter, and the actual band pass–filter for t=64 has no phase, as illustrated in the lower panel of Figure A2.1a, this is not universally true. For t=1, the phase shift is negative for longer cycles, around zero for the pass band, and positive for shorter cycles (the pattern for t=128 is exactly the opposite). Again, for t=5, the phase shift is dramatically smaller than for t=1.

Similar problems arise in applying the Whittaker–Henderson filter. The upper panel of Figure A2.1b shows the gain of the Whittaker–Henderson filter for a sample with 128 observations, for observation 1 and 64. The value λ=10 has been used. Since the sample is finite, the actual filter (the v_s values) will differ between observations. The gain function for the first (t=1) and last (t=128) coincide, but differs from the gain for an observation in the middle of the sample (t=64). It is worth noting that while the former seems to keep more of the longer cycles than the latter, the opposite is true for shorter cycles. The lower panel of Figure A2.1b illustrates the obvious phase shifts at the beginning of the sample: at t=1 the phase is negative, that is, output lags input. This is natural, since at t=1 only contemporaneous and leaded values of the input series are available. For the seven year cycle, the lag is about one year. Analogously, the filter for t=128 gives a positive phase. But, in the middle of the sample the filter is symmetric in the time domain, which gives a zero phase. According to Figure A2.1b, the phase vanishes fairly quickly as one moves into the interior of the sample. The phase for t=5 is fairly unimportant.

Figure A2.1c shows the gain and the phase for the first–difference filter. From the upper panel it is clear that the filter keeps a great deal of the long cycles and actually magnifies the short cycles. The phase for the first–difference filter is positive. At seven year cycles the lead is about 1.25 year and at three year cycles it is about 0.25 year.

Figure A2.2 brings together the gain functions for the three different filters in order to highlight the differences. It is clear that the Whittaker–Henderson filter differs from the band pass filter by keeping more of the long cycles and all the short cycles. The first–difference filter is even more extreme in both these respects.

A2.5 Estimation of spectra and coherencies

This section summarizes the procedures for estimating spectra and coherencies. Most of the material is adapted from Koopmans (1974).

The estimation of spectra proceeds in three steps. First, the random spectral measure $Z(\omega_j)$ of the time series x is calculated by applying the FFT in (A2.9). Second, the *periodogram* is constructed by

(A2.14) $$I^{x}(\omega_j) = T/(2\pi)\,|Z(\omega_j)|^2.$$

Third, the weighted average over $\pm k$ frequencies of the periodogram is our estimate of the spectrum

(A2.15a) $$\hat{S}^{x}(\omega_j) = \sum_{i=-k}^{k} W_i I(\omega_{j-i}),$$

where W_i is a tent shaped sequence of weights which fulfill

(A2.15b) $$\sum_{i=-k}^{k} W_i = 1.$$

The *equivalent degrees of freedom* is given by

(A2.16a) $$r = 2\Big/\sum_{i=-k}^{k} W_i^2,$$

and a $100(1-\alpha)\%$ confidence interval is given by

(A2.16b) $$r\hat{S}^{x}(\omega_j)/b \;\le\; S(\omega_j) \;\le\; r\hat{S}^{x}(\omega_j)/a,$$

where a and b are given by $Prob(a \le \chi_r^2 \le b) = 1-\alpha$.

The estimation of the coherencies of two series x and y goes in a similar way. First, the spectrum of each series is estimated. Second, using the random spectral measures of each series, $Z^{x}(\omega_j)$ and $Z^{y}(\omega_j)$, the multivariate periodogram for the two series is calculated as

(A2.17) $$I^{xy}(\omega_j) = T/(2\pi)\; Z^{x}(\omega_j) Z^{y}(\omega_j)^*,$$

where the star (*) denotes the complex conjugate. Third, weighting $I^{xy}(\omega_j)$ as in (A2.15), gives the estimated cross spectrum $\hat{S}^{xy}(\omega_j)$. Finally, the coherence is obtained by

(A2.18) $$\hat{C}^{xy}(\omega_j) = |\hat{S}^{xy}(\omega_j)|/(\hat{S}^{x}(\omega_j)\hat{S}^{y}(\omega_j))^{\frac{1}{2}}.$$

An approximate $100(1-\alpha)\%$ confidence interval is given by

$$\hat{C}^{xy}(\omega_j)_{\min} = \tanh\{\; \operatorname{arctanh}(\hat{C}^{xy}(\omega_j)) - Crit\times(2(2k-1))^{-\frac{1}{2}} - (2(2k-1))^{-1} \;\}$$
$$\hat{C}^{xy}(\omega_j)_{\max} = \tanh\{\; \operatorname{arctanh}(\hat{C}^{xy}(\omega_j)) + Crit\times(2(2k-1))^{-\frac{1}{2}} - (2(2k-1))^{-1} \;\}$$

where *Crit* denotes the critical value for $\alpha/2$ in the standard normal distribution.

Appendix 3
Statistical inference on filtered data

This appendix discusses some problems of statistical inference on filtered data.

A3.1 Bandpass filtered data

Statistical inference on band–pass filtered time–series turns out to be a little less straightforward than might be expected. This is due to the following theorem[22]:

A process is purely linearly non–deterministic if

$$\int_{-\pi}^{\pi} \log f(\omega)\mathrm{d}\omega > -\infty$$

where f is the spectral density of the process. Otherwise it is linearly deterministic, so that x_1 can be predicted without error using a linear prediction function given the history of x up until t–1.

Since a pure band–pass filter is constructed to nullify the spectrum over a band of frequencies with an asymptotically positive measure, it follows that a filtered process becomes deterministic. Inference based on asymptotic properties of non–deterministic processes is thus invalid. Another important implication is that no band–pass filtered process can be Granger–caused by another process: since a deterministic process is perfectly linearly predictable from its own history, no other process can help predict it.

In the following, we discuss two ways of computing significance levels for band–pass filtered series. The first way appears more appealing but has problems for tests on sub–samples and also seems to have lower power. The second way is therefore used in this paper.

Method 1. First we note that zero correlation between the two filtered series y_f and x_f

---

22 See e.g. Whittle (1983) p. 26.

is equivalent to a zero regression coefficient β in the bivariate regression:

(A3.1) $$y_f = x_f\beta + \varepsilon .$$

Here, however, both y_f and x_f as well as ε are deterministic.

Let no subscript denote an unfiltered series and let the subscript r denote the remainder after filtering so that, for example, $y = y_f + y_r$. If we then run the regression:

(A3.2) $$y = x_f\beta + \varepsilon ,$$

we will have deterministic regressors, but y and thus the regression will be non–deterministic. Fortunately, regressions (A3.1) and (A3.2) will both yield the same estimate $\hat{\beta}$. This is because the space spanned by y_r is orthogonal to the space spanned by x_f Letting F represent the band–pass filter in the time domain and noting that F is symmetric and idempotent[23] we have that:

(A3.3)
$$\begin{aligned} \bar{\beta} &= (x_f'x_f)^{-1}x_f'y_f \\ &= (x_f'x_f)^{-1}x'F'F_y \\ &= (x_f'x_f)^{-1}x'F'y \\ &= (x_f'x_f)^{-1}x_f'y \end{aligned}$$

But since x_f and x_r are also orthogonal we may include x_f in the regression and run:

(A3.4) $$y = x_f\beta + x_r\gamma + v .$$

This will reduce the residual variance if there is some correlation between y and x_f and hence increase the power of the test. To test whether the correlation between filtered series is zero, we test if β in A3.4 is significantly different from zero. To account for non–spherical residuals we use a Newey–West estimator for the variance of $\hat{\beta}$.[24]

In our case we are interested in statistics for the sub–samples as well as for the

---

23 Following Engle (1974) the basic band–pass filter can be written $\mathbf{W^*AW}$ where $\mathbf{W}' = [W_0\ W_1 \ldots W_{T-1}]$, where $w_k = (1, e^{i\theta k}, e^{2i\theta k}, \ldots e^{(T-1)i\theta k}), \theta_k = 2\pi k/T$, $\mathbf{W^*}$ is the complex conjugate of the transpose of $\mathbf{W}$ and $\mathbf{A}$ is a diagonal matrix with a symmetric diagonal of ones and zeros such that a one represent included frequencies. Using this and the fact that $\mathbf{W'W} = \mathbf{WW'} = \mathrm{I}$, it is easy to show that $\mathbf{F}$ is symmetric and idempotent.

24 We use four lags in the computation of var $(\hat{\beta})$ See Newey–West (1987).

whole period. In this case the method is less well suited. The problem arises because the orthogonality, which gives us an equal $\hat{\beta}$ in (A3.1) and (A3.2), does not hold if we filter the series over the full sample period but run the regression for a sub–sample. In practice, this will cause unreasonable results in small samples. For instance, correlation coefficient between two filtered series which is close to zero for a sub–sample may be spuriously significant. The remedy is obviously to use one filter for every sub–sample that we study. This, however, leaves us with too small samples.

Another problem is that in practice we don't use the basic filter described in Footnote 23. Among other things, we are padding the series with zeros to reduce some finite sample problems with band–pass filters.[25] This procedure will also produce non–orthogonality between x_f and x_r. We have therefore chosen another method to compute significance levels.

Method 2. Our second method relies on the fact that it is only when the filter sets the spectral power for some frequencies (with strictly positive measure) *exactly* to zero that the series becomes deterministic. If we use a filter that reduce the spectral power of non–business cycle frequencies to some constant κ bounded away from zero, we may, by choosing κ small enough, get filtered series arbitrary close to the band–pass filtered series. In this case, our filtered process stays non–deterministic allowing the use of standard asymptotic results.

Instead of specifying κ to some arbitrary constant strictly bigger than zero, we have actually set it to exactly zero. This is purely for convenience since there exists some κ strictly bigger than zero for which all results would be close (e.g. within the numeric accuracy of GAUSS) to the reported results.

Significance levels for the reported correlations have thus been computed by running regression A3.1 and testing for β being different from zero using the consistent

---

25 See Appendix 2 for a description of the filter.

Newey–West estimator of the variance of $\hat{\beta}$. The Newey–West estimator is used since the residuals are not assumed to be spherical. In addition to the likely presence of non–spherical disturbances before filtering, the filtering procedure will introduce autocorrelation even if the original residual covariance matrix is diagonal.

We have compared the two methods of computing significance levels. The first method sometimes gives unreasonable results for sub–samples. We also find that the first method on average rejects zero correlation less frequently. For the full sample the first method rejects 165 of 840 contemporaneous correlations being zero on the 10% level. Reassuringly, all of these where also significantly different from zero according to the second method. But the second method yields another 240 significant correlations, totaling 405 (Table 4.2). Since the first method includes more noise than the second, it seems reasonable that its power is lower.

Given the discussion above, it is obvious that the reported significance levels must be interpreted with caution. This point is further strengthened by the fact that we don't know the small–sample behavior of the Newey–West covariance estimator in this case.

A3.2 Whittaker–Henderson filtered data

A Whittaker–Henderson filtered series includes spectral power at all frequencies. Therefore the problem of deterministic processes discussed above does not arise. Granger–causality tests between Whittaker–Henderson filtered series are still problematic, however, for the reason discussed in Section 5.2.

By filtering out virtually all of the lowest frequencies the Whittaker–Henderson filter typically introduces autocorrelation in the filtered series. All significance tests involving these series in the paper therefore rely on covariance matrices that have been recomputed with the Newey–West method.

TABLES

Table 3.1 Correlations with GDP

Band-pass filtered data

	t-1	t	t+1
Private. Consumption (C)	-0.04	0.54	0.19
Inflation (Inf)	-0.25	-0.16	-0.04

Table 4.1 General Statistics

	Std. Dev. %	Rel. Std. Dev.	Correlation* with reference t-1***	t	t+1	Average Sq. Coh.	Average Time Shift
Nominal and Financial Variables							
GDP Defl. (Py)	3.22	1.90	0.04	-0.13	-0.17	0.09	-0.25
Inflation (Inf)	3.42	2.02	-0.25	-0.16	-0.04	0.08	-1.52
Nom. GDP (Ynom)	3.44	2.03	0.14	0.37	-0.05	0.23	-0.18
Money (M2)	3.53	2.09	0.08	0.23	0.02	0.07	-0.64
Real Money (M2/Py)	3.84	2.27	-0.02	0.27	0.23	0.10	-0.09
Discount Rate (R)	0.45	0.27	0.06	0.16	0.21	0.08	-0.30
Interest Rate (R2)	0.54	0.32	-0.02	0.01	0.17	0.06	-1.61
Real Disc. (R-Infl)	3.48	2.06	0.25	0.16	0.06	0.08	0.80
Real Int. (R2-Infl)	3.51	2.07	0.24	0.19	0.09	0.07	0.81
GDP Components							
GDP (Y)	1.70	1.00	0.22	1.00	0.22	.	.
Priv. Cons. (C)	2.23	1.31	-0.04	0.58	0.19	0.44	-0.11
Public Cons. (G)	2.88	1.70	0.34	0.07	-0.16	0.11	0.92
Investments (I)	6.90	4.07	0.20	0.55	0.04	0.33	0.06
Exports (X)	6.43	3.80	0.19	0.48	-0.15	0.39	0.18
Imports (M)	10.19	6.01	0.08	0.30	-0.05	0.18	0.07
Rel. Price C (Pc/Py)	1.50	0.89	0.33	-0.03	-0.23	0.13	1.42
Rel. Price I (Pi/Py)	2.32	1.37	-0.22	-0.03	0.06	0.04	-1.06
Rel. Price X (Px/Py)	3.18	1.88	-0.04	0.21	0.12	0.07	-0.21
Rel. Price M (Pm/Py)	3.27	1.93	0.09	0.17	0.06	0.04	0.18
Manufacturing and Labor Market Variables							
Manuf. Prod. (Yman)	3.70	2.18	0.30	0.56	0.11	0.34	0.16
Rel. Pr. Yman (Pman/Py)**	1.97	0.53	-0.20	-0.09	0.07	0.06	-1.67
Wage Rate (W)**	3.95	1.07	0.21	0.14	-0.09	0.05	0.75
Real Wage (W/Pman)**	3.22	0.87	0.15	0.22	0.09	0.05	0.16
Real Cons. W (W/Pc)**	2.47	0.67	-0.03	0.32	0.25	0.12	-0.21
Wage Cost (Wc)**	4.07	1.10	0.21	0.14	-0.06	0.05	0.54
Real Wc (Wc/Pman)**	3.25	0.88	0.15	0.21	0.13	0.04	0.11
Hours Manuf. (H)**	2.97	0.80	0.26	0.30	-0.01	0.16	0.00
Workers (N)**	2.63	0.71	0.24	0.31	-0.03	0.14	0.03
Hours per Worker (H/N)**	1.52	0.41	0.09	0.06	0.06	0.07	0.20
Productivity (Pr)**	4.00	1.08	0.13	0.72	0.34	0.54	-0.07
Wage Share (Wshare)**	2.71	0.73	-0.04	-0.60	-0.24	0.44	1.46
Unemployment (U)**	1.03	0.28	-0.14	-0.15	0.13	0.16	-0.44
International Variables							
Current Account (Ca)	1.32	0.78	-0.01	-0.01	0.01	0.05	-0.25
Net Export (Nx)	1.45	0.85	0.02	0.04	-0.03	0.04	0.07
Terms of Trade (Tot)	2.36	1.39	-0.19	0.05	0.08	0.05	-0.85
Foreign Demand (Fy)	1.63	0.96	0.32	0.23	-0.11	0.09	0.39
Output U.K. (Uk)	1.76	1.04	0.31	-0.05	-0.35	0.13	0.88
Output Denmark (Dk)	2.28	1.35	-0.10	0.30	0.16	0.19	0.05
Output Norway (No)	2.06	1.21	0.12	0.39	-0.16	0.33	0.09
Output Germany (Ge)	5.45	3.22	0.27	0.16	0.04	0.05	-0.11
Output France (Fr)	2.78	1.64	-0.19	-0.05	-0.05	0.10	-0.19
Output US (US)	3.25	1.92	0.28	0.35	0.02	0.09	0.58

* *Correlation with GDP except for variables marked with ***

** *Correlation with Manufacturing Production*

*** *The series is leading reference with 1 year (corr{ref(t),series(t-1)})*

**** *Black cell represents at least 10 % significance*

Table 4.2 Contemperaneous Correlation Matrix, Full Sample

	Py	Inf	Ynom	M2	M2/Py	R	R2	R-Inf	R2-Inf	Y	C	G	I	X	M	Pc/Py	Pi/Py	Px/Py	Pm/Py	Yman	Pman	W	W/Pm	W/Pc	Wc	Wc/P	H	N	H/N	Pr	Wshare	U	Ca	Nx	Tot	Fy	Uk	Dk	No	Ge	Fr	Us
GDP Defl. (Py)	1.00	0.53	0.67	0.31	-0.57	0.22	0.23	-0.49	-0.49	-0.13	0.25	-0.35	0.34	-0.16	0.33	0.01	-0.29	0.33	0.35	0.00	-0.15	0.80	0.08	-0.03	0.81	0.09	0.43	0.56	-0.23	-0.25	0.33	-0.46	-0.59	-0.64	-0.03	0.09	0.14	-0.19	0.09	-0.03	0.12	0.09
Inflation (Inf)		1.00	0.42	0.06	-0.37	-0.07	0.04	-0.99	-0.99	-0.16	0.17	-0.47	0.05	-0.00	0.19	-0.24	0.07	0.48	0.53	-0.21	0.12	0.01	-0.59	-0.53	0.03	-0.57	0.51	0.43	0.22	-0.55	0.11	-0.74	-0.27	-0.31	-0.08	0.06	0.34	-0.00	-0.02	-0.25	0.16	0.16
Nom. GDP (Ynom)			1.00	0.40	-0.40	0.26	0.22	-0.37	-0.37	0.37	0.52	-0.29	0.59	0.09	0.46	-0.00	-0.26	0.42	0.41	0.28	-0.10	0.75	0.10	0.06	0.76	0.14	0.56	0.71	-0.20	-0.10	0.22	-0.50	-0.55	-0.58	-0.00	0.19	0.11	-0.04	0.25	0.05	0.09	0.25
Money (M2)				1.00	0.59	0.15	0.13	-0.06	-0.04	0.23	0.16	-0.31	0.51	-0.13	0.19	0.14	-0.23	0.37	0.23	0.06	0.20	0.35	-0.00	0.06	0.39	0.02	0.31	0.28	0.00	-0.10	0.10	-0.07	-0.42	-0.41	0.22	0.01	-0.13	0.06	0.07	-0.00	0.06	-0.01
Real Money (M2/Py)					1.00	-0.07	-0.06	0.36	0.36	0.27	-0.10	-0.01	0.07	-0.03	-0.13	0.16	-0.02	0.03	-0.06	0.03	0.28	-0.37	-0.07	0.05	-0.33	-0.04	-0.10	-0.26	0.19	0.15	-0.21	0.33	0.12	0.15	0.14	-0.06	-0.25	0.23	-0.01	0.02	-0.04	-0.09
Discount Rate (R)						1.00	0.88	0.20	0.21	0.16	0.20	0.09	0.21	-0.14	0.10	-0.03	-0.05	0.06	0.08	0.19	-0.13	0.33	0.26	0.25	0.33	0.27	0.09	0.24	-0.20	0.09	0.11	-0.11	-0.40	-0.34	-0.02	-0.06	-0.27	-0.03	-0.07	0.05	0.05	0.01
Interest Rate (R2)							1.00	0.07	0.11	0.01	0.11	-0.02	0.11	-0.18	0.08	-0.08	-0.10	0.15	0.09	0.09	-0.02	0.29	0.14	0.21	0.26	0.12	0.11	0.24	-0.19	0.00	0.08	-0.09	-0.34	-0.32	0.08	-0.10	-0.23	-0.09	-0.06	0.02	-0.02	-0.02
Real Disc. (R-Infl)								1.00	1.00	0.18	-0.14	0.48	-0.02	-0.01	-0.17	0.23	-0.07	-0.46	-0.51	0.23	-0.13	0.03	0.61	0.56	0.01	0.60	-0.49	-0.39	-0.24	0.55	-0.10	0.73	0.21	0.28	0.08	-0.07	-0.37	0.00	0.01	0.25	-0.15	-0.16
Real Int. (R2-Infl)									1.00	0.19	-0.16	0.46	-0.01	-0.03	-0.17	0.26	-0.11	-0.45	-0.50	0.23	-0.13	0.04	0.62	0.56	0.02	0.60	-0.48	-0.36	-0.25	0.55	-0.10	0.73	0.21	0.25	0.08	-0.07	-0.36	0.00	0.03	0.25	-0.16	-0.15
GDP (Y)										1.00	0.56	0.07	0.55	0.48	0.30	-0.03	-0.03	0.21	0.17	0.56	0.09	-0.01	0.06	0.17	0.06	0.12	0.36	0.39	0.02	0.29	-0.18	-0.13	-0.01	0.04	0.05	0.23	-0.05	0.30	0.39	0.18	-0.06	0.35
Priv. Cons. (C)											1.00	-0.18	0.46	0.44	0.67	-0.49	-0.13	0.06	0.00	0.34	-0.09	0.20	0.05	0.29	0.23	0.08	0.39	0.51	-0.10	0.03	0.04	-0.46	-0.46	-0.40	0.08	-0.06	-0.22	0.44	0.50	-0.20	0.25	0.11
Public Cons. (G)												1.00	-0.21	-0.04	-0.15	0.32	-0.12	-0.37	-0.10	0.06	-0.39	-0.03	0.54	0.20	0.01	0.59	-0.51	-0.48	-0.05	0.37	0.08	0.46	0.03	0.15	-0.36	-0.12	-0.22	-0.12	-0.02	0.15	-0.35	-0.14
Investments (I)													1.00	0.15	0.47	0.07	-0.24	0.08	0.07	0.23	-0.08	0.36	0.15	0.08	0.40	0.15	0.55	0.55	-0.08	-0.17	0.29	-0.48	-0.57	-0.47	0.01	0.36	0.17	0.30	0.29	0.15	0.14	0.30
Exports (X)														1.00	0.59	-0.24	-0.07	-0.13	-0.09	0.29	-0.10	-0.15	0.05	0.12	-0.13	0.04	0.16	0.18	0.04	0.14	-0.10	-0.14	0.11	0.17	-0.04	-0.06	0.04	0.20	0.63	-0.42	0.40	-0.04
Imports (M)															1.00	-0.15	-0.32	-0.07	0.01	0.14	-0.21	0.34	0.21	0.20	0.35	0.23	0.27	0.43	-0.19	-0.08	0.22	-0.33	-0.65	-0.63	-0.11	-0.02	-0.09	0.38	0.58	-0.30	0.46	-0.08
Rel. Price C (Pc/Py)																1.00	-0.37	-0.04	0.31	-0.16	-0.23	0.15	0.31	-0.38	0.16	0.39	-0.18	-0.16	-0.04	-0.01	0.29	0.30	-0.09	-0.17	-0.49	0.06	0.11	-0.27	-0.11	0.18	-0.27	-0.02
Rel. Price I (Pi/Py)																	1.00	0.11	-0.10	-0.16	0.48	-0.35	-0.44	0.03	-0.35	-0.53	-0.14	-0.19	0.14	-0.15	-0.22	-0.03	0.35	0.36	0.28	-0.07	-0.02	0.05	-0.38	-0.04	0.07	-0.04
Rel. Price X (Px/Py)																		1.00	0.73	0.09	0.46	0.14	-0.44	-0.18	0.23	-0.39	0.36	0.38	0.01	-0.13	-0.16	-0.25	-0.00	-0.06	0.33	0.07	0.09	-0.12	-0.10	0.05	-0.20	0.20
Rel. Price M (Pm/Py)																			1.00	-0.06	0.12	0.12	-0.28	-0.45	0.21	-0.20	0.24	0.28	-0.03	-0.19	0.01	-0.35	-0.16	-0.24	-0.40	0.03	0.19	-0.12	-0.06	-0.03	-0.26	0.22
Manuf. Prod. (Yman)																				1.00	-0.09	0.14	0.22	0.32	0.14	0.21	0.30	0.31	0.06	0.72	-0.60	-0.15	0.09	0.14	0.21	0.30	0.05	0.06	0.23	0.23	0.09	0.39
Rel. Pr. Yman (Pman/Py)																					1.00	-0.19	-0.69	0.04	-0.16	-0.68	0.08	0.04	0.00	-0.13	-0.36	0.04	0.25	0.24	0.45	0.06	0.09	-0.07	-0.20	0.14	-0.07	-0.03
Wage Rate (W)																						1.00	0.54	0.46	0.99	0.53	0.11	0.34	-0.47	0.10	0.31	0.01	-0.56	-0.56	0.03	-0.03	-0.18	-0.20	0.14	0.07	0.05	-0.11
Real Wage (W/Pman)																							1.00	0.56	0.50	0.96	-0.34	-0.16	-0.36	0.45	0.28	0.44	-0.26	-0.22	-0.21	-0.18	-0.41	-0.01	0.22	0.03	-0.02	-0.21
Real Cons. W (W/Pc)																								1.00	0.46	0.54	-0.29	-0.08	-0.47	0.52	-0.09	0.43	-0.10	0.00	0.35	-0.22	-0.57	0.09	0.21	0.06	0.08	-0.31
Wage Cost (Wc)																									1.00	0.53	0.12	0.38	-0.47	0.09	0.31	0.02	-0.56	-0.60	0.03	-0.06	-0.19	-0.20	0.11	0.06	0.04	-0.14
Real Wc (Wc/Pman)																										1.00	-0.34	-0.15	-0.35	0.45	0.29	0.44	-0.29	-0.27	-0.26	-0.22	-0.44	-0.02	0.19	0.01	-0.02	-0.26
Hours Manuf. (H)																											1.00	0.67	0.42	-0.42	0.19	-0.88	-0.25	-0.25	0.17	0.48	0.47	0.24	0.20	0.10	0.15	0.48
Workers (N)																												1.00	-0.04	-0.31	0.22	-0.80	-0.41	-0.43	0.13	0.42	0.33	0.26	0.30	0.10	0.14	0.40
Hours per Worker (H/N)																													1.00	-0.29	0.03	-0.20	0.23	0.28	0.06	0.23	0.34	0.09	-0.08	0.00	0.09	0.22
Productivity (Pr)																														1.00	-0.71	0.56	0.26	0.27	0.06	-0.05	-0.30	-0.09	0.09	0.16	-0.02	0.02
Wage Share (Wshare)																															1.00	-0.05	-0.45	-0.45	-0.23	-0.09	-0.01	0.06	0.05	-0.13	-0.01	-0.21
Unemployment (U)																																1.00	0.36	0.39	0.12	-0.32	-0.41	-0.37	-0.24	0.11	-0.23	-0.46
Current Account (Ca)																																	1.00	0.96	0.20	0.12	0.17	-0.17	-0.16	0.19	-0.29	0.16
Net Export (Nx)																																		1.00	0.26	0.09	0.14	-0.17	-0.15	0.15	-0.24	0.12
Terms of Trade (Tot)																																			1.00	0.06	-0.12	-0.02	-0.03	0.10	0.09	-0.01
Foreign Demand (Fy)																																				1.00	0.74	0.25	-0.01	0.75	-0.12	0.71
Output U.K. (Uk)																																					1.00	-0.11	-0.12	0.34	-0.09	0.54
Output Denmark (Dk)																																						1.00	0.30	0.05	0.25	0.18
Output Norway (No)																																							1.00	-0.33	0.32	-0.03
Output Germany (Ge)																																								1.00	-0.49	0.51
Output France (Fr)																																									1.00	-0.34
Output US (US)																																										1.00

