

N^o 2005/2

Oslo
April 6, 2005

Staff Memo

Economics Department

Norwegian Business Cycles 1982-2003

by

Tore Anders Husebø and Bjørn-Roger Wilhelmsen



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ISSN 1504-2596 (online only)

ISBN 82-7553-290-6 (online only)

Norwegian Business Cycles 1982-2003*

Tore Anders Husebø and Bjørn-Roger Wilhelmsen[†]

Abstract

This paper analyses stylised facts regarding business cycles in Norway. We examine the empirical relationships between the aggregate business cycle and the cyclical components of individual macroeconomic time series. The results indicate that the stylised facts about Norwegian business cycles are fairly similar to the stylised facts about the US and the euro area cycles. Consumption and investment are strongly procyclical and broadly contemporaneous with the business cycle. Imports are procyclical and lead the cycle. Hours worked, the number of people employed and the unemployment rate are strongly correlated with the cycle and lag output by around 2 quarters. Domestic inflation is strongly procyclical and lags output by around 5 quarters. Consumption and real wage income are strongly and broadly contemporaneously correlated. Our results differ from the consensus opinion in the literature in that Norwegian labour productivity is acyclical and real wages are procyclical. While the latter deviation seems to be an inherent feature of the Norwegian economy, we argue that the cyclical behaviour of productivity in our sample has been significantly obscured by special factors in the 1990s.

*We thank Hilde Bjørnland, Anne Berit Christiansen, Sharon McCaw, Bjørn Naug, Kjetil Olsen and participants at Norges Bank seminars for very constructive comments. We are grateful to Douglas Laxton (IMF) for providing some of the code used in this paper. Also thanks to Gjermund Grimsby for technical assistance. All the views expressed in the paper are those of the authors and not necessarily those of the Norges Bank

[†]Both Norges Bank, Economics Department

1 Introduction

Business cycles are broadly-based movements of macroeconomic variables (Burns and Mitchell, 1946). During a boom, output rises, employment rises and unemployment falls. During a recession, output of goods and services decline, employment falls and unemployment rises. The sequence of booms and recessions is called the business cycle. The empirical relationships between Gross Domestic Product (GDP) and various aspects of the economy are commonly referred to as the "stylised facts" or "broad regularities" of business cycles.

Following the influential paper by Kydland and Prescott (1990), stylised facts methods have become a popular alternative to econometric models for analysing business cycle properties. In broad terms, stylised-facts methods involve fewer assumptions about the structure of the economy, which is highly uncertain and difficult to model, thus allowing the data to speak with fewer restraints. The methodology involves filtering raw data and calculating bivariate correlations between de-trended macroeconomic variables at different leads and lags. The results may serve as an intuitive and useful benchmark for policymakers in practice.

Recent studies of business cycle regularities include Stock and Watson (1998) and Rebelo and King (2000) for the US and Agresti and Mojon (2001) for the euro area. The results indicate that the cyclical relationships between several macroeconomic variables and GDP are quite similar in the US and the euro area, both in terms of strength and in terms of whether they lead, lag or coincide with GDP.

With respect to Norwegian data, Bjørnland (2000) has previously reported stylised facts about the cyclical components of 10 macroeconomic variables between 1967 and 1994.¹ In this paper we update and extend the analysis of Bjørnland (2000) to 30 macroeconomic variables for the Norwegian economy. We evaluate our results against those in Bjørnland (2000) and against results recently obtained for the euro area and the US.

Besides the fact that we consider a larger set of macroeconomic variables, we deviate from Bjørnland (2000) in that the sample period we consider is from 1982 to 2003, leaving out the first 15 years, but extending the sample period at the end. The main argument for using a more recent sample period is that the structure of the Norwegian economy has changed substantially from the 1960s and 1970s. Production

¹Another interesting reference is