* *Black cell represents at least 10 % significance*

Table 4.3 Contemperaneous Correlation Matrix, Pre-war

	Py	Inf	Yno	M2	M2/Py	R	R2	R-Inf	R2-Inf	Y	C	G	I	X	M	Pc/Py	Pi/Py	Px/Py	Pm/Py	Yman	Pman	W	W/Pm	W/Pc	Wc	Wc/P	H	N	H/N	Pr	Wshare	U	Ca	Nx	Tot	Fy	Uk	Dk	No	Ge	Fr	Us
GDP Defl. (Py)	1.00	0.52	0.87	0.65	-0.08	-0.03	-0.00	-0.46	-0.46	-0.09	0.09	-0.85	0.44	-0.36	0.45	0.32	-0.49	0.43	0.26	0.01	0.09	0.86	-0.17	-0.26	0.91	-0.15	0.73	0.70	0.01	-0.33	0.32	-0.99	-0.61	-0.71	0.15	0.77	0.51	-0.34	0.02	0.74	0.29	0.38
Inflation (Inf)		1.00	0.49	0.31	-0.03	-0.62	-0.58	-1.00	-0.99	0.03	-0.10	-0.55	0.10	-0.16	0.04	0.43	-0.08	0.69	0.68	-0.27	0.30	0.16	-0.65	-0.74	0.28	-0.60	0.45	0.31	0.31	-0.47	0.25	0.84	0.00	-0.21	-0.12	0.28	0.45	-0.43	-0.12	0.15	-0.27	0.11
Nom. GDP (Ynom)			1.00	0.66	0.01	0.19	0.07	-0.43	-0.41	0.42	0.44	-0.73	0.69	-0.14	0.56	0.41	-0.26	0.51	0.37	0.09	0.05	0.74	-0.15	-0.32	0.65	-0.08	0.76	0.74	0.14	-0.34	0.37	-0.99	-0.63	-0.67	0.09	0.70	0.41	-0.21	0.09	0.73	0.22	0.52
Money (M2)				1.00	0.69	0.05	0.13	-0.28	-0.25	0.24	0.28	-0.79	0.66	-0.18	0.57	0.15	-0.46	0.47	0.06	0.03	0.28	0.66	-0.14	0.04	0.69	-0.16	0.55	0.50	0.07	-0.23	0.18	-1.00	-0.57	-0.53	0.47	0.42	0.14	-0.12	0.41	0.50	0.23	0.21
Real Money (M2/Py)					1.00	0.03	0.19	0.03	0.06	0.18	0.18	-0.24	0.20	-0.06	0.17	-0.03	-0.34	0.11	-0.06	-0.00	0.20	0.04	-0.00	0.26	0.07	-0.03	0.03	-0.15	0.06	0.07	-0.12	-0.88	-0.15	-0.10	0.16	-0.18	-0.31	0.16	0.51	-0.04	0.00	-0.06
Discount Rate (R)						1.00	0.71	0.69	0.67	0.44	0.53	0.16	0.34	0.08	0.24	-0.06	0.05	-0.40	-0.26	0.39	-0.32	0.22	0.56	0.40	0.20	0.56	-0.05	0.03	-0.10	0.34	-0.10	-0.99	-0.38	-0.24	-0.09	0.07	-0.29	0.20	-0.09	0.39	0.42	0.26
Interest Rate (R2)							1.00	0.62	0.66	0.15	0.40	-0.04	0.23	-0.01	0.30	-0.31	-0.07	-0.32	-0.38	0.32	-0.25	0.23	0.49	0.53	0.09	0.44	-0.07	0.01	-0.10	0.33	-0.19	-0.20	-0.31	-0.27	0.13	-0.03	-0.27	0.32	0.03	0.18	0.33	0.09
Real Disc. (R-Infl)								1.00	0.99	0.03	0.15	0.53	-0.06	0.16	-0.01	-0.41	0.09	-0.68	-0.66	0.30	-0.32	-0.12	0.67	0.73	-0.23	0.62	-0.42	-0.26	-0.29	0.47	-0.25	-0.73	-0.05	0.17	0.10	-0.25	-0.45	0.42	0.10	-0.09	0.30	-0.06
Real Int. (R2-Infl)									1.00	0.02	0.13	0.47	-0.01	0.10	-0.00	-0.36	0.02	-0.67	-0.64	0.30	-0.33	-0.09	0.69	0.72	-0.22	0.61	-0.41	-0.24	-0.32	0.47	-0.26	-0.60	-0.06	0.11	0.06	-0.24	-0.44	0.45	0.13	-0.10	0.30	-0.09
GDP (Y)										1.00	0.72	0.10	0.58	0.38	0.29	0.22	0.37	0.24	0.26	0.15	-0.05	-0.10	0.02	-0.14	0.13	0.18	0.31	0.21	0.32	-0.12	0.23	-1.00	-0.26	-0.04	-0.08	0.10	-0.09	0.23	0.19	0.22	-0.08	0.46
Priv. Cons. (C)											1.00	-0.05	0.50	0.16	0.63	-0.11	0.01	0.05	-0.07	0.17	-0.27	0.10	0.22	0.09	0.20	0.33	0.35	0.31	0.27	-0.12	0.29	-0.96	-0.60	-0.43	0.16	0.09	-0.13	0.06	0.33	0.18	0.16	0.36
Public Cons. (G)												1.00	-0.43	0.33	-0.46	-0.32	0.54	-0.42	-0.28	0.14	-0.19	-0.68	0.29	0.34	-0.73	0.35	-0.74	-0.65	-0.12	0.47	-0.38	0.64	0.57	0.66	-0.10	-0.56	-0.43	0.21	-0.25	-0.47	-0.20	-0.20
Investments (I)													1.00	-0.02	0.50	0.10	-0.03	0.27	0.05	0.01	0.14	0.49	-0.00	0.06	0.62	-0.05	0.56	0.49	0.04	-0.39	0.42	-0.89	-0.75	-0.45	0.24	0.52	0.27	-0.12	0.26	0.60	0.21	0.19
Exports (X)														1.00	0.26	-0.31	0.42	-0.29	-0.29	0.11	-0.07	-0.35	0.04	0.14	-0.33	-0.01	0.16	-0.01	0.45	-0.12	0.15	0.77	0.46	0.57	0.06	0.06	0.30	0.06	0.14	-0.27	-0.09	0.07
Imports (M)															1.00	-0.07	-0.32	0.07	-0.26	0.11	-0.12	0.50	0.14	0.09	0.53	0.18	0.62	0.67	0.19	-0.29	0.42	-0.74	-0.70	-0.57	0.43	0.60	0.37	-0.14	0.47	0.44	0.43	0.20
Rel. Price C (Pc/Py)																1.00	-0.17	0.39	0.75	-0.12	-0.02	0.19	-0.14	-0.67	0.41	0.12	0.01	0.26	-0.37	-0.02	0.10	-0.82	-0.20	-0.38	-0.55	0.23	0.03	0.06	-0.17	0.42	-0.02	0.19
Rel. Price I (Pi/Py)																	1.00	-0.04	0.01	-0.09	0.29	-0.47	-0.22	0.07	-0.46	-0.44	-0.30	-0.21	0.03	-0.11	-0.06	0.99	0.46	0.54	-0.06	-0.14	0.09	0.23	-0.50	-0.14	-0.44	0.04
Rel. Price X (Px/Py)																		1.00	0.66	-0.04	0.41	0.22	-0.54	-0.46	0.51	-0.42	0.46	0.41	0.16	-0.26	0.07	-0.47	-0.15	-0.21	0.23	0.34	0.35	-0.20	-0.04	0.33	-0.26	0.19
Rel. Price M (Pm/Py)																			1.00	-0.21	0.13	-0.02	-0.44	-0.77	0.22	-0.26	0.09	0.16	-0.06	-0.17	0.09	1.00	0.19	-0.19	-0.55	-0.06	0.07	-0.11	-0.43	0.11	-0.63	0.21
Manuf. Prod. (Yman)																				1.00	-0.37	0.20	0.51	0.34	0.20	0.52	0.17	0.05	0.29	0.76	-0.64	-0.67	-0.02	0.06	0.23	0.16	-0.06	-0.05	0.03	0.12	0.46	0.42
Rel. Pr. Yman (Pman/Py)																					1.00	0.06	-0.74	-0.02	0.16	-0.63	0.12	0.06	-0.01	-0.38	0.04	0.01	0.11	0.13	0.30	0.26	0.30	0.04	0.01	0.26	-0.18	-0.18
Wage Rate (W)																						1.00	0.19	0.19	0.99	0.13	0.61	0.61	-0.14	-0.11	0.20	-1.00	-0.67	-0.57	0.27	0.74	0.37	-0.25	0.14	0.62	0.40	0.37
Real Wage (W/Pman)																							1.00	0.60	0.06	0.99	-0.19	-0.11	-0.20	0.56	-0.16	-0.99	-0.22	-0.10	-0.04	-0.16	-0.36	0.06	0.14	-0.03	0.30	0.17
Real Cons. W (W/Pc)																								1.00	0.07	0.60	-0.16	-0.21	-0.12	0.43	-0.27	-0.45	-0.12	0.18	0.46	-0.05	-0.23	0.12	0.34	0.06	0.29	-0.06
Wage Cost (Wc)																									1.00	0.09	0.60	0.73	-0.16	-0.11	0.18	-1.00	-0.65	-0.72	0.33	0.73	0.37	-0.25	0.11	0.63	0.34	0.39
Real Wc (Wc/Pman)																										1.00	-0.19	-0.08	-0.20	0.57	-0.19	-1.00	-0.22	-0.22	-0.19	-0.16	-0.36	0.06	0.10	-0.01	0.27	0.21
Hours Manuf. (H)																											1.00	0.69	0.55	-0.46	0.47	0.10	-0.40	-0.37	0.41	0.67	0.57	-0.06	0.32	0.26	0.29	0.32
Workers (N)																												1.00	0.18	-0.51	0.56	-0.93	-0.59	-0.56	0.25	0.76	0.57	-0.01	0.29	0.47	0.36	0.30
Hours per Worker (H/N)																													1.00	-0.19	0.12	1.00	0.15	0.26	0.25	0.07	0.25	-0.12	0.10	-0.30	0.01	0.15
Productivity (Pr)																														1.00	-0.91	-0.61	0.22	0.19	-0.10	-0.26	-0.42	0.01	-0.15	-0.01	0.23	0.18
Wage Share (Wshare)																															1.00	0.21	-0.37	-0.34	-0.01	0.25	0.34	0.01	0.21	0.02	-0.13	-0.09
Unemployment (U)																																1.00	0.98	0.98	-0.79	-0.91	0.87	-0.35	-0.99	-0.98	-0.98	-0.98
Current Account (Ca)																																	1.00	0.96	-0.35	-0.40	-0.04	0.15	-0.26	-0.52	-0.47	-0.11
Net Export (Nx)																																		1.00	0.01	-0.41	-0.06	0.16	-0.17	-0.60	-0.37	-0.16
Terms of Trade (Tot)																																			1.00	0.46	0.33	-0.13	0.37	0.27	0.30	0.02
Foreign Demand (Fy)																																				1.00	0.60	-0.10	0.03	0.66	0.49	0.30
Output U.K. (Uk)																																					1.00	-0.25	-0.14	0.24	0.08	0.17
Output Denmark (Dk)																																						1.00	0.24	-0.23	0.13	-0.07
Output Norway (No)																																							1.00	-0.16	0.19	-0.07
Output Germany (Ge)																																								1.00	0.35	0.32
Output France (Fr)																																									1.00	-0.06
Output US (US)																																										1.00

* *Shaded entry represents at least 10 % significance*

Table 4.4 Contemperaneous Correlation Matrix, Inter-war

	Py	Inf	Yno	M2	M2/Py	R	R2	R-Inf	R2-Inf	Y	C	G	I	X	M	Pc/Py	Pi/Py	Px/Py	Pm/Py	Yman	Pman/
GDP Defl. (Py)	1.00	0.50	0.86	0.15	-0.95	0.60	0.64	-0.47	-0.47	-0.23	0.50	-0.34	0.17	-0.15	0.56	-0.41	0.04	0.09	0.27	0.03	-0.35
Inflation (Inf)		1.00	0.32	-0.26	-0.58	0.07	0.28	-1.00	-1.00	-0.35	0.51	-0.67	0.15	0.17	0.54	-0.73	0.22	0.40	0.70	-0.26	-0.11
Nom. GDP (Ynom)			1.00	0.20	-0.80	0.42	0.35	-0.30	-0.31	0.29	0.74	-0.22	0.55	0.21	0.67	-0.41	-0.15	-0.00	0.13	0.51	-0.38
Money (M2)				1.00	0.17	0.18	0.03	0.27	0.27	0.09	0.12	-0.31	-0.02	-0.27	0.06	-0.03	0.54	0.29	-0.19	0.06	0.12
Real Money (M2/Py)					1.00	-0.55	-0.64	0.55	0.55	0.26	-0.46	0.24	-0.18	0.06	-0.54	0.41	0.13	0.00	-0.33	-0.01	0.39
Discount Rate (R)						1.00	0.84	-0.00	-0.01	-0.33	-0.03	-0.20	-0.03	-0.55	-0.04	-0.11	0.02	-0.12	-0.06	-0.09	-0.31
Interest Rate (R2)							1.00	-0.25	-0.23	-0.54	-0.07	-0.38	-0.29	-0.48	-0.16	-0.22	0.06	0.24	0.29	-0.33	0.03
Real Disc. (R-Infl)								1.00	1.00	0.31	-0.51	0.66	-0.15	-0.20	-0.54	0.72	-0.22	-0.41	-0.70	0.26	0.09
Real Int. (R2-Infl)									1.00	0.30	-0.52	0.65	-0.17	-0.20	-0.56	0.72	-0.22	-0.39	-0.69	0.25	0.11
GDP (Y)										1.00	0.49	0.22	0.74	0.68	0.22	-0.01	-0.36	-0.18	-0.26	0.92	-0.06
Priv. Cons. (C)											1.00	-0.41	0.72	0.52	0.76	-0.74	0.11	0.10	0.21	0.55	-0.19
Public Cons. (G)												1.00	-0.08	-0.10	-0.24	0.80	-0.49	-0.63	-0.46	0.15	-0.14
Investments (I)													1.00	0.61	0.84	-0.39	-0.38	-0.28	-0.06	0.83	-0.47
Exports (X)														1.00	0.42	-0.32	-0.41	-0.03	-0.02	0.65	-0.11
Imports (M)															1.00	-0.47	-0.03	-0.11	0.07	0.34	-0.53
Rel. Price C (Pc/Py)																1.00	-0.36	-0.26	-0.33	-0.13	0.06
Rel. Price I (Pi/Py)																	1.00	0.40	0.10	-0.49	0.41
Rel. Price X (Px/Py)																		1.00	0.77	-0.33	0.68
Rel. Price M (Pm/Py)																			1.00	-0.35	0.36
Manuf. Prod. (Yman)																				1.00	-0.32
Rel. Pr. Yman (Pman/Py)																					1.00
Wage Rate (W)																					
Real Wage (W/Pman)																					
Real Cons. W (W/Pc)																					
Wage Cost (Wc)																					
Real Wc (Wc/Pman)																					
Hours Manuf. (H)																					
Workers (N)																					
Hours per Worker (H/N)																					
Productivity (Pr)																					
Wage Share (Wshare)																					
Unemployment (U)																					
Current Account (Ca)																					
Net Export (Nx)																					
Terms of Trade (Tot)																					
Foreign Demand (Fy)																					
Output U.K. (Uk)																					
Output Denmark (Dk)																					
Output Norway (No)																					
Output Germany (Ge)																					
Output France (Fr)																					
Output US (US)																					

	W	W/Pm	W/Pc	Wc	Wc/P	H	N	H/N	Pr	Wshar	U	Ca	Nx	Tot	Fy	Uk	Dk	No	Ge	Fr	Us
GDP Defl. (Py)	0.69	0.04	0.10	0.68	0.03	0.24	0.49	-0.42	-0.19	0.34	-0.42	-0.71	-0.71	-0.25	-0.12	0.08	-0.13	-0.07	-0.26	0.30	-0.09
Inflation (Inf)	-0.25	-0.80	-0.68	-0.26	-0.80	0.69	0.65	0.38	-0.65	0.28	-0.68	-0.49	-0.50	-0.42	0.15	0.53	0.54	0.25	-0.69	0.52	0.30
Nom. GDP (Ynom)	0.62	0.09	0.16	0.62	0.09	0.44	0.67	-0.27	0.13	-0.10	-0.44	-0.53	-0.48	-0.19	0.22	0.24	0.00	0.22	0.02	0.29	0.21
Money (M2)	0.32	0.24	0.37	0.33	0.24	-0.11	0.01	-0.29	0.16	0.06	0.10	-0.02	-0.06	0.70	-0.23	-0.46	0.15	-0.11	0.06	-0.14	-0.17
Real Money (M2/Py)	-0.56	0.04	0.01	-0.58	0.05	-0.27	-0.49	0.33	0.23	-0.31	0.44	0.70	0.68	0.47	0.04	-0.23	0.18	0.04	0.28	-0.34	0.03
Discount Rate (R)	0.54	0.23	0.21	0.55	0.23	-0.14	0.17	-0.71	0.03	0.26	-0.02	-0.34	-0.41	-0.09	-0.16	-0.06	-0.41	-0.36	-0.00	-0.10	-0.03
Interest Rate (R2)	0.50	0.01	0.14	0.50	0.01	-0.17	0.06	-0.60	-0.19	0.34	-0.06	-0.23	-0.31	-0.06	-0.25	-0.06	-0.35	-0.30	-0.21	0.14	-0.20
Real Disc. (R-Infl)	0.28	0.81	0.70	0.29	0.82	-0.71	-0.65	-0.43	0.65	-0.26	0.68	0.47	0.48	0.41	-0.16	-0.54	-0.57	-0.27	0.69	-0.52	-0.30
Real Int. (R2-Infl)	0.28	0.81	0.70	0.29	0.81	-0.71	-0.66	-0.42	0.85	-0.26	0.69	0.48	0.50	0.42	-0.17	-0.54	-0.57	-0.27	0.69	-0.52	-0.31
GDP (Y)	-0.11	0.11	0.12	-0.10	0.12	0.41	0.36	0.27	0.59	-0.85	-0.07	0.33	0.43	0.10	0.66	0.31	0.26	0.57	0.52	-0.01	0.57
Priv. Cons. (C)	0.07	-0.34	-0.13	0.07	-0.34	0.80	0.87	0.20	-0.12	-0.30	-0.75	-0.40	-0.32	-0.16	0.39	0.41	0.59	0.50	-0.22	0.41	0.49
Public Cons. (G)	0.21	0.67	0.38	0.21	0.67	-0.55	-0.56	-0.19	0.60	-0.06	0.68	0.04	0.13	-0.28	-0.17	-0.30	-0.65	-0.19	0.42	-0.50	-0.22
Investments (I)	-0.05	-0.06	-0.11	-0.05	-0.07	0.74	0.80	0.19	0.21	-0.49	-0.53	-0.14	-0.06	-0.27	0.77	0.62	0.38	0.39	0.36	0.07	0.75
Exports (X)	-0.37	-0.31	-0.28	-0.37	-0.31	0.64	0.45	0.66	0.15	-0.72	-0.38	0.31	0.41	-0.01	0.72	0.56	0.48	0.71	0.22	0.59	0.45
Imports (M)	0.13	-0.20	-0.25	0.12	-0.21	0.69	0.74	0.21	-0.25	0.10	-0.71	-0.68	-0.63	-0.27	0.24	0.31	0.44	0.37	-0.22	0.39	0.25
Rel. Price C (Pc/Py)	0.15	0.59	0.27	0.15	0.59	-0.71	-0.77	-0.18	0.46	0.06	0.80	0.25	0.24	0.09	-0.27	-0.44	-0.67	-0.19	0.42	-0.54	-0.35
Rel. Price I (Pi/Py)	-0.07	-0.29	0.00	-0.06	-0.29	-0.04	-0.02	-0.06	-0.46	0.38	-0.19	-0.22	-0.28	0.44	-0.55	-0.49	0.45	-0.09	-0.66	0.05	-0.28
Rel. Price X (Px/Py)	-0.19	-0.58	-0.30	-0.19	-0.58	0.21	0.13	0.24	-0.50	0.01	-0.29	0.21	0.11	0.36	0.00	0.08	0.43	0.28	-0.35	0.16	0.09
Rel. Price M (Pm/Py)	-0.21	-0.69	-0.53	-0.22	-0.69	0.39	0.33	0.30	-0.68	0.16	-0.51	-0.12	-0.17	-0.31	0.14	0.43	0.32	0.18	-0.47	0.07	0.32
Manuf. Prod. (Yman)	0.11	0.23	0.21	0.12	0.23	0.42	0.46	0.09	0.65	-0.79	-0.11	0.21	0.31	0.02	0.70	0.39	0.10	0.43	0.62	0.12	0.52
Rel. Pr. Yman (Pman/Py)	-0.18	-0.23	0.12	-0.18	-0.23	-0.24	-0.32	0.05	-0.12	-0.12	0.21	0.45	0.39	0.47	-0.28	-0.35	0.20	0.19	-0.24	-0.09	-0.19
Wage Rate (W)	1.00	0.71	0.74	1.00	0.70	-0.40	-0.08	-0.84	0.43	0.28	0.32	-0.44	-0.42	0.04	-0.41	-0.45	-0.62	-0.39	0.20	-0.13	-0.46
Real Wage (W/Pman)		1.00	0.86	0.72	1.00	-0.70	-0.49	-0.71	0.81	0.07	0.77	-0.02	0.02	0.13	-0.33	-0.57	-0.77	-0.50	0.61	-0.44	-0.49
Real Cons. W (W/Pc)			1.00	0.75	0.86	-0.62	-0.37	-0.79	0.73	0.01	0.66	0.04	0.07	0.33	-0.40	-0.65	-0.54	-0.45	0.45	-0.32	-0.53
Wage Cost (Wc)				1.00	0.71	-0.40	-0.08	-0.84	0.44	0.28	0.32	-0.42	-0.41	0.04	-0.40	-0.45	-0.62	-0.39	0.21	-0.14	-0.48
Real Wc (Wc/Pman)					1.00	-0.70	-0.49	-0.71	0.81	0.07	0.77	-0.01	0.03	0.14	-0.32	-0.56	-0.77	-0.51	0.62	-0.45	-0.49
Hours Manuf. (H)						1.00	0.92	0.58	-0.41	-0.33	-0.93	-0.19	-0.17	-0.26	0.69	0.77	0.77	0.61	-0.21	0.44	0.77
Workers (N)							1.00	0.22	-0.30	-0.21	-0.90	-0.38	-0.36	-0.28	0.59	0.66	0.61	0.43	-0.15	0.34	0.70
Hours per Worker (H/N)								1.00	-0.39	-0.37	-0.45	0.28	0.32	-0.07	0.50	0.55	0.65	0.63	-0.21	0.40	0.46
Productivity (Pr)									1.00	-0.53	0.66	0.39	0.46	0.24	0.14	-0.24	-0.53	-0.08	0.81	-0.26	-0.10
Wage Share (Wshare)										1.00	-0.00	-0.66	-0.74	-0.21	-0.71	-0.41	-0.21	-0.62	-0.48	-0.21	-0.54
Unemployment (U)											1.00	0.43	0.43	0.31	-0.42	-0.64	-0.75	-0.45	0.50	-0.46	-0.59
Current Account (Ca)												1.00	0.98	0.48	0.36	0.10	0.00	0.17	0.50	-0.01	0.13
Net Export (Nx)													1.00	0.41	0.40	0.13	-0.01	0.22	0.52	0.04	0.14
Terms of Trade (Tot)														1.00	-0.19	-0.51	0.18	0.16	0.15	0.12	-0.33
Foreign Demand (Fy)															1.00	0.85	0.34	0.47	0.46	0.17	0.65
Output U.K. (Uk)																1.00	0.35	0.35	0.13	0.27	0.82
Output Denmark (Dk)																	1.00	0.57	-0.43	0.39	0.46
Output Norway (No)																		1.00	-0.16	0.53	0.45
Output Germany (Ge)																			1.00	-0.35	0.17
Output France (Fr)																				1.00	-0.06
Output US (US)																					1.00

• *Black cell represents at least 10 % significance*

Table 4.5 Contemperaneous Correlation Matrix, Post-war

	Py	Inf	Ynom	M2	M2/Py	R	R2	R-Inf	R2-Inf	Y	C	G	I	X	M	Pc/Py	Pi/Py	Px/Py	Pm/Py	Ymen	Pman/
GDP Defl. (Py)	1.00	0.88	0.79	-0.13	-0.56	0.20	0.26	-0.54	-0.52	-0.19	-0.06	0.04	-0.15	-0.18	0.15	-0.72	0.49	0.42	0.17	-0.01	-0.18
Inflation (Inf)		1.00	0.66	-0.06	-0.31	0.22	0.30	-0.96	-0.92	0.23	0.23	-0.41	-0.07	0.27	0.55	-0.70	0.12	0.71	0.39	0.37	0.38
Nom. GDP (Ynom)			1.00	0.26	-0.13	0.36	0.37	-0.59	-0.57	0.44	0.19	-0.04	0.13	0.10	0.38	-0.70	0.44	0.80	0.55	0.51	0.23
Money (M2)				1.00	0.90	0.15	0.08	0.11	0.09	0.62	0.51	-0.15	0.52	0.14	0.31	-0.09	0.05	0.43	0.42	0.39	0.57
Real Money (M2/Py)					1.00	0.04	-0.05	0.33	0.31	0.61	0.46	-0.14	0.50	0.19	0.19	0.25	-0.18	0.17	0.28	0.33	0.55
Discount Rate (R)						1.00	0.95	0.07	0.15	0.29	0.25	0.12	0.16	-0.09	0.23	-0.20	0.01	0.30	0.26	0.29	0.09
Interest Rate (R2)							1.00	-0.04	0.07	0.21	0.23	-0.03	0.16	-0.22	0.17	-0.23	-0.08	0.28	0.17	0.27	0.16
Real Disc. (R-Infl)								1.00	0.99	-0.15	-0.16	0.45	0.12	-0.30	-0.49	0.66	-0.12	-0.64	-0.33	-0.29	-0.36
Real Int. (R2-Infl)									1.00	-0.15	-0.15	0.51	0.14	-0.33	-0.48	0.62	-0.15	-0.64	-0.37	-0.27	-0.36
GDP (Y)										1.00	0.39	-0.13	0.43	0.42	0.38	-0.07	-0.01	0.67	0.64	0.84	0.63
Priv. Cons. (C)											1.00	-0.49	0.54	0.28	0.77	-0.53	-0.09	0.25	0.01	0.24	0.39
Public Cons. (G)												1.00	-0.37	-0.40	-0.50	0.33	0.08	-0.28	-0.06	-0.16	-0.39
Investments (I)													1.00	0.17	0.41	-0.13	-0.33	0.11	-0.05	0.32	0.10
Exports (X)														1.00	0.61	-0.23	0.23	0.40	0.41	0.42	0.17
Imports (M)															1.00	-0.69	0.16	0.45	0.24	0.36	0.33
Rel. Price C (Pc/Py)																1.00	-0.36	-0.47	-0.06	-0.20	-0.04
Rel. Price I (Pi/Py)																	1.00	0.38	0.48	0.09	-0.06
Rel. Price X (Px/Py)																		1.00	0.67	0.70	0.60
Rel. Price M (Pm/Py)																			1.00	0.65	0.59
Manuf. Prod. (Yman)																				1.00	0.45
Rel. Pr. Yman (Pman/Py)																					1.00

	W	W/Pm	W/Pc	Wc	Wc/P	H	N	H/N	Pr	Wshare	U	Ca	Nx	Tot	Fy	Uk	Dk	No	Ge	Fr	Us
GDP Defl. (Py)	0.86	0.20	0.56	0.78	0.16	-0.09	0.13	-0.40	0.06	0.12	0.01	-0.12	-0.14	0.55	-0.19	-0.38	-0.40	-0.14	-0.04	-0.05	0.17
Inflation (Inf)	0.28	-0.45	0.19	0.30	-0.45	0.43	0.60	-0.45	0.07	-0.33	-0.50	-0.20	-0.24	0.71	-0.02	-0.07	-0.32	-0.28	0.10	-0.00	0.22
Nom. GDP (Ynom)	0.73	-0.08	0.59	0.70	-0.06	0.23	0.50	-0.47	0.43	-0.29	-0.26	-0.31	-0.34	0.59	-0.16	-0.39	-0.29	-0.16	-0.04	-0.05	0.12
Money (M2)	0.06	-0.28	0.29	0.17	-0.19	-0.04	0.08	-0.13	0.54	-0.48	0.02	-0.49	-0.45	0.07	-0.36	-0.42	0.06	0.03	-0.41	0.02	-0.24
Real Money (M2/Py)	-0.34	-0.33	-0.01	-0.20	-0.22	0.00	0.00	0.07	0.42	-0.46	0.01	-0.35	-0.32	-0.19	-0.21	-0.18	0.23	0.09	-0.33	0.03	-0.28
Discount Rate (R)	0.30	0.07	0.33	0.33	0.11	0.52	0.60	-0.10	-0.10	0.17	-0.46	-0.58	-0.53	0.14	-0.10	-0.46	-0.07	-0.01	0.01	0.01	-0.10
Interest Rate (R2)	0.27	-0.07	0.23	0.25	-0.09	0.62	0.62	-0.19	-0.23	0.07	-0.60	-0.53	-0.53	0.26	-0.12	-0.36	-0.26	-0.04	0.07	-0.18	0.04
Real Disc. (R-Infl)	-0.20	0.48	-0.10	-0.21	0.49	-0.29	-0.45	0.43	-0.10	0.39	0.37	0.03	0.09	-0.68	-0.01	-0.07	0.30	0.27	-0.10	0.00	-0.26
Real Int. (R2-Infl)	-0.18	0.51	-0.06	-0.22	0.51	-0.23	-0.38	0.43	-0.15	0.40	0.32	-0.00	0.06	-0.64	-0.01	-0.10	0.28	0.32	-0.08	-0.01	-0.23
GDP (Y)	-0.10	-0.43	0.12	-0.01	-0.36	0.50	0.61	-0.15	0.61	-0.65	-0.43	-0.33	-0.33	0.14	0.04	-0.07	0.12	-0.05	-0.01	-0.02	-0.05
Priv. Cons. (C)	-0.08	-0.33	0.29	0.04	-0.22	0.26	0.33	-0.19	0.09	-0.23	-0.18	-0.75	-0.77	0.48	-0.52	-0.47	0.23	-0.03	-0.60	0.35	-0.40
Public Cons. (G)	0.36	0.60	0.26	0.40	0.66	-0.33	-0.34	0.45	0.10	0.46	0.41	0.09	0.17	-0.46	0.21	-0.11	-0.06	0.26	0.28	-0.02	-0.27
Investments (I)	-0.09	-0.05	0.12	-0.09	-0.06	0.18	0.23	-0.22	0.26	-0.20	-0.14	-0.39	-0.40	0.31	-0.25	-0.36	0.36	0.06	-0.41	0.00	-0.03
Exports (X)	-0.26	-0.24	-0.02	-0.26	-0.26	0.09	0.25	-0.11	0.46	-0.44	-0.07	0.07	0.09	0.06	0.18	0.17	0.46	0.20	-0.25	0.61	0.07
Imports (M)	0.06	-0.30	0.35	0.12	-0.28	0.21	0.46	-0.43	0.30	-0.35	-0.26	-0.63	-0.64	0.47	-0.24	-0.29	0.27	0.15	-0.46	0.54	-0.25
Rel. Price C (Pc/Py)	-0.59	0.01	-0.67	-0.56	0.03	-0.07	-0.31	0.40	-0.21	0.10	0.10	0.41	0.44	-0.60	0.31	0.48	0.06	-0.09	0.36	-0.36	0.08
Rel. Price I (Pi/Py)	0.53	0.17	0.43	0.46	0.13	-0.25	-0.09	-0.25	0.35	-0.12	0.18	-0.03	-0.03	-0.13	-0.15	-0.16	-0.13	0.09	-0.22	0.37	-0.06
Rel. Price X (Px/Py)	0.27	-0.51	0.21	0.34	-0.45	0.44	0.56	-0.32	0.49	-0.61	-0.41	-0.24	-0.25	0.38	-0.11	-0.18	-0.30	-0.31	-0.01	-0.06	0.17
Rel. Price M (Pm/Py)	0.10	-0.47	0.01	0.19	-0.40	0.32	0.38	-0.16	0.53	-0.62	-0.30	-0.12	-0.11	-0.11	0.01	-0.01	-0.27	-0.25	0.09	-0.06	0.12
Manuf. Prod. (Yman)	0.01	-0.34	0.14	0.01	-0.35	0.64	0.66	-0.11	0.69	-0.68	-0.58	-0.19	-0.21	0.20	0.24	0.01	0.06	0.08	0.17	-0.01	0.17
Rel. Pr. Yman (Pman/Py)	-0.28	-0.89	-0.17	-0.13	-0.76	0.40	0.43	-0.27	0.21	-0.76	-0.40	-0.34	-0.40	0.11	-0.18	0.05	-0.29	-0.27	0.01	-0.27	-0.07
Wage Rate (W)	1.00	0.51	0.84	0.91	0.47	-0.28	0.03	-0.29	0.24	0.24	0.20	-0.21	-0.19	0.36	-0.17	-0.56	-0.24	0.18	-0.10	0.08	-0.05
Real Wage (W/Pman)		1.00	0.50	0.37	0.92	-0.48	-0.41	0.25	0.03	0.71	0.49	0.15	0.23	-0.15	0.12	-0.28	0.29	0.47	-0.08	0.31	-0.11
Real Cons. W (W/Pc)			1.00	0.78	0.49	-0.23	0.10	-0.21	0.42	0.14	0.22	-0.44	-0.40	0.41	-0.23	-0.68	0.07	0.46	-0.35	0.40	-0.31
Wage Cost (Wc)				1.00	0.50	-0.19	0.07	-0.23	0.19	0.29	0.25	-0.39	-0.33	0.34	-0.37	-0.68	-0.31	0.02	-0.21	0.14	-0.34
Real Wc (Wc/Pman)					1.00	-0.44	-0.40	0.32	-0.02	0.80	0.56	-0.02	0.10	-0.17	-0.06	-0.42	0.22	0.34	-0.19	0.39	-0.40
Hours Manuf. (H)						1.00	0.84	-0.05	-0.12	-0.27	-0.64	-0.25	-0.29	0.28	0.04	0.05	-0.17	-0.32	0.23	-0.20	0.15
Workers (N)							1.00	-0.47	0.10	-0.33	-0.83	-0.41	-0.45	0.44	0.12	-0.03	-0.00	-0.11	0.18	-0.02	0.09
Hours per Worker (H/N)								1.00	-0.10	0.29	0.35	0.35	0.42	-0.36	0.11	0.00	0.06	0.08	0.06	0.04	-0.03
Productivity (Pr)									1.00	-0.61	0.06	-0.02	-0.02	-0.01	0.25	-0.05	0.29	0.43	-0.02	0.22	0.04
Wage Share (Wshare)										1.00	0.40	0.02	0.11	-0.08	-0.19	-0.31	0.03	0.00	-0.12	0.16	-0.30
Unemployment (U)											1.00	0.25	0.32	-0.28	-0.29	-0.29	0.11	0.28	-0.44	0.30	-0.36
Current Account (Ca)												1.00	0.96	-0.26	0.54	0.59	0.04	-0.01	0.42	-0.22	0.60
Net Export (Nx)													1.00	-0.31	0.52	0.53	0.06	0.00	0.39	-0.16	0.53
Terms of Trade (Tot)														1.00	-0.24	-0.35	-0.11	-0.15	-0.19	0.00	0.12
Foreign Demand (Fy)															1.00	0.72	0.37	0.29	0.60	-0.18	0.61
Output U.K. (Uk)																1.00	0.10	-0.11	0.69	-0.28	0.49
Output Denmark (Dk)																	1.00	0.44	-0.15	0.44	-0.02
Output Norway (No)																		1.00	-0.11	0.48	-0.18
Output Germany (Ge)																			1.00	-0.60	0.55
Output France (Fr)																				1.00	-0.47
Output US (US)																					1.00

- *Black cell represents at least 10 % significance*

Table 4.6 Standard Deviations for Sub-Samples

Nominal and Financial Variables

	Pre-war*		Inter-war		Post-war	
	Std.	Rel. Std.	Std.	Rel. Std.	Std.	Rel. Std.
GDP Defl. (Py)	2.91	1.83	4.57	1.90	1.77	1.47
Inflation (Inf)	2.74	1.72	6.03	2.51	2.18	1.82
Nom. GDP (Ynom)	3.19	2.00	4.64	1.93	1.94	1.61
Money (M2)	4.40	2.77	1.45	0.60	3.33	2.77
Real Money (M2/Py)	2.90	1.82	4.57	1.90	3.97	3.31
Discount Rate (R)	0.35	0.22	0.37	0.16	0.62	0.52
Interest Rate (R2)	0.29	0.18	0.38	0.16	0.83	0.69
Real Disc. (R-Infl)	2.97	1.87	6.02	2.50	2.14	1.78
Real Int. (R2-Infl)	2.90	1.83	5.95	2.47	2.18	1.81

GDP Components

GDP (Y)	1.59	1.00	2.41	1.00	1.20	1.00
Priv. Cons. (C)	1.62	1.02	2.58	1.07	1.11	0.93
Public Cons. (G)	2.67	1.68	4.03	1.67	1.95	1.62
Investments (I)	8.13	5.11	7.89	3.28	2.82	2.34
Exports (X)	4.23	2.66	5.91	2.46	3.39	2.82
Imports (M)	4.89	3.07	6.13	2.55	5.71	4.75
Rel. Price C (Pc/Py)	1.04	0.65	1.83	0.76	0.99	0.82
Rel. Price I (Pi/Py)	2.32	1.46	2.17	0.90	0.92	0.76
Rel. Price X (Px/Py)	2.71	1.70	3.45	1.43	3.47	2.89
Rel. Price M (Pm/Py)	3.15	1.98	3.36	1.40	3.22	2.68

Manufacturing and Labor Market Variables

Manuf. Prod. (Yman)	4.14	2.60	5.34	2.22	2.04	1.69
Rel. Pr. Yman (Pman/Py)	1.70	0.41	1.59	0.30	1.84	0.90
Wage Rate (W)	3.08	0.74	6.07	1.14	2.25	1.10
Real Wage (W/Pman)	2.35	0.57	4.53	0.85	2.42	1.19
Real Cons. W (W/Pc)	2.07	0.50	3.58	0.67	1.55	0.76
Wage Cost (Wc)	3.25	0.79	6.04	1.13	2.31	1.14
Real Wc (Wc/Pman)	2.26	0.55	4.54	0.85	2.33	1.14
Hours Manuf. (H)	3.47	0.84	4.46	0.84	1.47	0.72
Workers (N)	2.70	0.65	3.71	0.69	1.71	0.84
Hours per Worker (H/N)	1.74	0.42	1.78	0.33	0.93	0.46
Productivity (Pr)	5.02	1.21	5.34	1.00	1.58	0.77
Wage Share (Wshare)	3.34	0.81	2.01	0.38	1.95	0.96
Unemployment (U)	.	.	1.88	0.35	0.21	0.10

International Variables

Current Account (Ca)	1.02	0.64	1.26	0.53	0.81	0.67
Net Export (Nx)	1.19	0.75	1.43	0.60	0.79	0.66
Terms of Trade (Tot)	2.37	1.49	2.33	0.97	1.69	1.41
Foreign Demand (Fy)	1.16	0.73	2.13	0.88	1.23	1.03
Output U.K. (Uk)	1.57	0.99	2.47	1.03	1.29	1.07
Output Denmark (Dk)	1.08	0.68	2.74	1.14	1.70	1.41
Output Norway (No)	1.24	0.78	2.22	0.92	1.65	1.37
Output Germany (Ge)	2.26	1.42	5.36	2.22	3.68	3.06
Output France (Fr)	2.08	1.31	3.05	1.27	1.65	1.37
Output US (US)	2.38	1.50	5.16	2.14	2.28	1.90

* *See appendix for exact sample lengths*

Table 4.7 Correlations* for Sub-samples

Nominal and Financial Variables

	Pre-war***			Inter-war			Post-war		
	t-1****	t	t+1	t-1	t	t+1	t-1	t	t+1
GDP Defl. (Py)	-0.12	-0.09	0.03	0.12	-0.23	-0.30	-0.43	-0.19	0.46
Inflation (Inf)	-0.29	0.03	0.16	-0.20	-0.33	-0.06	-0.38	0.23	0.51
Nom. GDP (Ynom)	-0.04	0.42	0.10	0.25	0.29	-0.16	-0.21	0.44	0.58
Money (M2)	-0.21	0.24	0.03	-0.31	0.09	0.18	0.44	0.62	0.14
Real Money (M2/Py)	-0.40	0.18	0.22	-0.20	0.26	0.35	0.55	0.61	-0.08
Discount Rate (R)	0.23	0.44	0.15	0.16	-0.33	-0.12	-0.27	0.29	0.59
Interest Rate (R2)	0.09	0.15	0.06	0.14	-0.54	-0.34	-0.31	0.21	0.59
Real Disc. (R-Infl)	0.30	0.03	-0.13	0.21	0.31	0.05	0.31	-0.15	-0.35
Real Int. (R2-Infl)	0.27	0.02	-0.09	0.21	0.30	0.04	0.26	-0.15	-0.31

GDP Components

GDP (Y)	0.14	1.00	0.14	0.26	1.00	0.26	0.29	1.00	0.29
Priv. Cons. (C)	0.07	0.72	0.17	-0.12	0.49	0.22	-0.14	0.39	0.50
Public Cons. (G)	0.37	0.10	-0.16	0.19	0.22	-0.01	-0.05	-0.13	-0.03
Investments (I)	0.06	0.58	-0.04	0.27	0.74	0.33	0.06	0.43	0.31
Exports (X)	0.39	0.38	-0.37	0.43	0.68	-0.16	0.19	0.42	-0.08
Imports (M)	0.12	0.29	-0.10	0.07	0.22	-0.07	-0.20	0.38	0.48
Rel. Price C (Pc/Py)	-0.14	0.22	0.42	0.24	-0.01	-0.22	0.47	-0.07	-0.61
Rel. Price I (Pi/Py)	0.45	0.37	-0.34	-0.87	-0.36	0.29	0.14	-0.01	0.00
Rel. Price X (Px/Py)	-0.22	0.24	0.21	-0.24	-0.18	-0.07	0.13	0.67	0.38
Rel. Price M (Pm/Py)	-0.27	0.26	0.48	-0.23	-0.25	0.07	0.42	0.64	0.09

Manufacturing and Labor Market Variables

Manuf. Prod. (Yman)	0.27	0.15	-0.04	0.47	0.92	0.11	0.27	0.84	0.28
Rel. Pr. Yman (Pman/Py)**	-0.16	-0.37	-0.13	-0.28	-0.32	-0.09	0.36	0.46	0.07
Wage Rate (W)**	0.29	0.20	-0.06	0.08	0.11	-0.21	-0.42	0.01	0.56
Real Wage (W/Pman)**	0.14	0.51	0.26	0.00	0.23	0.11	-0.36	-0.34	0.09
Real Cons. W (W/Pc)**	0.10	0.34	0.16	-0.13	0.21	0.14	-0.39	0.14	0.55
Wage Cost (Wc)**	0.29	0.20	-0.01	0.09	0.12	-0.20	-0.49	0.01	0.64
Real Wc (Wc/Pman)**	0.14	0.52	0.35	0.00	0.23	0.13	-0.45	-0.35	0.18
Hours Manuf. (H)**	0.36	0.17	-0.09	0.19	0.42	0.17	-0.14	0.64	0.48
Workers (N)**	0.29	0.05	-0.19	0.17	0.46	0.19	-0.20	0.66	0.53
Hours per Worker (H/N)**	0.24	0.29	0.17	0.14	0.09	-0.02	0.06	-0.11	-0.04
Productivity (Pr)**	0.08	0.76	0.38	0.16	0.65	0.26	0.52	0.69	-0.04
Wage Share (Wshare)**	-0.02	-0.64	-0.27	-0.29	-0.79	-0.21	-0.66	-0.68	0.19
Unemployment (U)**	.	.	-0.26	-0.07	-0.11	-0.05	-0.06	-0.58	-0.24

International Variables

Current Account (Ca)	0.02	-0.26	-0.24	0.31	0.33	-0.04	0.28	-0.33	-0.64
Net Export (Nx)	0.17	-0.04	-0.34	0.32	0.43	-0.03	0.28	-0.33	-0.63
Terms of Trade (Tot)	0.12	-0.08	-0.40	-0.01	0.10	-0.19	-0.53	0.14	0.62
Foreign Demand (Fy)	0.38	0.10	-0.40	0.52	0.65	0.13	0.28	0.04	-0.37
Output U.K. (Uk)	0.40	-0.08	-0.60	0.37	0.31	0.12	0.34	-0.07	-0.63
Output Denmark (Dk)	-0.13	0.23	0.06	-0.41	0.25	0.36	0.09	0.12	-0.04
Output Norway (No)	-0.22	0.19	0.12	0.20	0.57	-0.26	0.04	-0.05	-0.09
Output Germany (Ge)	0.29	0.22	-0.03	0.66	0.52	0.01	0.19	-0.01	-0.29
Output France (Fr)	-0.09	-0.08	0.14	0.28	-0.01	-0.59	-0.25	-0.02	0.17
Output US (US)	0.54	0.48	-0.24	0.09	0.57	0.49	0.32	-0.05	-0.31

* Correlation with GDP except for variables marked with **
** Correlation with Manufacturing Production
*** See appendix for exact sample lengts
**** The series is leading reference with 1 year (corr(ref(t),series(t-1)))
***** Shaded entry represents at least 10 % significance

Table 4.8 Comparisons Between Different Filters

Nominal and Financial Variables

	Relative Standard Deviation			Correlation* with Reference		
	Band-pass	First diff.	Wh.Hend.	Band-pass	First diff.	Wh.Hend.
GDP Defl. (Py)	1.90	2.35	2.31	-0.13	-0.25	-0.24
Inflation (Inf)	2.02	1.95	2.07	-0.16	-0.08	-0.10
Nom. GDP (Ynom)	2.03	2.32	2.29	0.37	0.18	0.20
Money (M2)	2.09	2.29	2.14	0.23	-0.07	-0.03
Real Money (M2/Py)	2.27	1.93	1.98	0.27	0.22	0.24
Discount Rate (R)	0.27	0.23	0.24	0.16	-0.10	-0.04
Interest Rate (R2)	0.32	0.30	0.30	0.01	-0.12	-0.12
Real Disc. (R-Infl)	2.06	1.95	2.07	0.18	0.07	0.09
Real Int. (R2-Infl)	2.07	1.99	2.11	0.19	0.07	0.08
GDP Components						
GDP (Y)	1.00	1.00	1.00	1.00	1.00	1.00
Priv. Cons. (C)	1.31	1.34	1.39	0.58	0.64	0.66
Public Cons. (G)	1.70	1.96	2.08	0.07	0.04	-0.03
Investments (I)	4.07	4.34	4.22	0.55	0.48	0.56
Exports (X)	3.80	4.28	4.28	0.48	0.54	0.56
Imports (M)	6.01	5.84	5.81	0.30	0.36	0.40
Rel. Price C (Pc/Py)	0.89	0.83	0.84	-0.03	-0.07	-0.14
Rel. Price I (Pi/Py)	1.37	1.21	1.27	-0.03	0.03	0.00
Rel. Price X (Px/Py)	1.88	1.87	1.79	0.21	0.07	0.13
Rel. Price M (Pm/Py)	1.93	1.86	1.81	0.17	0.05	0.05
Manufacturing and Labor Market Variables						
Manuf. Prod. (Yman)	2.18	2.33	2.30	0.56	0.51	0.58
Rel. Pr. Yman (Pman/Py)**	0.53	0.51	0.49	-0.09	-0.23	-0.18
Wage Rate (W)**	1.07	1.01	1.05	0.14	-0.10	0.02
Real Wage (W/Pman)**	0.87	0.90	0.95	0.22	0.23	0.18
Real Cons. W (W/Pc)**	0.67	0.67	0.70	0.32	0.23	0.26
Wage Cost (Wc)**	1.10	1.05	1.07	0.14	-0.11	0.03
Real Wc (Wc/Pman)**	0.88	0.91	0.95	0.21	0.21	0.18
Hours Manuf. (H)**	0.80	0.74	0.76	0.30	0.28	0.33
Workers (N)**	0.71	0.68	0.71	0.31	0.27	0.34
Hours per Worker (H/N)**	0.41	0.43	0.41	0.06	0.05	0.06
Productivity (Pr)**	1.08	1.07	1.04	0.72	0.75	0.72
Wage Share (Wshare)**	0.73	0.70	0.69	-0.60	-0.66	-0.63
Unemployment (U)**	0.28	0.23	0.25	-0.15	-0.17	-0.21
International Variables						
Current Account (Ca)	0.78	0.69	0.71	-0.01	0.05	0.01
Net Export (Nx)	0.85	0.73	0.77	0.04	0.10	0.07
Terms of Trade (Tot)	1.39	1.62	1.51	0.05	0.03	0.09
Foreign Demand (Fy)	0.96	0.98	0.90	0.23	0.27	0.23
Output U.K. (Uk)	1.04	1.04	1.12	-0.05	-0.02	-0.05
Output Denmark (Dk)	1.35	1.31	1.29	0.30	0.40	0.39
Output Norway (No)	1.21	1.26	1.23	0.39	0.50	0.49
Output Germany (Ge)	3.22	2.81	2.93	0.16	0.09	0.07
Output France (Fr)	1.64	2.18	2.15	-0.05	0.28	0.27
Output US (US)	1.92	1.77	1.84	0.35	0.13	0.16

* *Correlation with GDP except for variables marked with ***

** *Correlation with Manufacturing Production*

*** *Black cell represents at least 10 % significance*

Table 5.1 Granger-Causality Tests for Money on Real GDP

***F*-statistics and marginal significance levels**
First-differenced data*

Specification	Whole sample	Pre-war	Inter-war	Post-war
Bivariate	1.282	1.912	0.286	4.494
Significance	0.284	0.147	0.854	0.009
Multivariate	0.654	1.239	1.655	2.784
Significance	0.582	0.316	0.250	0.060

* *Black cells represent significance at or below 10%*

Table 5.2 Neutrality Tests for Money on Real GDP

B (1) and t-statistics
First-differenced data

Specification	Whole sample	Pre-war	Inter-war	Post-war
Bivariate	-0.092	-0.188	-0.196	-0.246
t-statistic	-1.764	-1.775	-0.887	-2.856
Multivariate	-0.122	-0.266	-0.914	-0.027
t-statistic	-1.294	-1.867	-1.818	-0.252

• *Black cells represent significance at or below 10%*

Table 5.3 Granger Causality Tests for Money on Prices

F-statistics and marginal significance levels
First-differenced data

Specification	Whole sample	Pre-war	Inter-war	Post-war
Bivariate	4.522	1.112	10.629	1.619
Significance	0.005	0.359	0.001	0.203
Multivariate	3.907	2.703	6.247	0.631
Significance	0.011	0.067	0.023	0.602

• *Black cells represent significance at or below 10%*

Table 5.4 Independence Tests for Real Wages and Employment

S-statistics and marginal significance levels

	Whole sample	Pre-war	Inter-war	Post-war
Cyclical component				
Band-pass	31.919	18.840	10.402	14.452
Significance	0.000	0.000	0.015	0.002
Whittaker-Henderson	32.588	5.643	11.451	5.922
Significance	0.000	0.130	0.010	0.115
First-differences	25.731	6.239	12.241	2.998
Significance	0.000	0.101	0.007	0.329
AR(1) innovations				
Band-pass	32.913	20.093	8.121	12.606
Significance	0.000	0.000	0.044	0.006
Whittaker-Henderson	26.217	4.318	9.026	4.967
Significance	0.000	0.229	0.029	0.174
First-differences	22.491	5.547	8.137	3.694
Significance	0.000	0.136	0.043	0.297
AR(2) innovations				
Band-pass	31.545	14.881	9.269	5.887
Significance	0.000	0.002	0.026	0.117
Whittaker-Henderson	24.380	2.430	13.627	7.826
Significance	0.000	0.488	0.003	0.050
First-differences	22.330	6.978	12.366	5.956
Significance	0.000	0.073	0.006	0.114

- *Black cells represent significance at or below 10%*

Table 5.5a Correlations with Foreign Demand

Filtering method	Pre-war*	Inter-war	Post-war
Band-pass			
GDP (Y)	0.10	0.66	0.10
Exports (X)	0.08	0.72	0.49
Manuf. Prod. (Yman)	0.16	0.70	0.30
Whittaker-Henderson			
GDP (Y)	0.27	0.70	0.18
Exports (X)	0.20	0.94	0.51
Manuf. Prod. (Yman)	0.16	0.76	0.25
First-difference			
GDP (Y)	0.07	0.62	0.39
Exports (X)	0.07	0.90	0.58
Manuf. Prod. (Yman)	0.06	0.69	0.44

* *See appendix for exact sample lengths*

Table 5.5b Correlations with Contemporaneous Exports

Band-pass filtered data

	Pre-war*	Inter-war	Post-war
Output U.K. (Uk)	0.30	0.58	0.44
Output Denmark (Dk)	0.06	0.48	0.39
Output Norway (No)	0.14	0.71	0.29
Output Germany (Ge)	-0.27	0.23	0.20
Output France (Fr)	-0.09	0.59	0.49
Output US (US)	0.08	0.45	0.08
Rel. Price Exp. (Px/Py)	-0.29	-0.03	0.31

* *See appendix for exact sample lengths*

** *Black cells represent significance at 10% or below*

Table 5.6 VAR-Equation for Exports

First-differenced data

	Pre-war*	Inter-war	Post-war
	0.60	3.61	0.13
	0.55	0.08	0.88
	0.25	-2.89	0.09
	0.29	1.36	0.11

* *See appendix for exact sample lengths*

Table 5.7 VAR-Equation for Export Prices

First-differenced data

	Pre-war*	Inter-war	Post-war
	0.90	1.24	11.33
	0.42	0.35	0.00
	0.18	-0.35	0.82
	-0.02	-0.40	-0.64

* *See appendix for exact sample lengths*

Table 5.8 Correlations with Current Account

Band-pass filtered data

	Pre-war*	Inter-war	Post-war
Terms of Trade (ToT)	-0.35	0.48	-0.26
Foreign Demand (Fy)	-0.40	0.36	0.54
GDP (Y)	-0.26	0.33	-0.33

* *See appendix for exact sample lengths*

** *Black cells represent significance at 10% or below*

Table 5.9 Skewness and Medians

	Full Sample*		Pre-war		Inter-war		Post-war	
	Skewness	Median	Skewness	Median	Skewness	Median	Skewness	Median
Nominal and Financial Variables								
GDP Defl. (Py)	-0.50	0.00	-0.09	0.11	-1.64	0.37	0.69	-0.07
Inflation (Inf)	-1.45	0.01	0.07	-0.03	-1.72	0.16	0.73	0.01
Nom. GDP (Ynom)	-1.06	0.14	0.10	0.09	-1.42	0.24	1.32	-0.20
Money (M2)	0.76	-0.09	1.33	-0.16	-0.54	0.06	1.00	-0.11
Real Money (M2/Py)	0.72	0.04	1.36	-0.08	1.61	-0.25	0.42	-0.03
Discount Rate (R)	0.25	-0.02	-0.21	-0.05	-0.34	0.09	0.19	-0.02
Interest Rate (R2)	1.17	-0.05	0.22	0.01	0.15	0.44	0.69	-0.16
Real Disc. (R-Infl)	1.36	-0.03	-0.18	-0.02	1.70	-0.17	-0.64	-0.08
Real Int. (R2-Infl)	1.27	-0.01	-0.18	0.03	1.66	-0.12	-0.51	-0.11
GDP Components								
GDP (Y)	-1.23	0.09	0.01	0.00	-1.26	0.21	-0.42	0.03
Priv. Cons. (C)	-0.55	0.07	0.15	-0.10	-1.15	0.28	-0.24	0.12
Public Cons. (G)	0.31	-0.06	0.09	-0.11	1.37	-0.19	0.18	0.01
Investments (I)	-0.02	0.00	-0.01	-0.03	-0.67	0.09	-0.54	0.01
Exports (X)	-0.57	0.08	0.62	-0.04	-0.36	0.09	-0.49	-0.02
Imports (M)	1.43	0.18	-0.37	0.09	-2.17	0.47	0.14	0.10
Rel. Price C (Pc/Py)	0.60	-0.04	0.15	-0.11	0.84	-0.19	-1.71	0.05
Rel. Price I (Pi/Py)	0.70	0.01	-0.14	0.06	0.41	-0.05	0.90	0.06
Rel. Price X (Px/Py)	0.46	-0.07	0.32	0.02	-0.31	0.06	1.69	-0.17
Rel. Price M (Pm/Py)	0.11	0.00	0.25	0.00	-1.25	0.27	1.45	-0.12
Manufacturing and Labor Market Variables								
Manuf. Prod. (Yman)	-0.32	0.08	0.09	0.04	-1.52	0.25	-0.66	0.07
Rel. Pr. Yman (Pman/Py)	0.77	-0.10	-0.19	0.00	-1.10	0.15	1.01	-0.20
Wage Rate (W)	-0.01	-0.09	-0.39	0.04	-3.16	0.57	1.16	-0.10
Real Wage (W/Pman)	0.42	0.06	-0.16	-0.01	2.44	-0.19	0.32	-0.06
Real Cons. W (W/Pc)	1.30	-0.04	0.28	-0.06	1.18	-0.11	-0.28	0.02
Wage Cost (Wc)	-0.05	-0.13	-0.28	0.02	-3.16	0.57	1.05	-0.29
Real Wc (Wc/Pman)	0.38	0.05	-0.36	-0.04	2.44	-0.19	0.40	-0.05
Hours Manuf. (H)	-1.50	0.01	-1.26	0.07	-1.93	0.19	0.05	0.03
Workers (N)	-1.15	0.00	-0.18	-0.06	-1.76	0.21	-0.34	0.07
Hours per Worker (H/N)	-0.06	0.01	0.48	0.12	1.45	-0.19	1.13	-0.18
Productivity (Pr)	0.26	0.08	-0.36	0.07	1.43	0.02	-0.19	0.00
Wage Share (Wshare)	0.48	0.01	0.43	-0.16	1.82	-0.19	0.39	0.01
Unemployment (U)	3.56	-0.13	0.43	-0.16	1.80	-0.15	0.10	-0.02
International Variables								
Current Account (Ca)	-0.42	0.02	-0.26	0.00	0.15	0.10	-0.02	-0.10
Net Export (Nx)	-0.37	0.00	-0.11	-0.03	0.39	0.03	0.15	-0.08
Terms of Trade (Tot)	0.36	-0.02	0.29	-0.09	-0.90	0.11	1.20	0.00
Foreign Demand (Fy)	-0.76	0.07	-0.36	0.08	-0.79	0.16	-0.25	0.08
Output U.K. (Uk)	-1.06	0.15	-0.29	-0.01	-1.04	0.25	-0.08	0.13
Output Denmark (Dk)	-0.87	0.07	-0.55	0.08	0.27	-0.09	0.04	0.01
Output Norway (No)	-0.44	0.05	-0.27	0.12	-1.04	0.07	-0.10	0.02
Output Germany (Ge)	-3.76	0.20	-0.62	0.16	-1.20	0.33	1.26	-0.17
Output France (Fr)	1.08	0.07	0.42	0.00	0.71	-0.13	1.44	0.01
Output US (US)	-0.61	0.09	-0.51	0.02	-0.52	0.10	-0.40	0.19

* *See appendix for exact sample lengths*

** *Black cell represents at least 5% significance.*

Table 6.1 Relative Importance of Business Cycle

Share of variance at business cycle frequencies

High

Inflation (Inf)	0.342
Real Discount (R-Inf)	0.343
Real Interest (R2-Inf)	0.333
Unemployment (U)	0.213
Current Account (Ca)	0.281
Net Exports (Nx)	0.335

Intermediate

Interest Rate (R)	0.101
Privivate Consumption (C)	0.108
Investments (I)	0.124
Imports (M)	0.104
Relative Price Investments (Pi/Py)	0.160
Relative Price Imports (Pm/Py)	0.101
Wage Share (Wshare)	0.114
Terms of Trade (ToT)	0.109
Output Denmark (Dk)	0.132

Low

GDP Deflator (Py)	0.011
Nominal GDP (Ynom)	0.008
Money Stock (M2)	0.025
Real Money (M2/Py)	0.061
GDP (Y)	0.064
Public Consumption (G)	0.031
Exports (X)	0.057
Relative Price Consumption (Pc/Py)	0.093
Relative Price Exports (Px/Py)	0.074
Manufacturing Production (Yman)	0.092
Relative Price Manuf. Prod. (Pman/Py)	0.046
Wage Rate (W)	0.009
Real Wage (W/Pman)	0.045
Real Consumption Wage (W/Pc)	0.054
Wage Cost (Wc)	0.025
Real Wage Cost (Wc/Pman)	0.032
Hours Worked Manufact. (H)	0.042
Workers (N)	0.043
Hours/Worker (H/N)	0.085
Productivity (Pr)	0.074
Foreign Demand (Fy)	0.014
Output UK (Uk)	0.075
Output Norway (No)	0.048
Output Germany (Ge)	0.099
Output France (Fr)	0.028
Output US (Us)	0.060

• *See appendix for exact sample lengths*

FIGURES

Figure 3.1a: Using log-linear trend

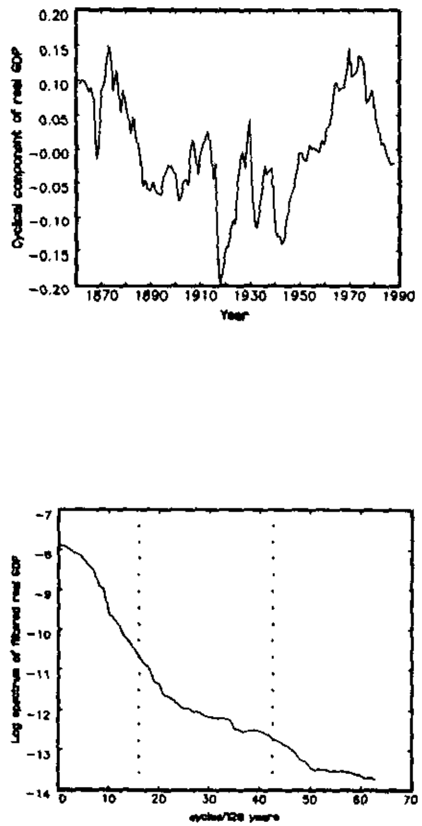


Figure 3.1b: Band pass

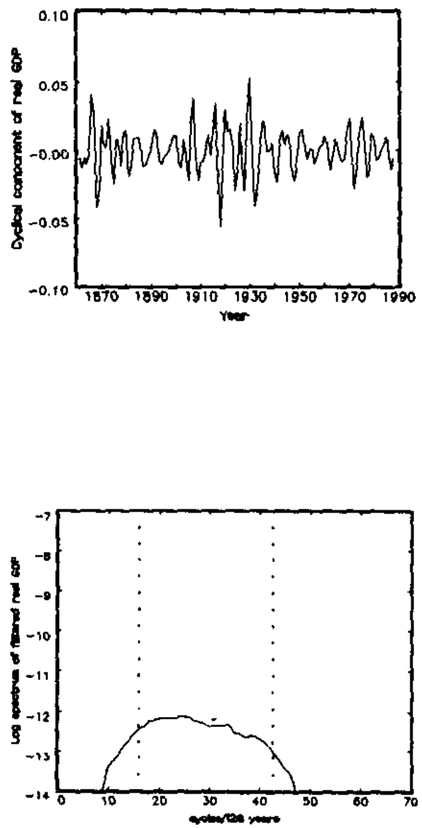


Figure 3.1c: Henderson-Whittaker

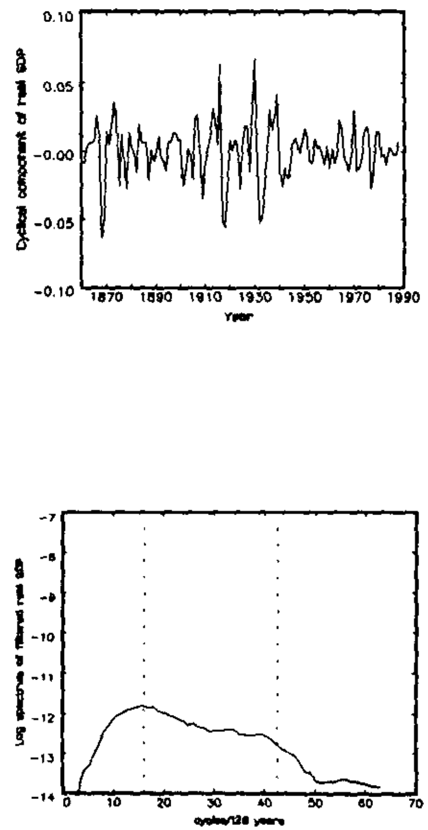


Figure 3.1d: First difference

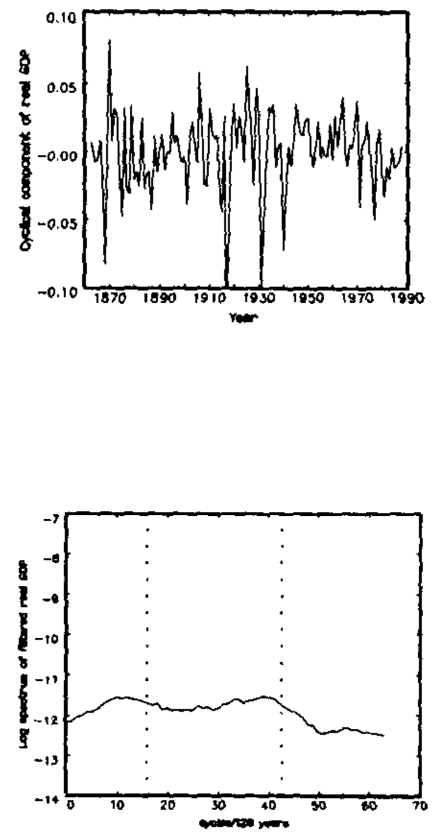


Figure 3.2: Different filters

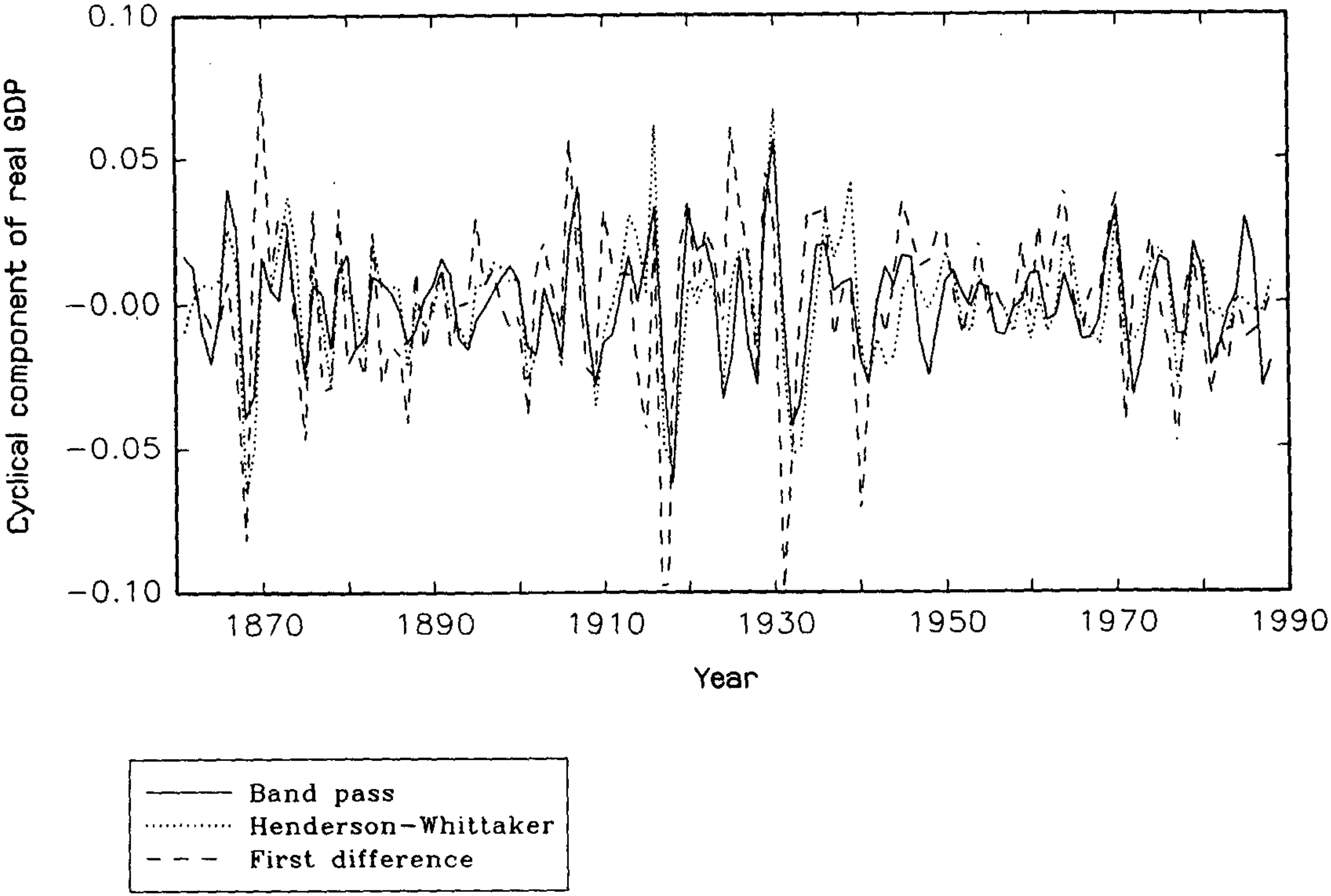


Figure 3.3a: coherence

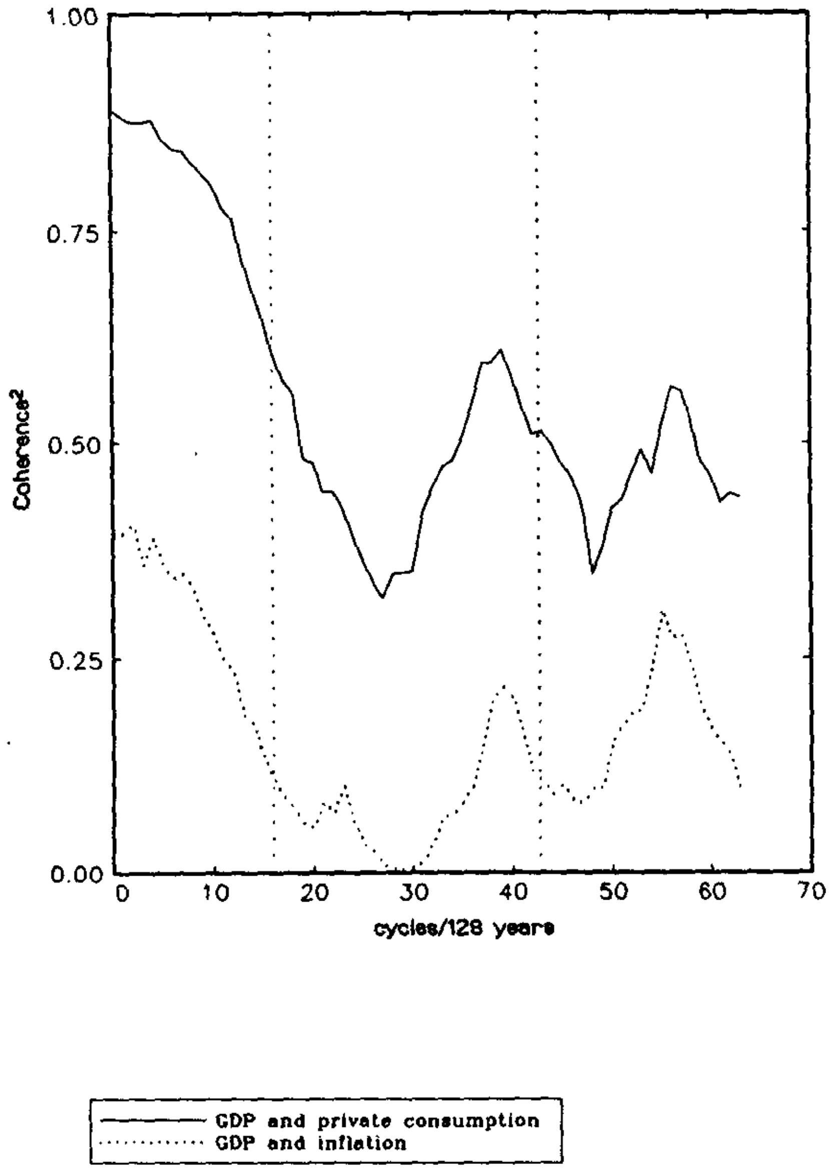


Figure 3.3b: phase

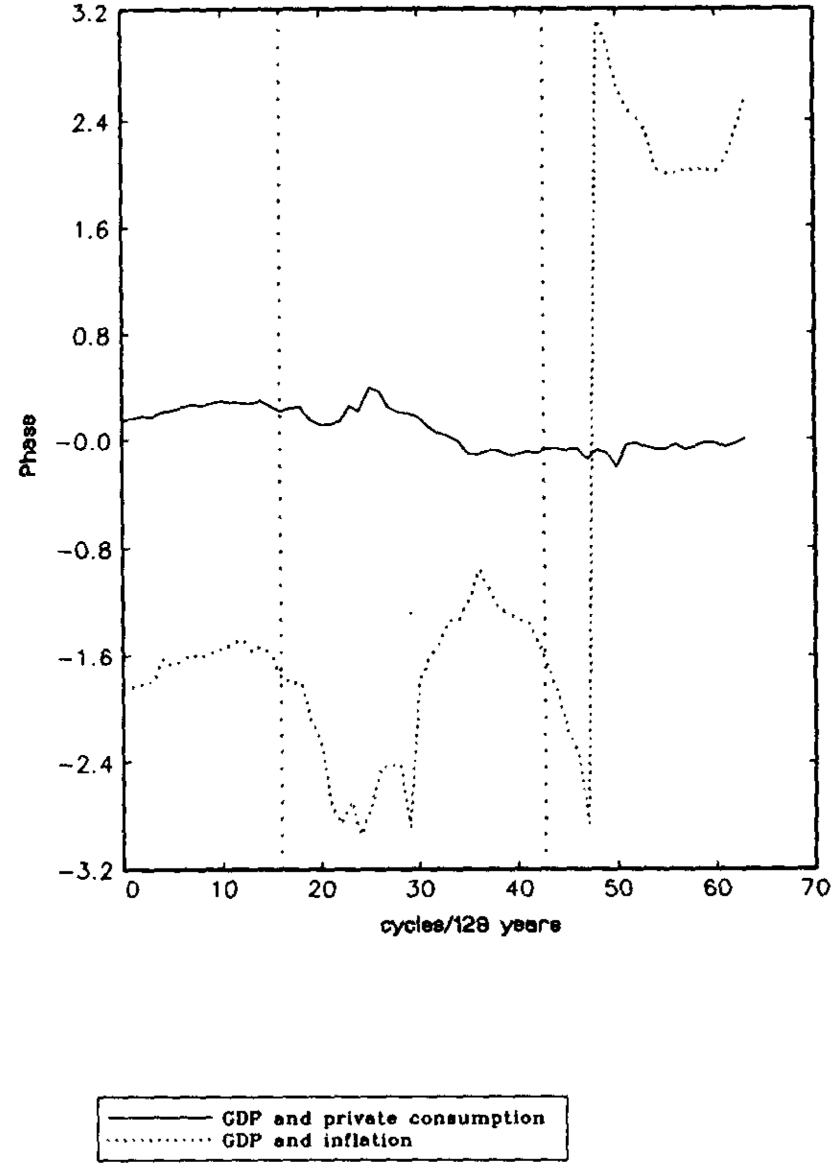


Figure 4.1a Deflator output

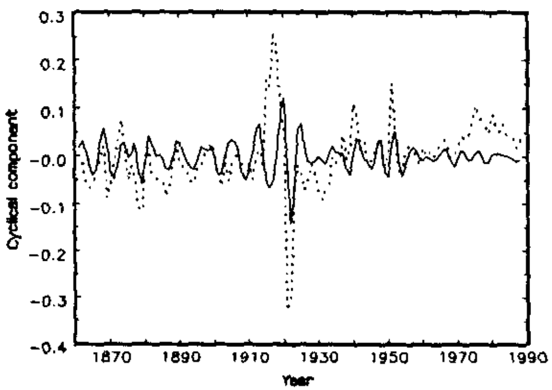


Figure 4.1b Inflation

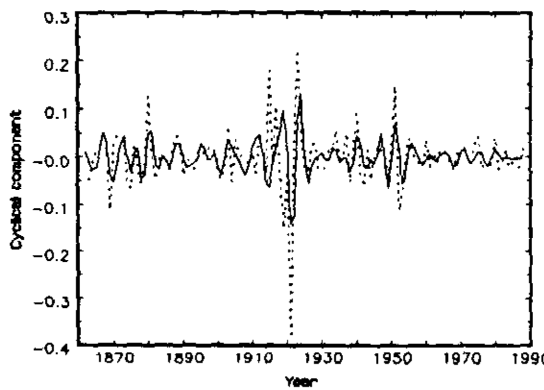


Figure 4.1c Nominal gdp

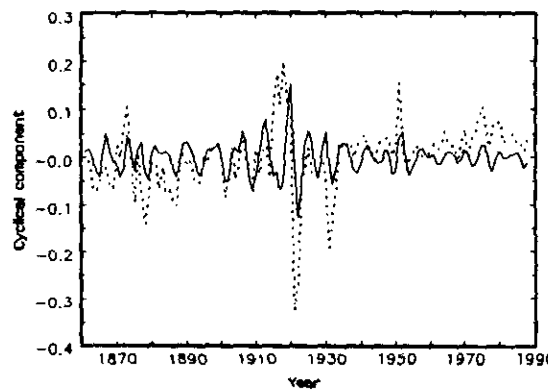


Figure 4.1d Money supply (nominal)

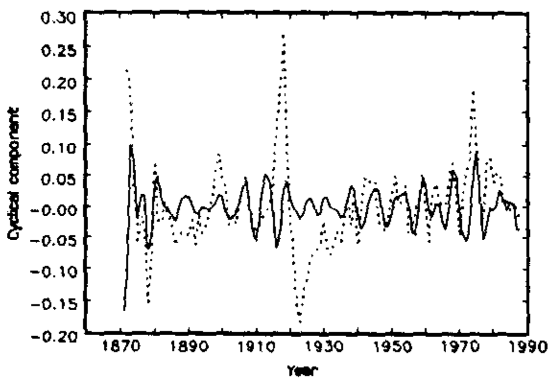


Figure 4.1e Money supply (real)

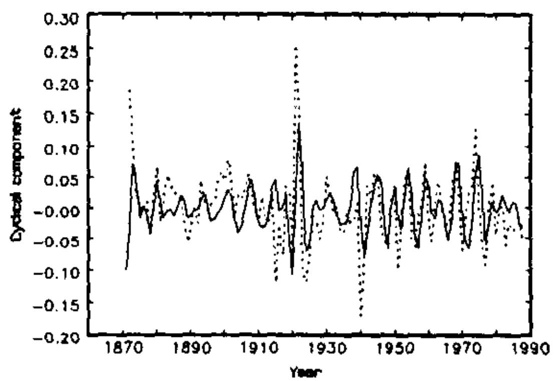


Figure 4.1f Official discount rate

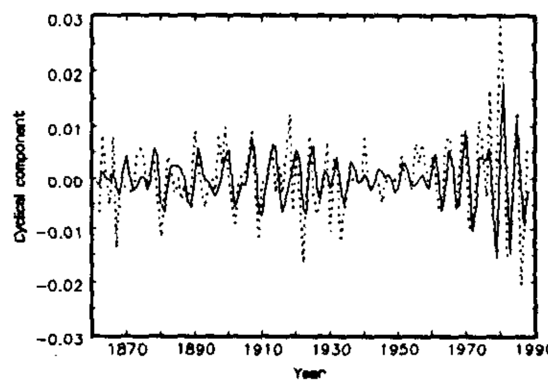


Figure 4.1g Interest rate

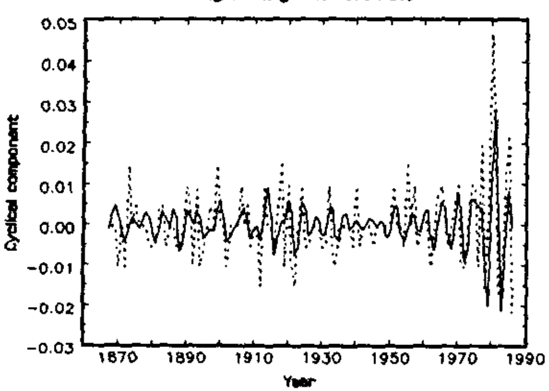


Figure 4.1h Official discount rate (real)

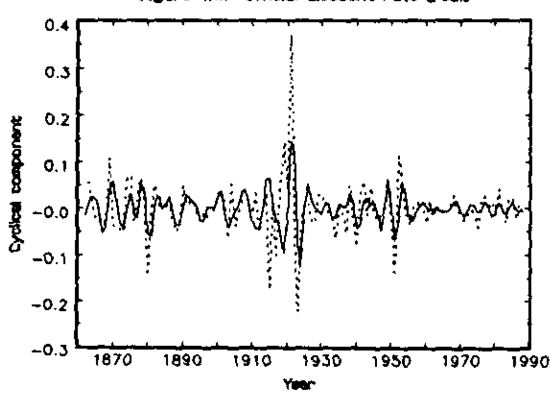
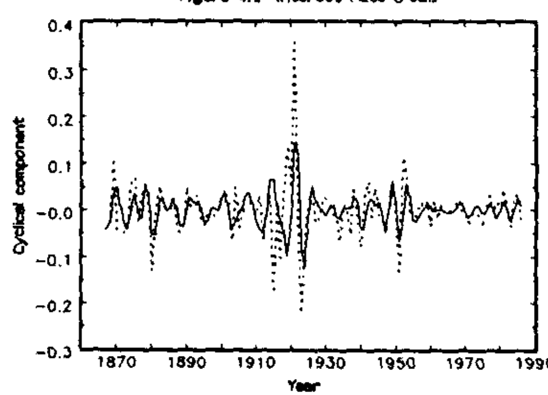


Figure 4.1i Interest rate (real)



——— Band pass filtered
··········· First-differenced

Figure 4.2a Output

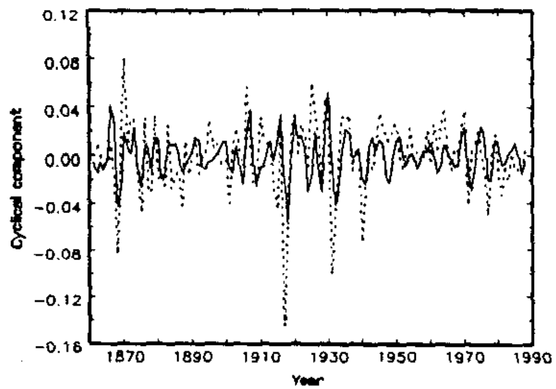


Figure 4.2b Private consumption

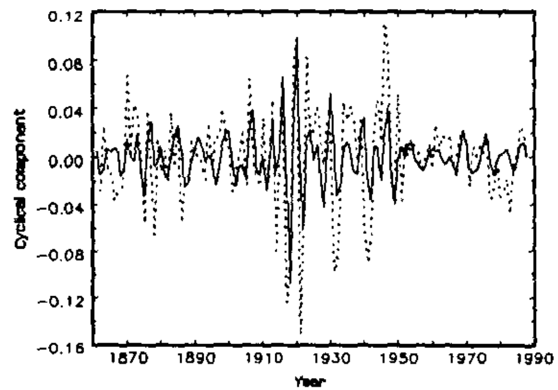


Figure 4.2c Public consumption

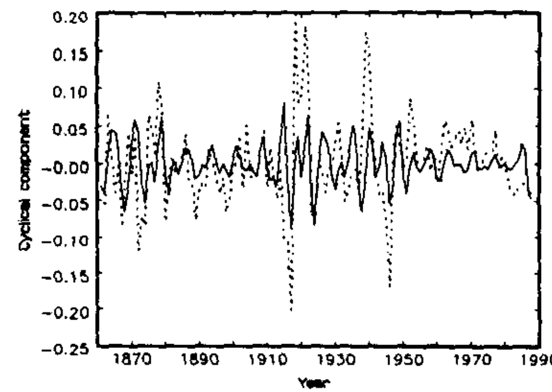


Figure 4.2d Investment

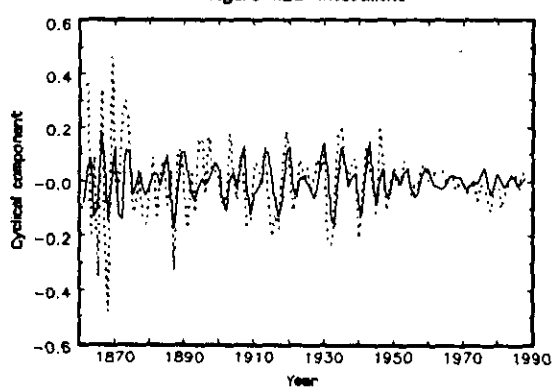


Figure 4.2e Export

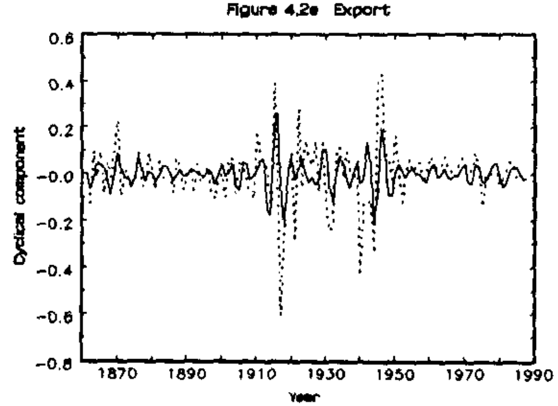


Figure 4.2f Import

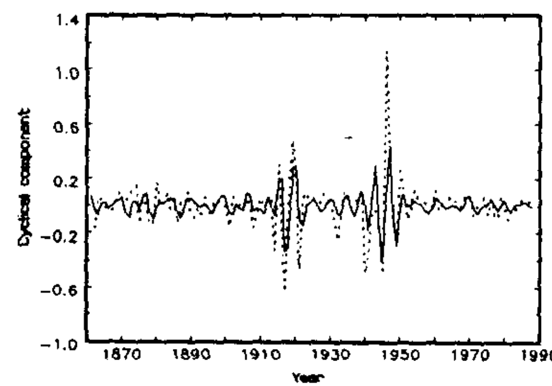


Figure 4.2g Relative price private consumption

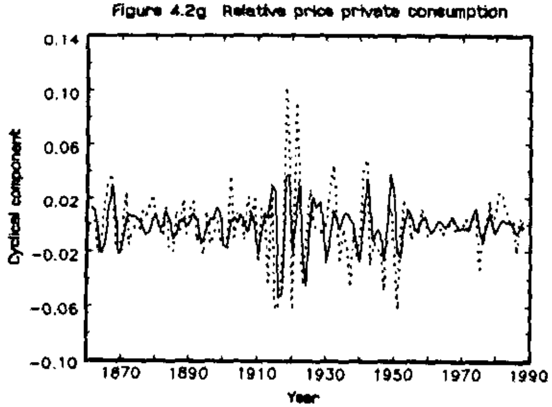


Figure 4.2h Relative price investment

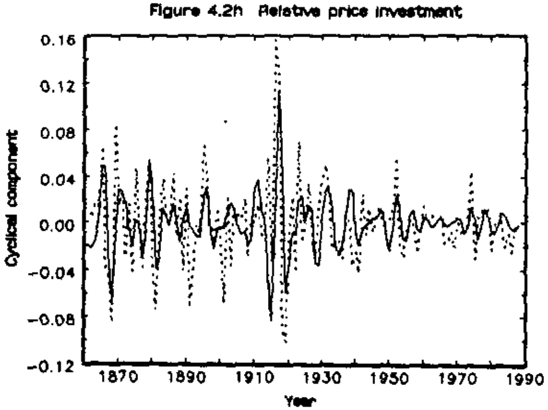
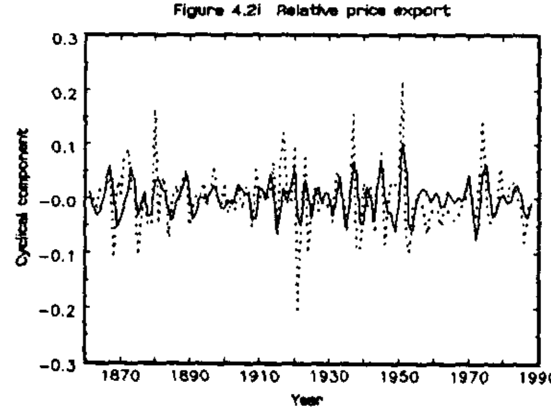


Figure 4.2i Relative price export



Band pass filtered
First-differenced

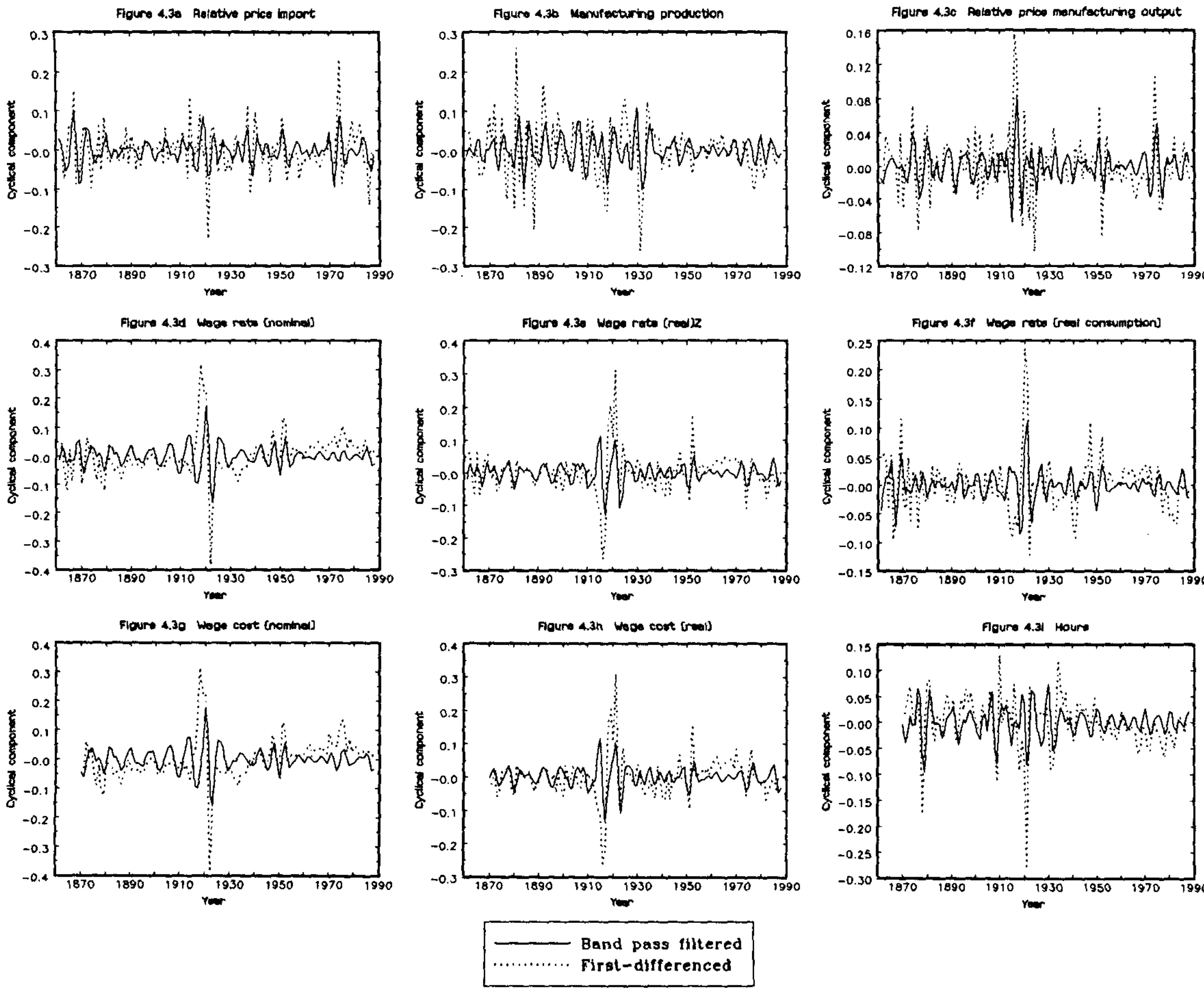


Figure 4.3a Relative price import
Figure 4.3b Manufacturing production
Figure 4.3c Relative price manufacturing output
Figure 4.3d Wage rate (nominal)
Figure 4.3e Wage rate (real)Z
Figure 4.3f Wage rate (real consumption)
Figure 4.3g Wage cost (nominal)
Figure 4.3h Wage cost (real)
Figure 4.3i Hours
Cyclical component
Year
Band pass filtered
First-differenced

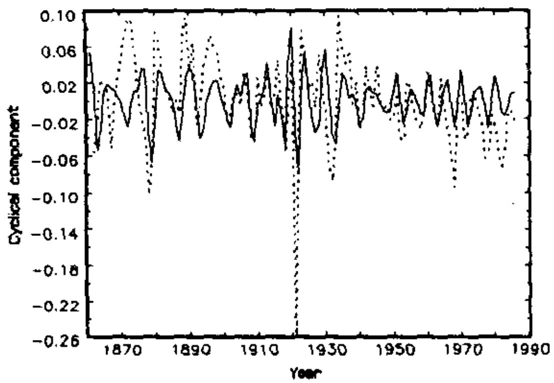


Figure 4.4a Employees

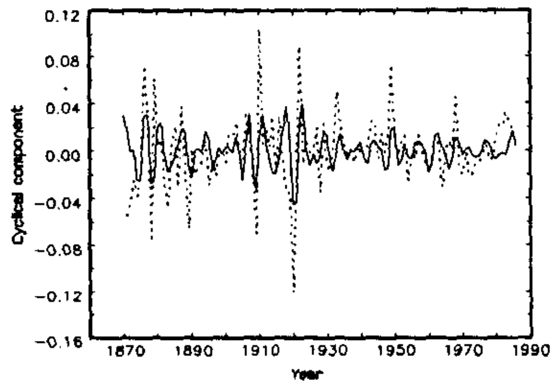


Figure 4.4b Hours/Employee

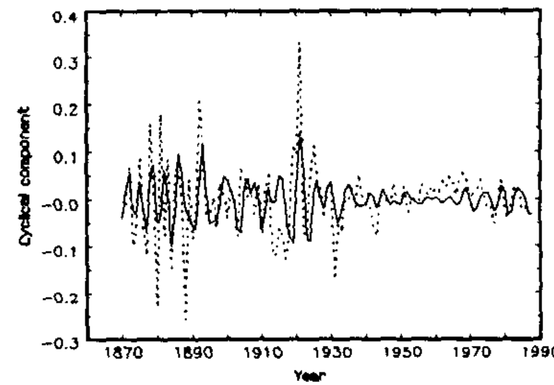


Figure 4.4c Productivity

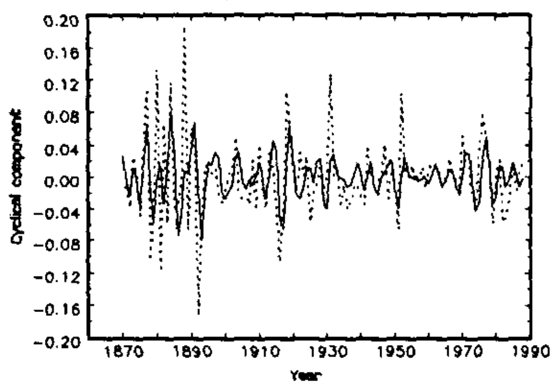


Figure 4.4d Wage share

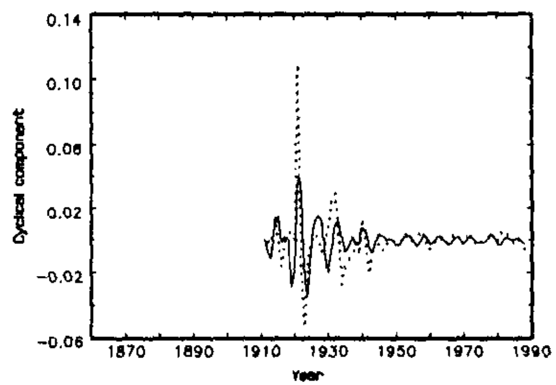


Figure 4.4e Unemployment

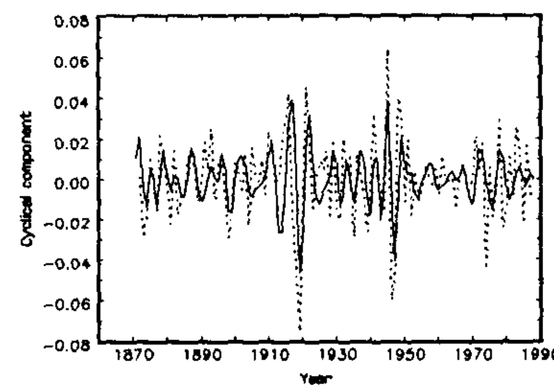


Figure 4.4f Current account (real)

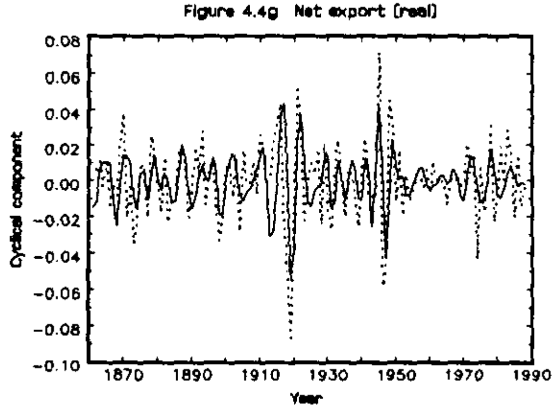


Figure 4.4g Net export (real)

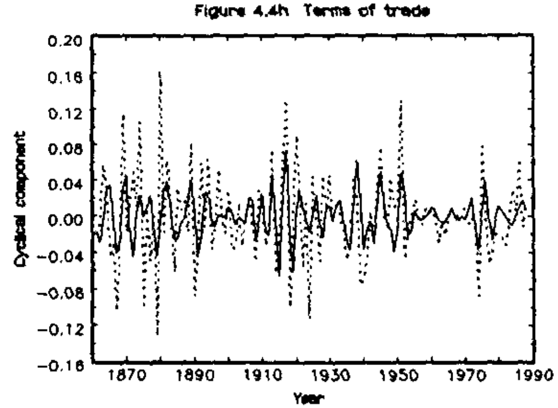


Figure 4.4h Terms of trade

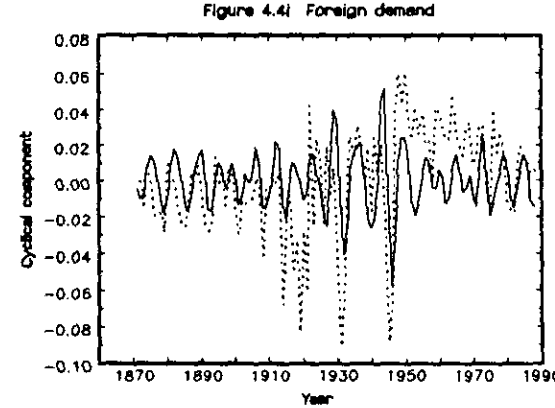


Figure 4.4i Foreign demand

Band pass filtered
First-differenced

Figure 4.5a Output UK

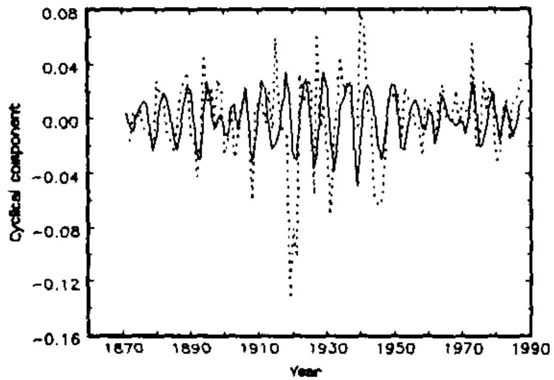


Figure 4.5b Output DK

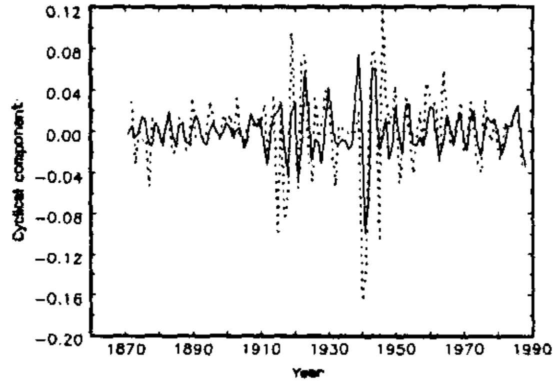


Figure 4.5c Output NO

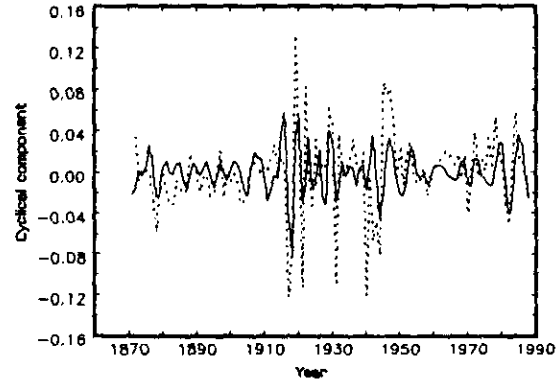


Figure 4.5d Output GE

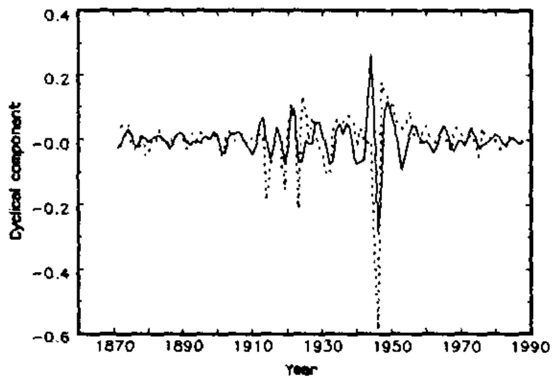


Figure 4.5e Output FR

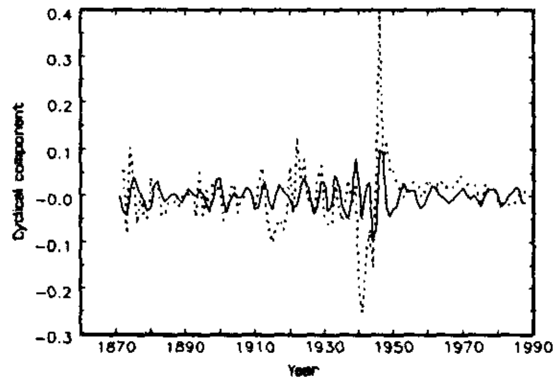


Figure 4.5f Output US

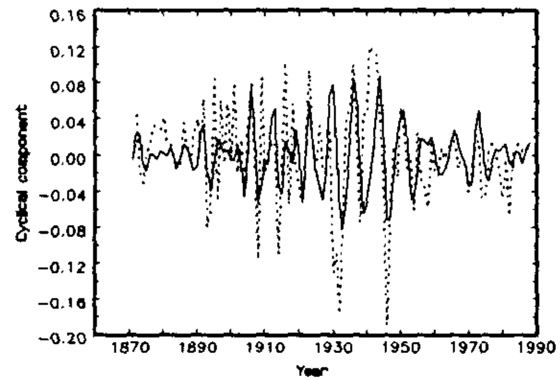


Figure 4.6a Deflator output

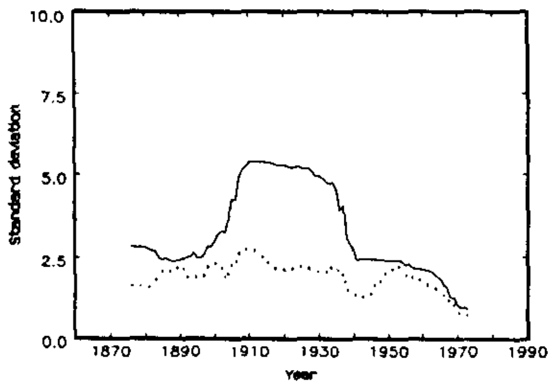


Figure 4.6b Inflation

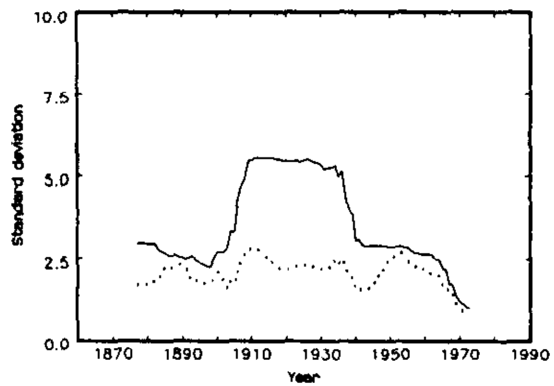


Figure 4.6c Nominal gdp

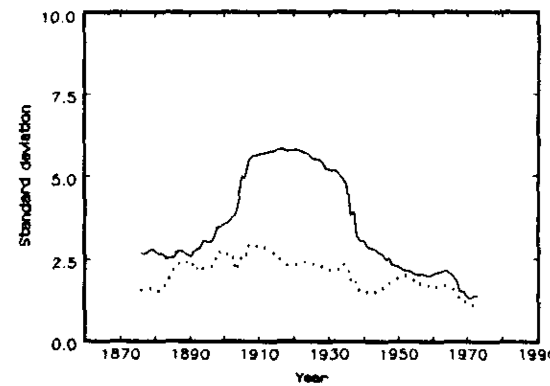


Figure 4.6d Money supply (nominal)

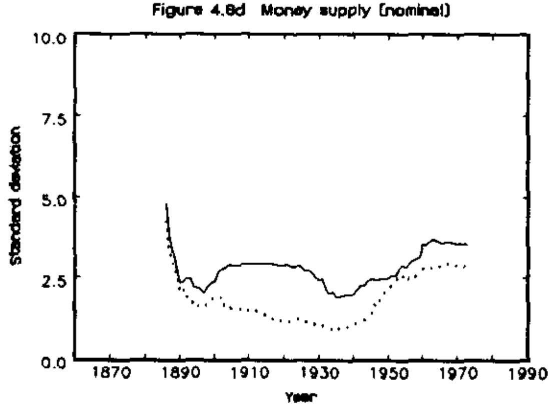


Figure 4.6e Money supply (real)

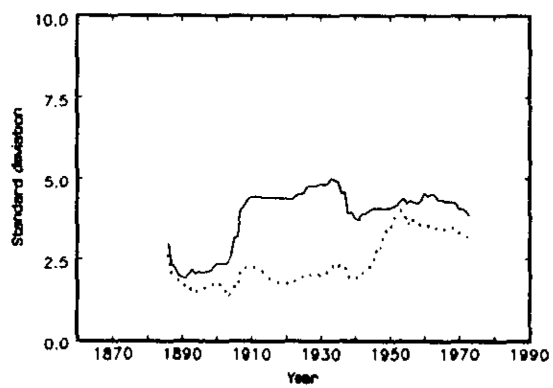


Figure 4.6f Official discount rate

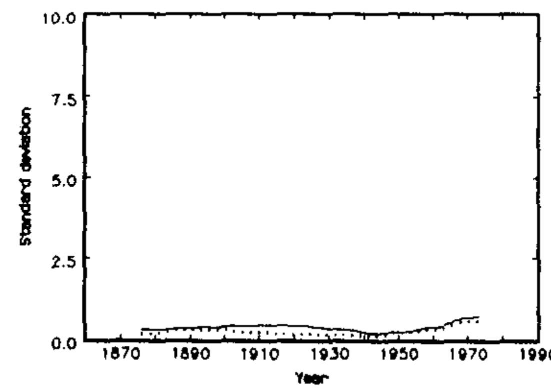


Figure 4.6g Interest rate

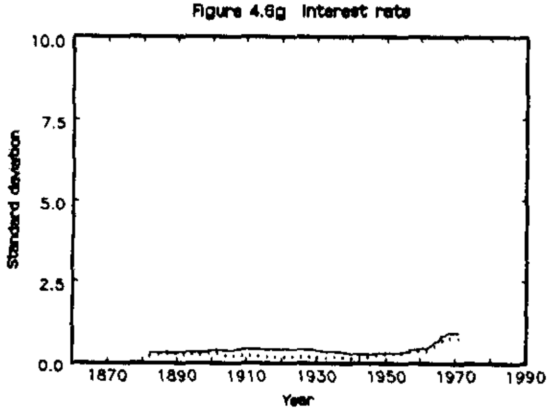


Figure 4.6h Official discount rate (real)

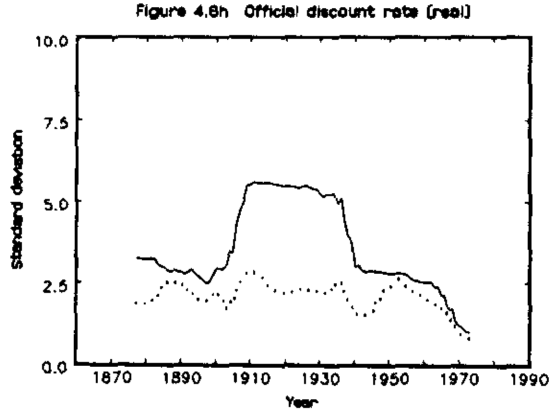
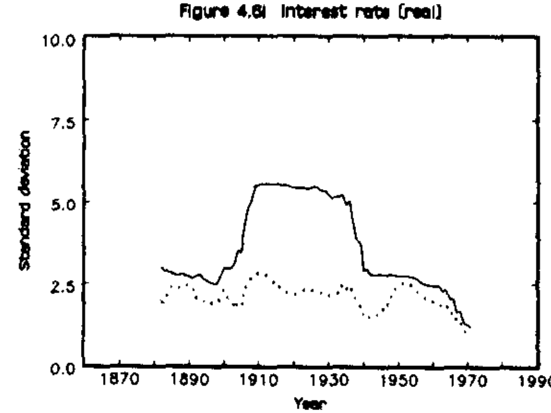


Figure 4.6i Interest rate (real)



——— Standard deviation
········· Relative standard deviation

Figure 4.7a Output

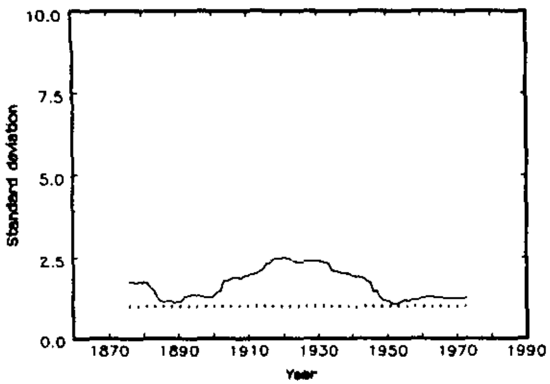


Figure 4.7b Private consumption

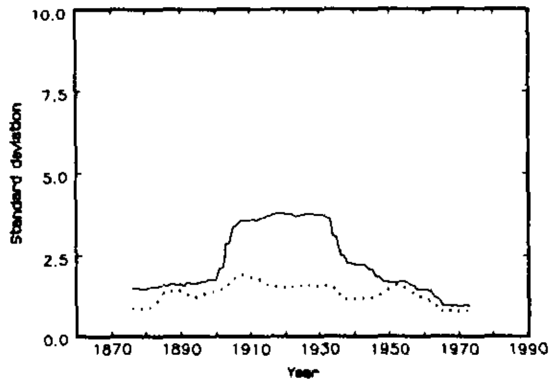


Figure 4.7c Public consumption

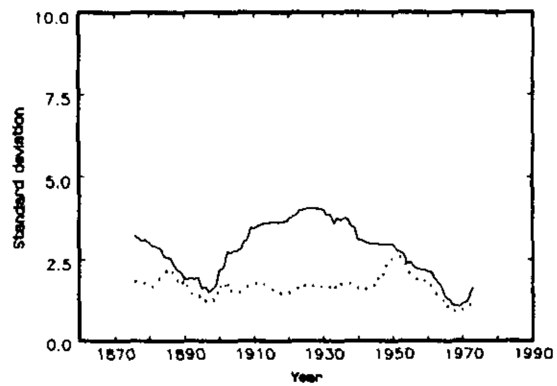


Figure 4.7d Investment

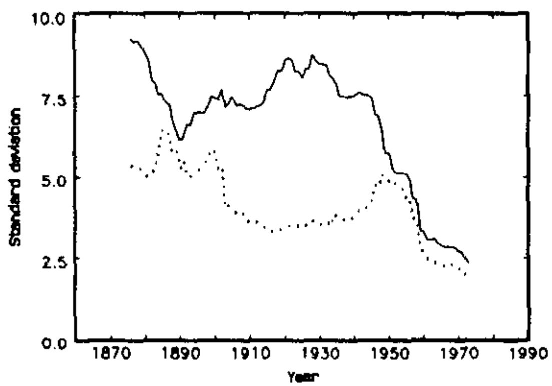


Figure 4.7e Export

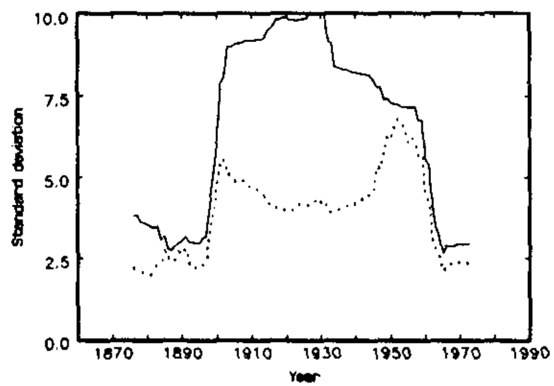


Figure 4.7f Import

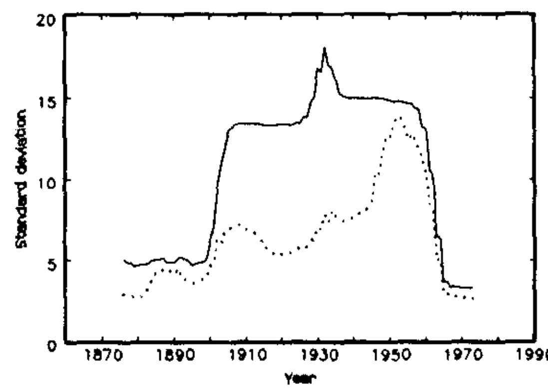


Figure 4.7g Relative price private consumption

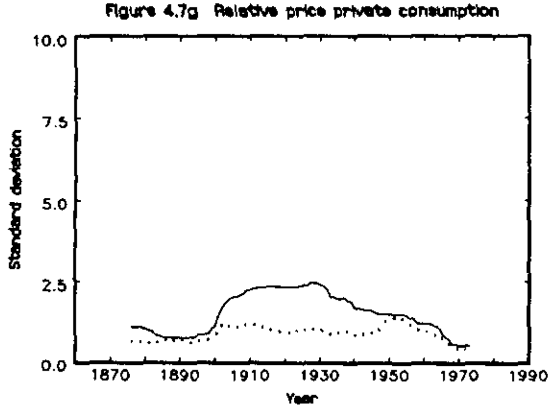


Figure 4.7h Relative price investment

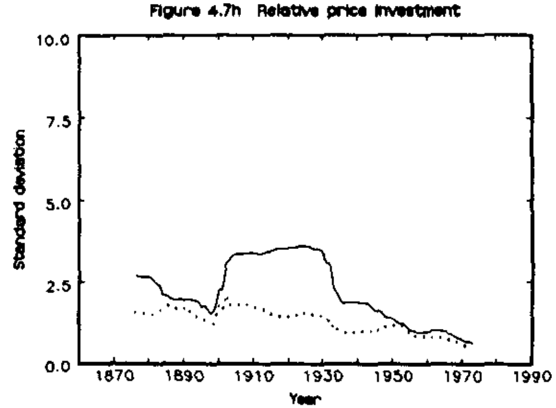
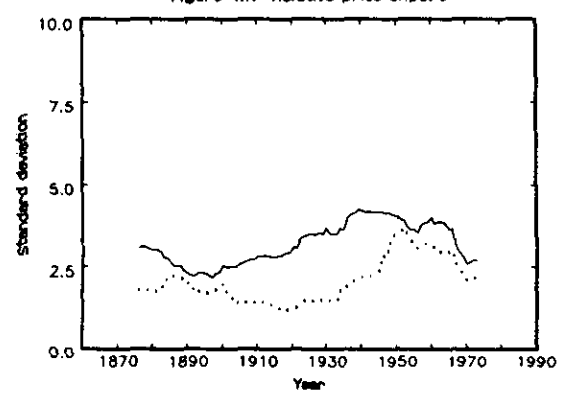


Figure 4.7i Relative price export



——— Standard deviation
········ Relative standard deviation

Figure 4.8a Relative price import

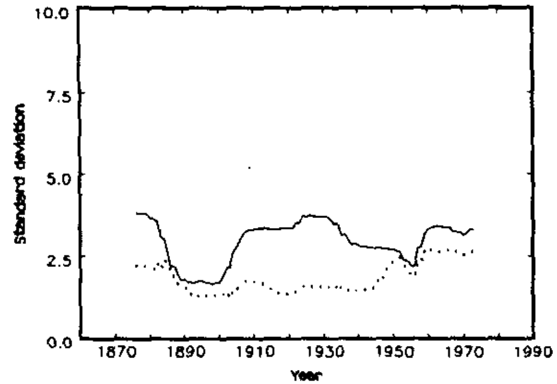


Figure 4.8b Manufacturing production

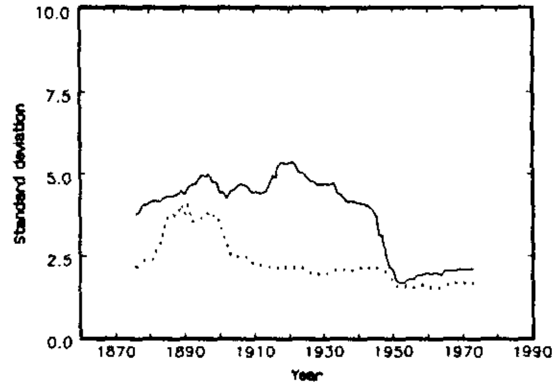


Figure 4.8c Relative price manufacturing output

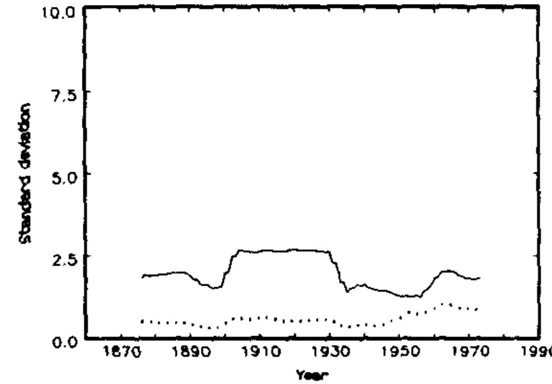


Figure 4.8d Wage rate (nominal)

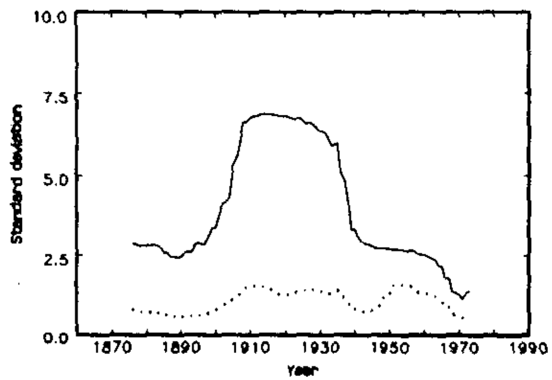


Figure 4.8e Wage rate (real)

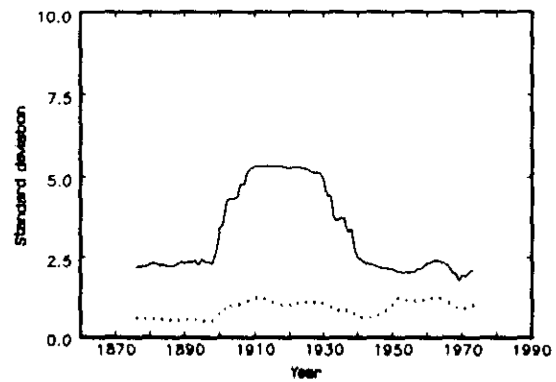


Figure 4.8f Wage rate (real consumption)

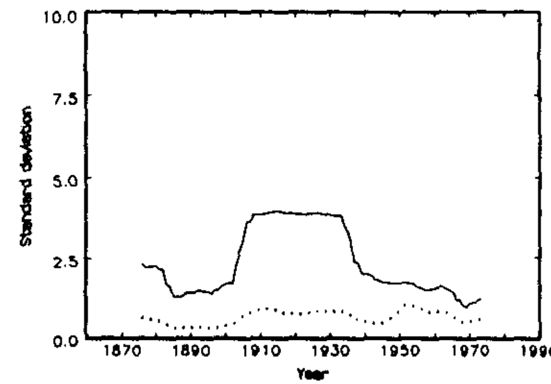


Figure 4.8g Wage cost (nominal)

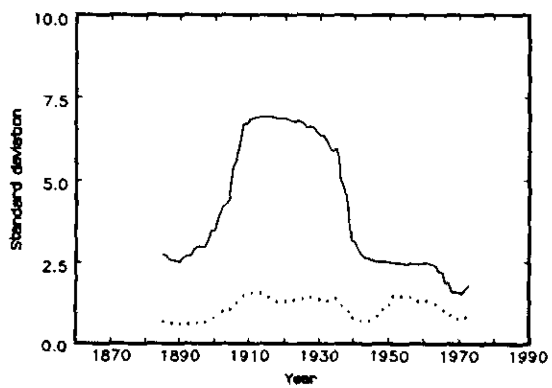


Figure 4.8h Wage cost (real)

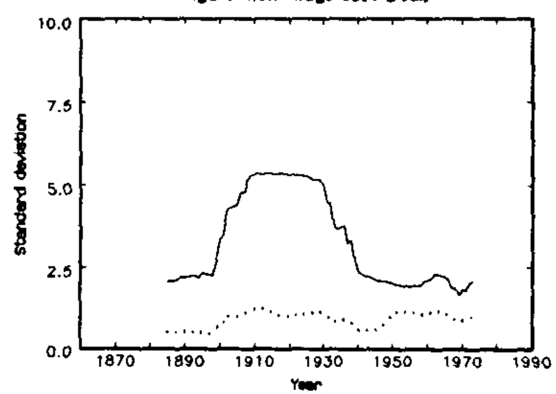
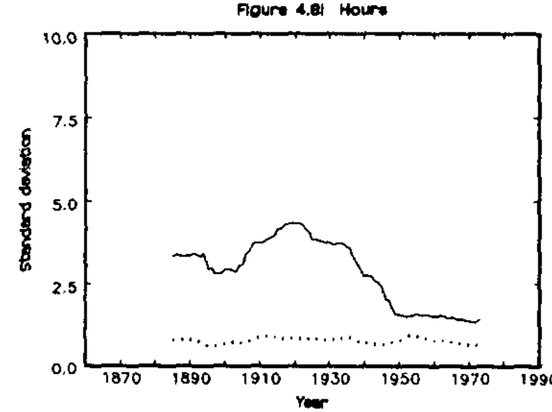


Figure 4.8i Hours



——— Standard deviation
·········· Relative standard deviation

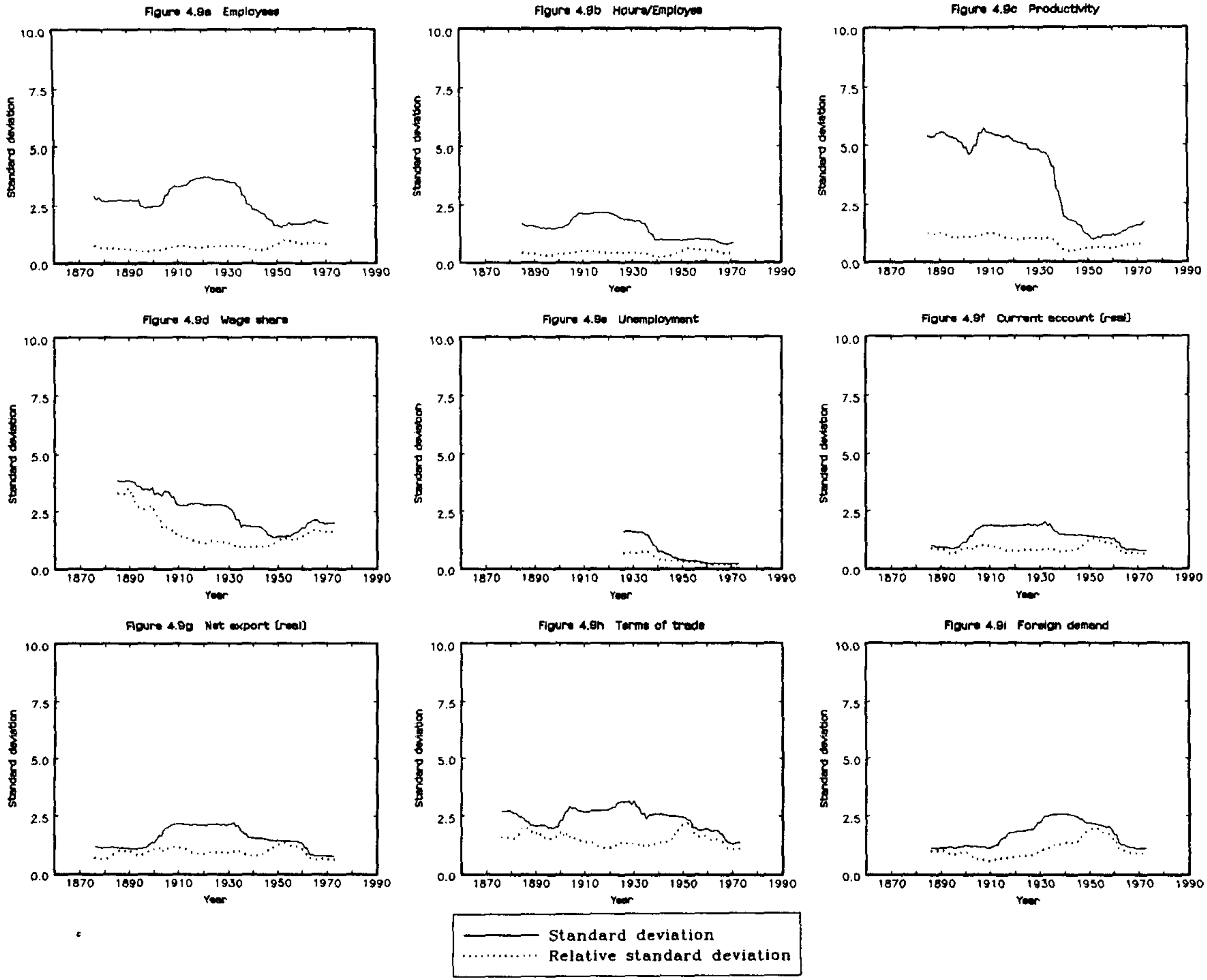


Figure 4.9a Employees
Figure 4.9b Hours/Employee
Figure 4.9c Productivity
Figure 4.9d Wage share
Figure 4.9e Unemployment
Figure 4.9f Current account (real)
Figure 4.9g Net export (real)
Figure 4.9h Terms of trade
Figure 4.9i Foreign demand
Standard deviation
Year
0.0
2.5
5.0
7.5
10.0
1870
1890
1910
1930
1950
1970
1990
Standard deviation
Relative standard deviation

Figure 4.10a Output UK

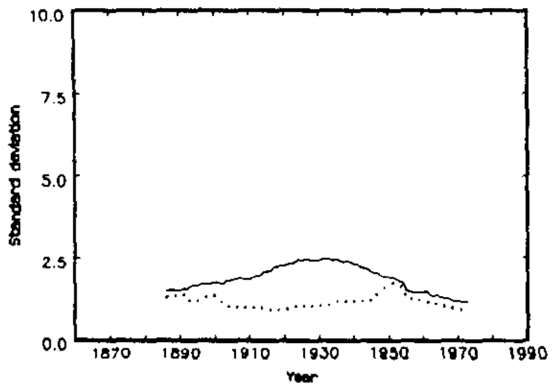


Figure 4.10b Output DK

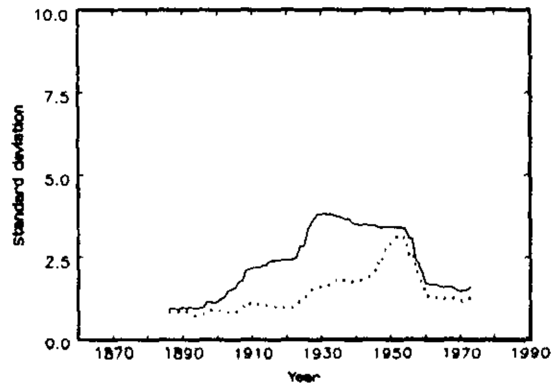


Figure 4.10c Output NO

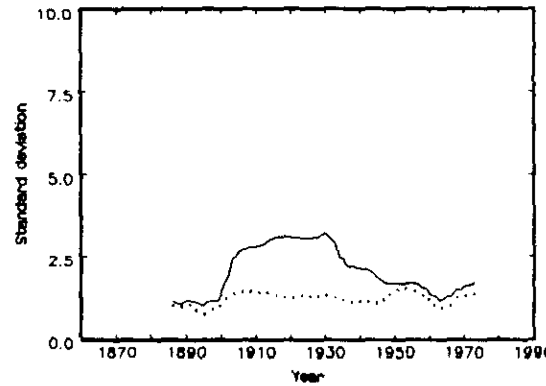


Figure 4.10d Output GE

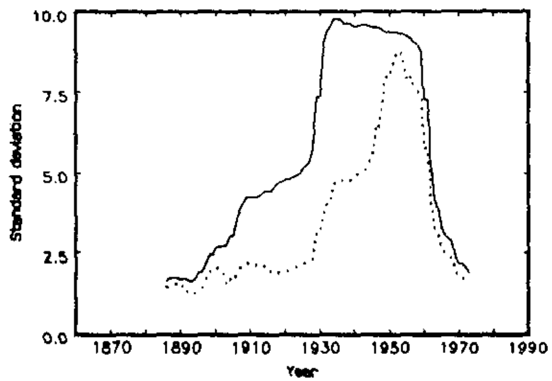


Figure 4.10e Output FR

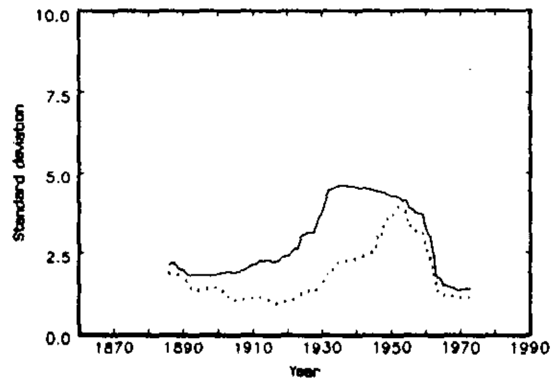
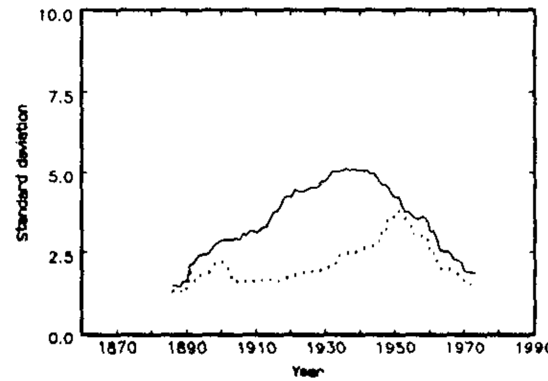


Figure 4.10f Output US



——— Standard deviation
··········· Relative standard deviation

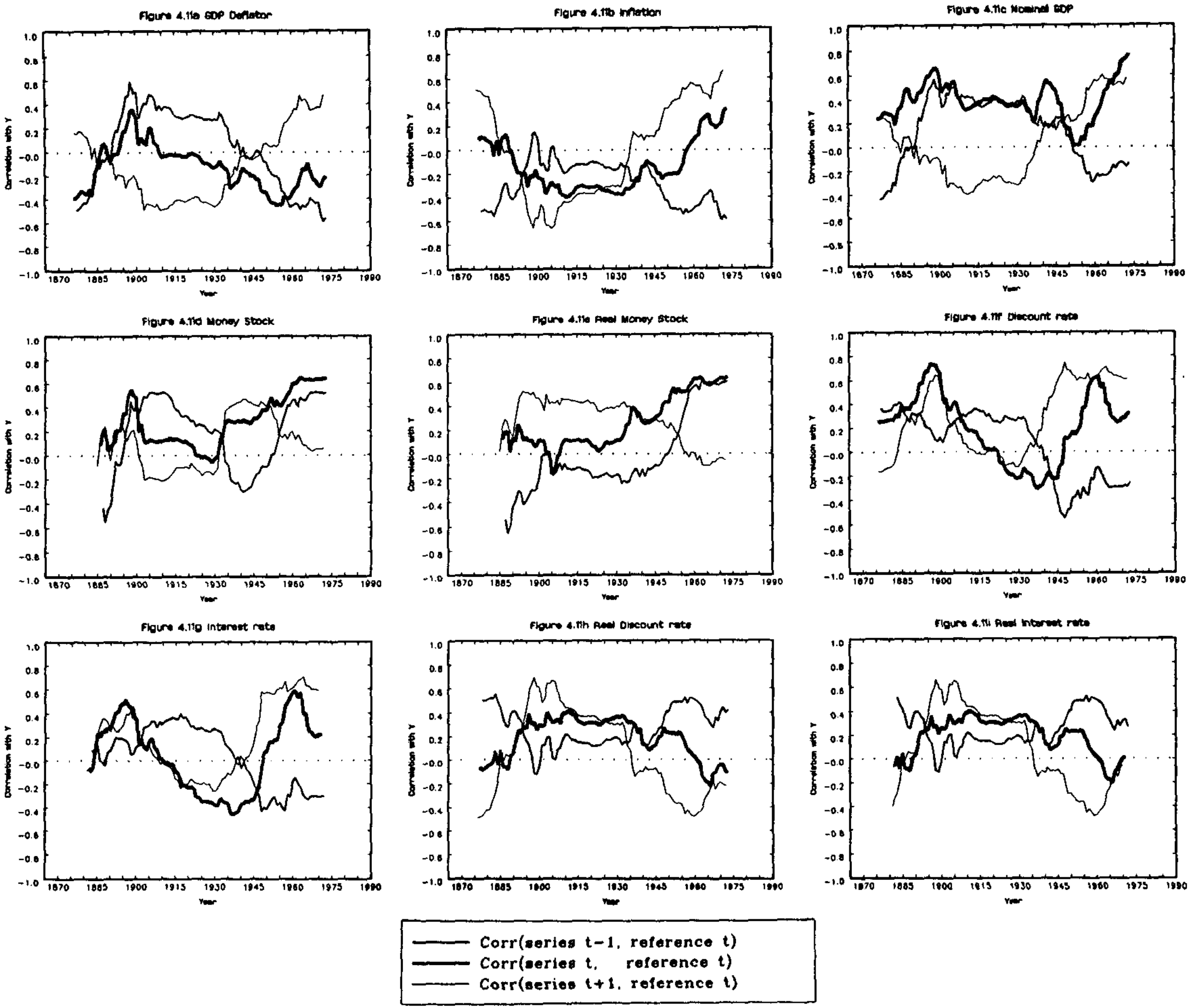


Figure 4.11a GDP Deflator
Figure 4.11b Inflation
Figure 4.11c Nominal GDP
Figure 4.11d Money Stock
Figure 4.11e Real Money Stock
Figure 4.11f Discount rate
Figure 4.11g Interest rate
Figure 4.11h Real Discount rate
Figure 4.11i Real Interest rate
Correlation with Y
Year
Corr(series t-1, reference t)
Corr(series t, reference t)
Corr(series t+1, reference t)

Figure 4.12a GDP

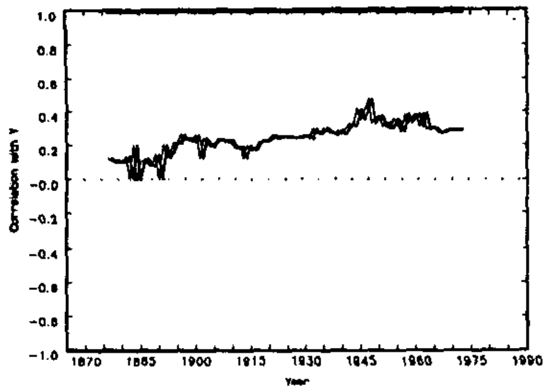


Figure 4.12b Private consumption

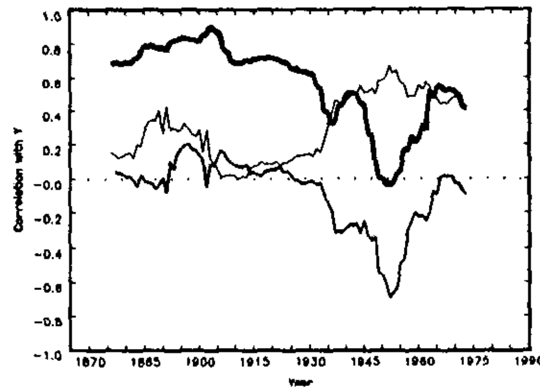


Figure 4.12c Public consumption

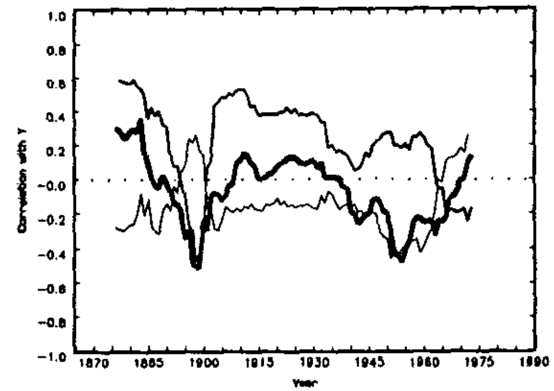


Figure 4.12d Investment

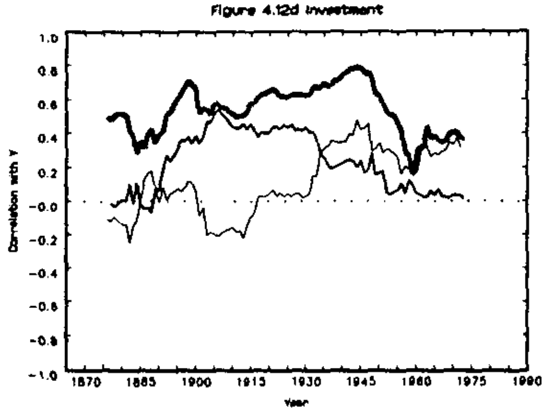


Figure 4.12e Expor

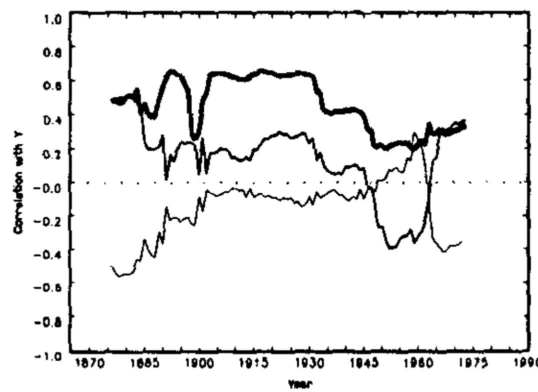


Figure 4.12f Import:

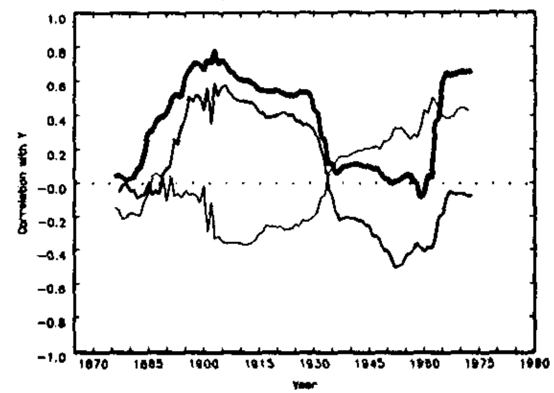


Figure 4.12g Relative price private consumption

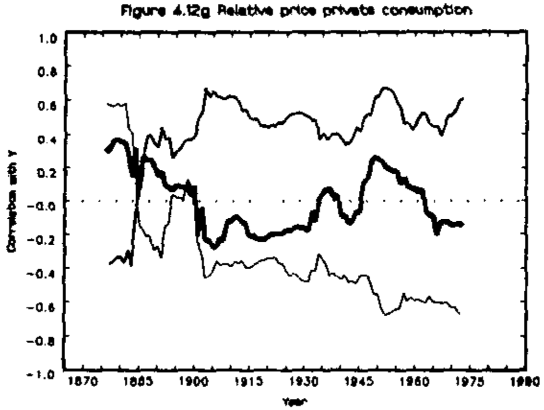


Figure 4.12h Relative price investment

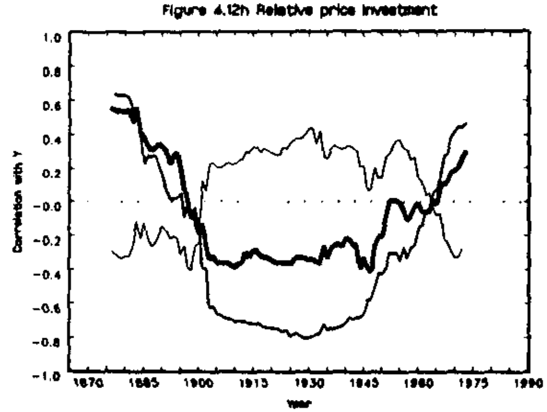
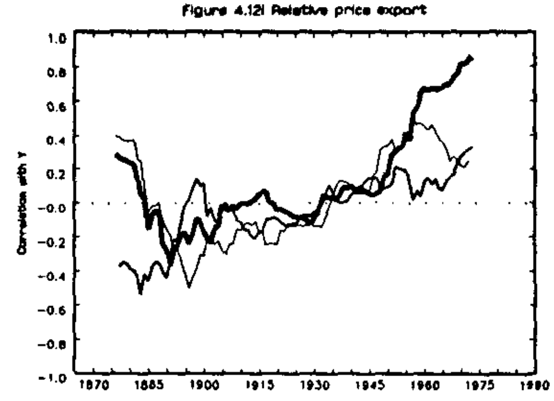


Figure 4.12i Relative price export



Corr(series t−1, reference t)
Corr(series t, reference t)
Corr(series t+1, reference t)

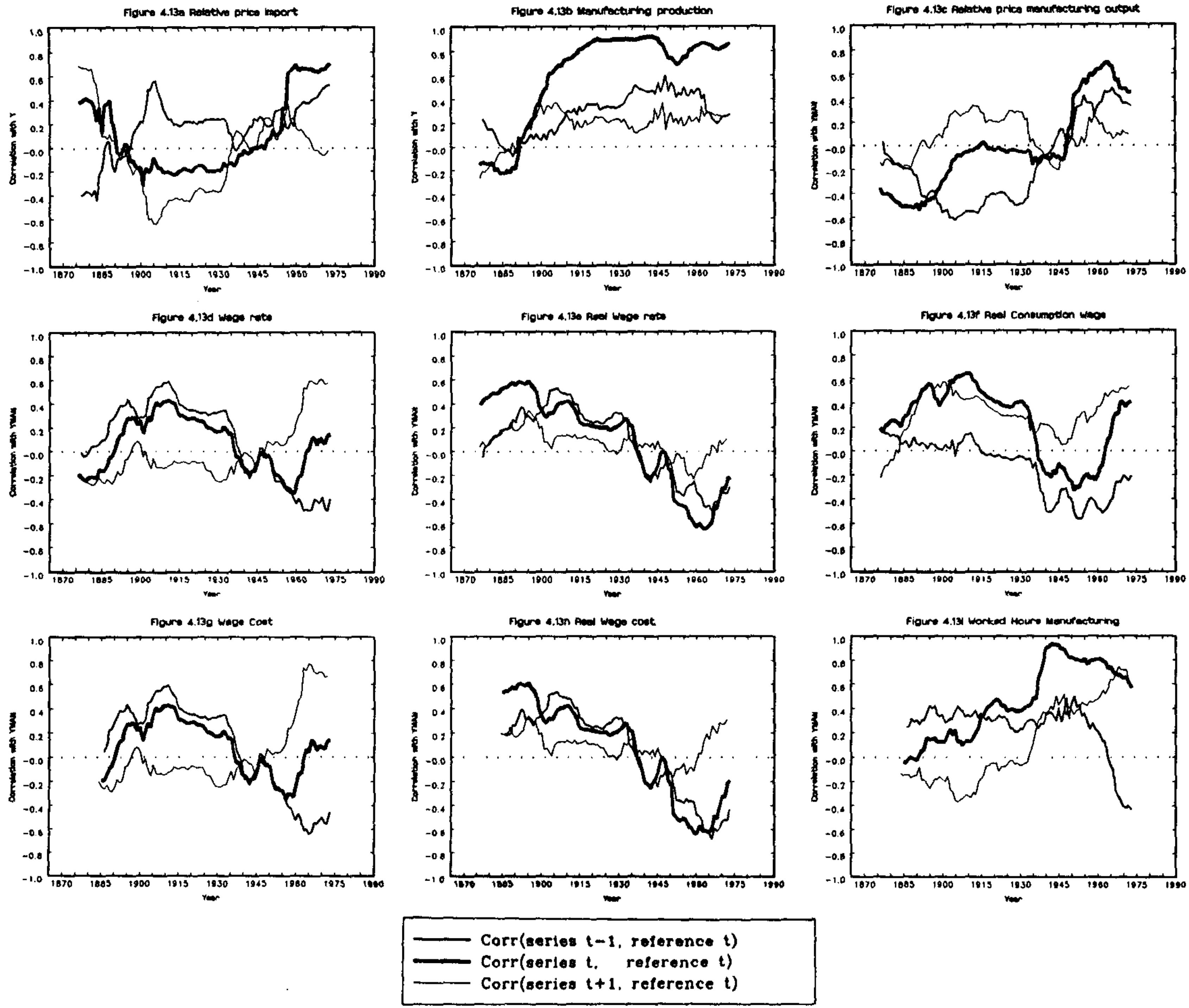


Figure 4.13a Relative price import
Figure 4.13b Manufacturing production
Figure 4.13c Relative price manufacturing output
Figure 4.13d Wage rate
Figure 4.13e Real Wage rate
Figure 4.13f Real Consumption wage
Figure 4.13g Wage Cost
Figure 4.13h Real Wage cost
Figure 4.13i Worked Hours Manufacturing
Year
Corr(series t-1, reference t)
Corr(series t, reference t)
Corr(series t+1, reference t)

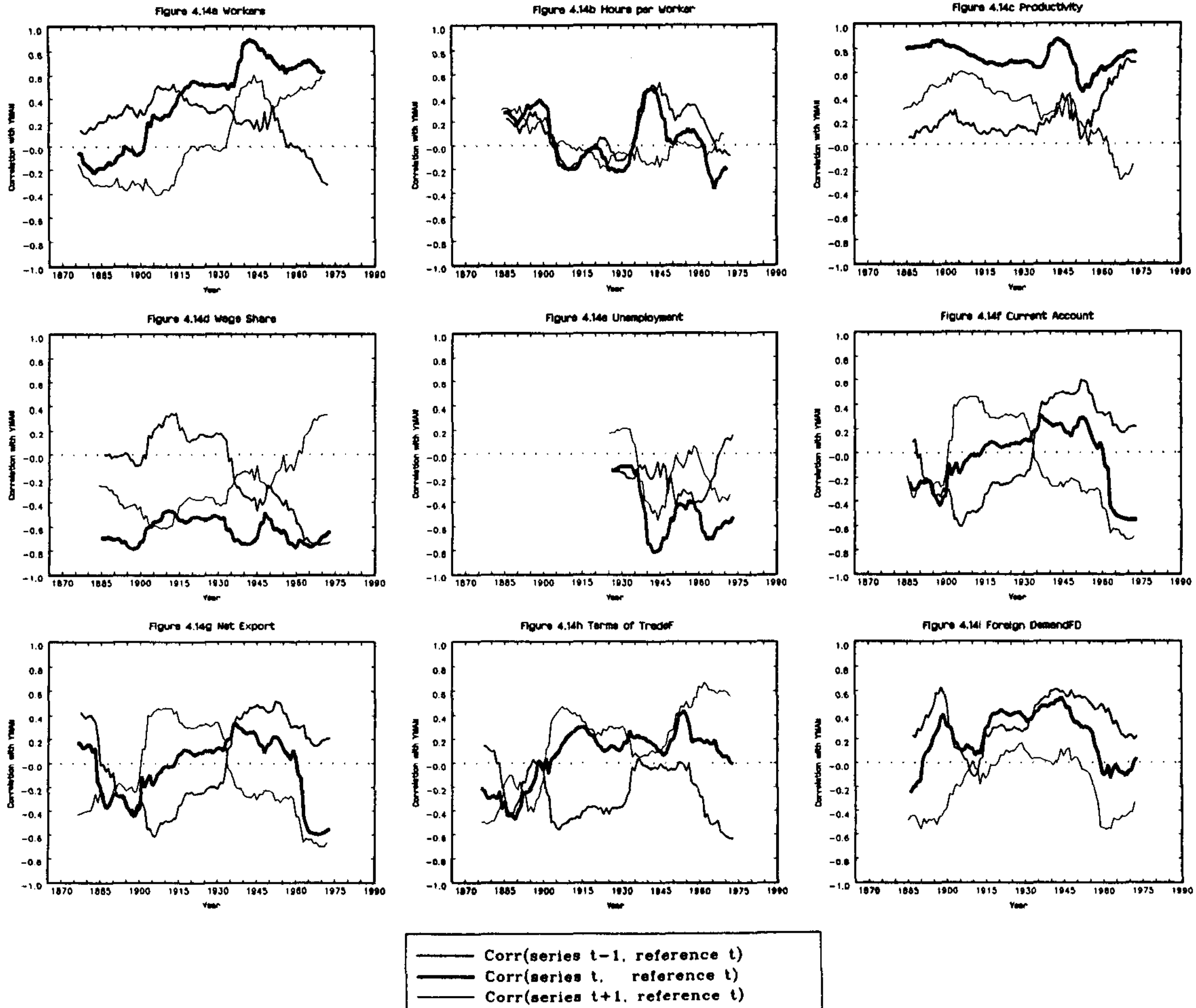


Figure 4.14a Workers
Figure 4.14b Hours per Worker
Figure 4.14c Productivity
Figure 4.14d Wage Share
Figure 4.14e Unemployment
Figure 4.14f Current Account
Figure 4.14g Net Export
Figure 4.14h Terms of TradeF
Figure 4.14i Foreign DemandFD
Correlation with YMAI
Year
Corr(series t-1, reference t)
Corr(series t, reference t)
Corr(series t+1, reference t)

Figure 4.15a Output UK

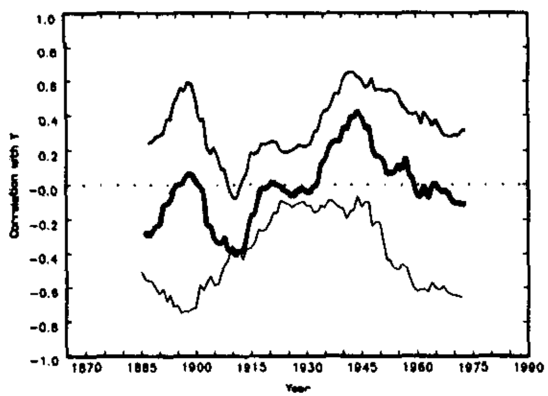


Figure 4.15b Output DK

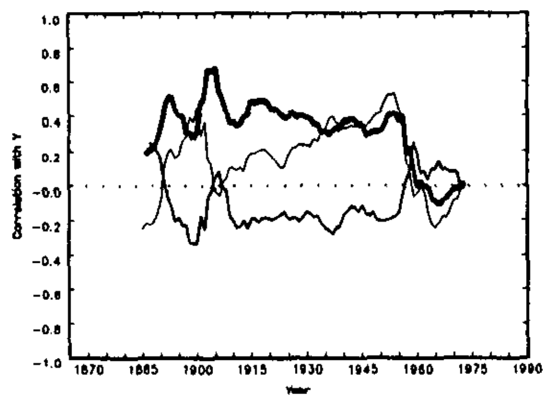


Figure 4.15c Output NO

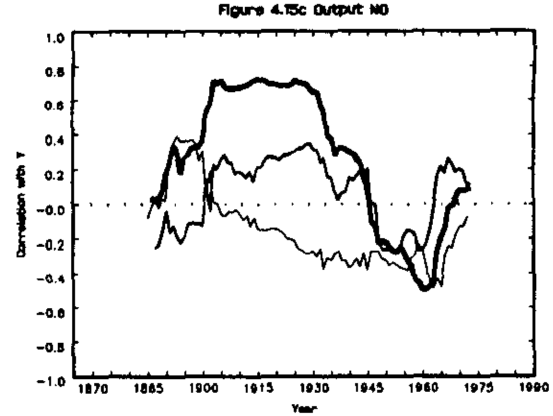


Figure 4.15d Output GE

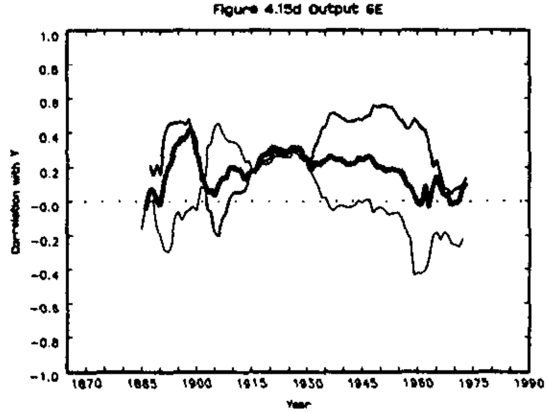


Figure 4.15e Output FR

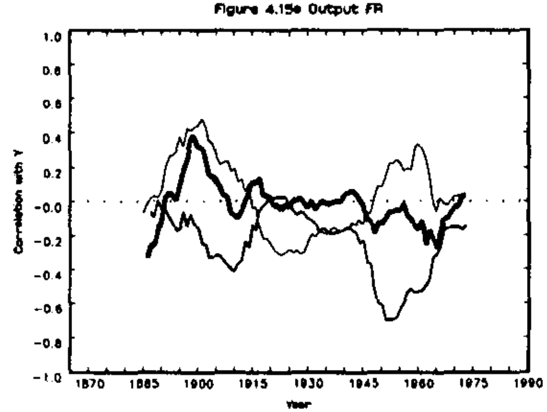
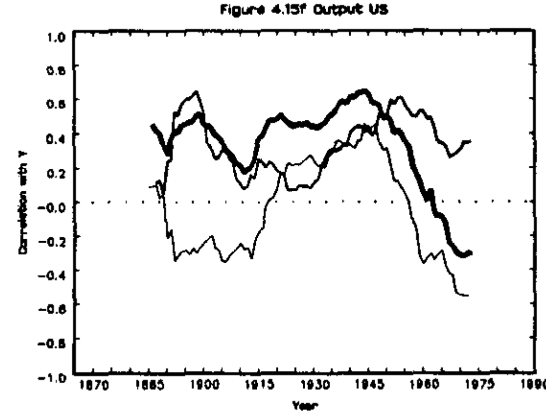


Figure 4.15f Output US



Corr(series t−1, reference t)
Corr(series t, reference t)
Corr(series t+1, reference t)

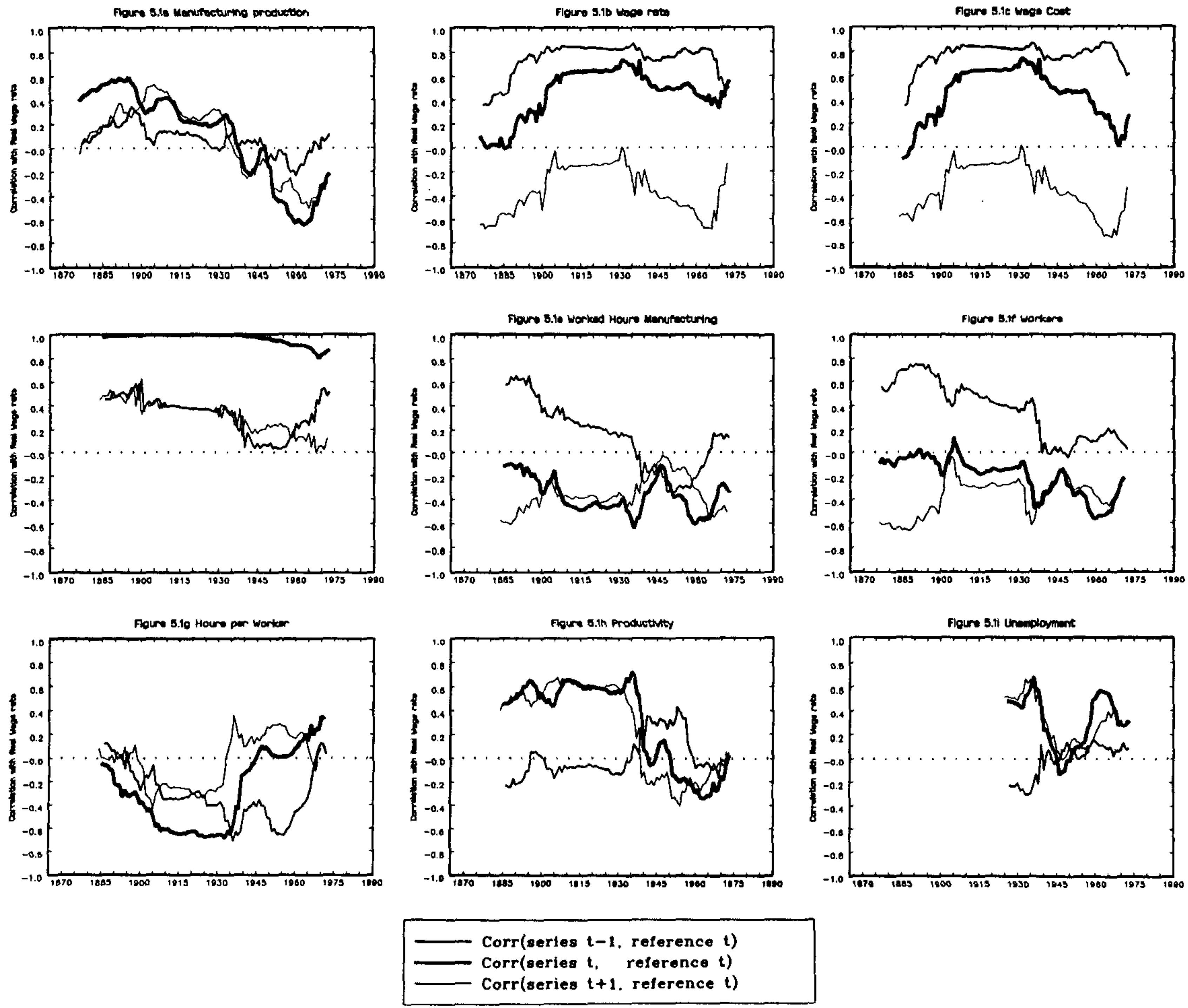


Figure 5.1a Manufacturing production
Figure 5.1b Wage rate
Figure 5.1c Wage Cost
Figure 5.1e Worked Hours Manufacturing
Figure 5.1f Workers
Figure 5.1g Hours per Worker
Figure 5.1h Productivity
Figure 5.1i Unemployment
Correlation with Real Wage rate
Corr(series t-1, reference t)
Corr(series t, reference t)
Corr(series t+1, reference t)

Figure 5.2: Coh Foreign demand and Swedish output

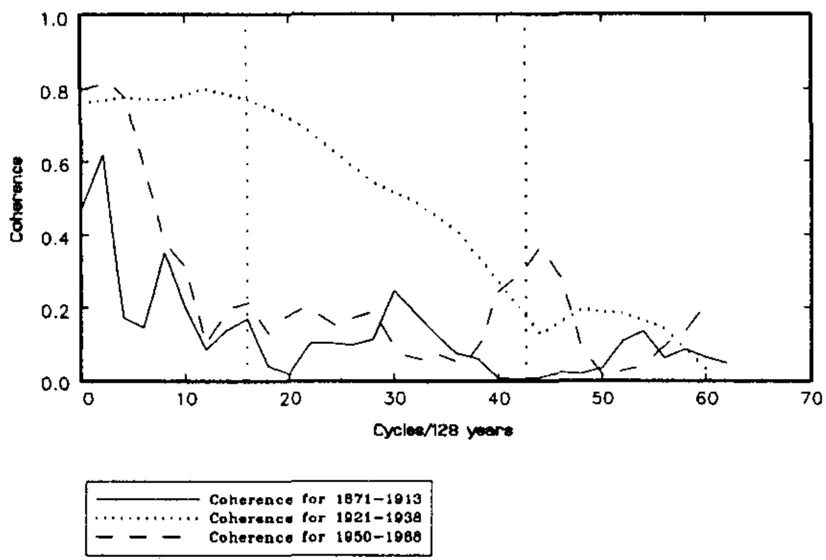


Figure 5.3: Coh Foreign demand and Swedish export

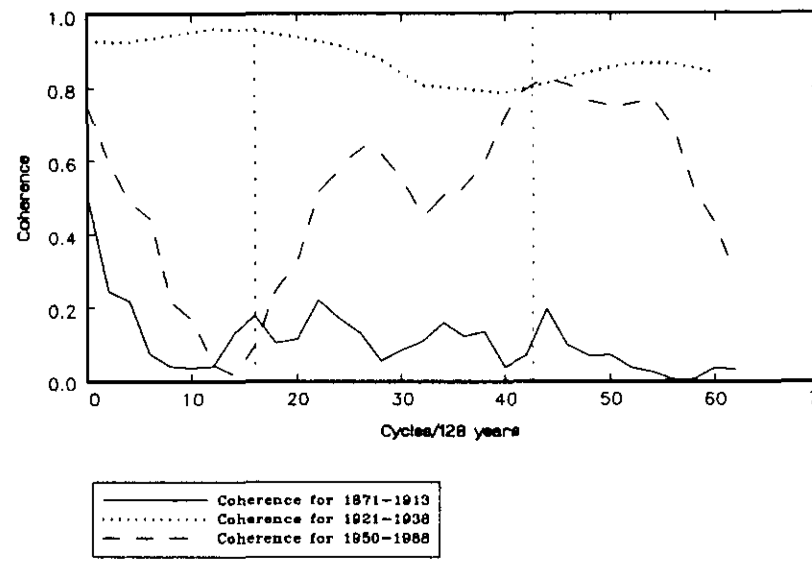


Figure 5.4: Coh Foreign demand and Swedish Manufacturing output

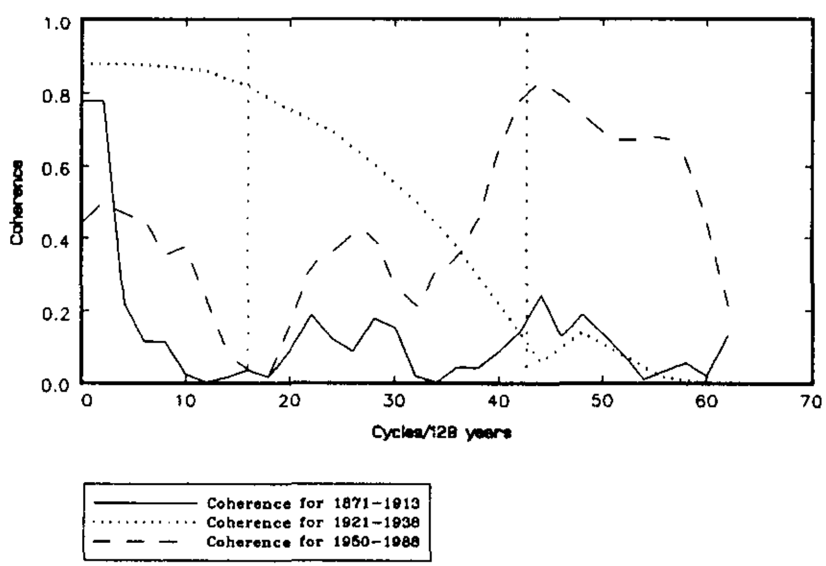


Figure 6.1: Relative importance of the business cycle

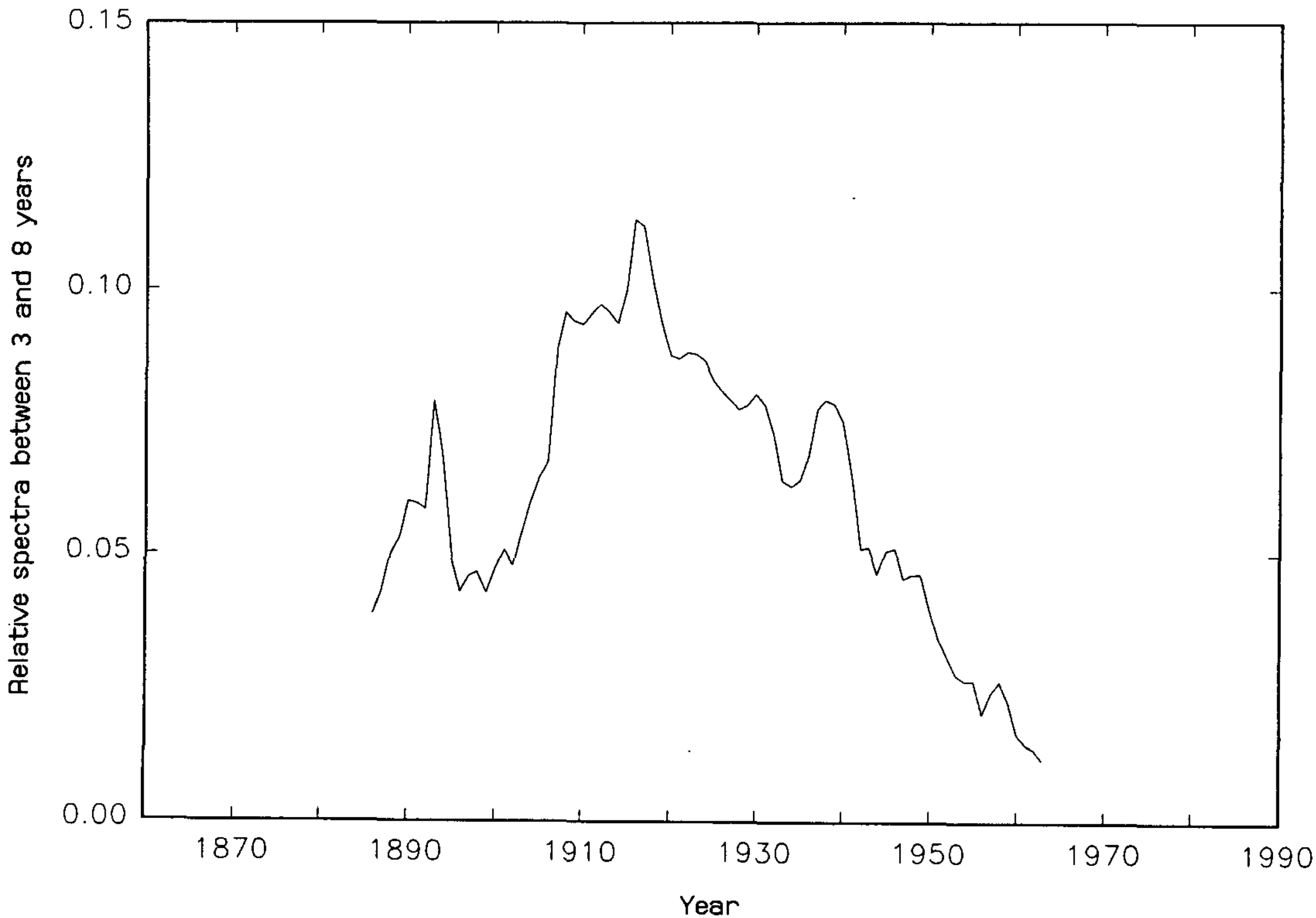


Figure A2.1a: Band pass filter

Figure A2.1b: Henderson-Whittaker λ=10

Figure A2.1c: First-difference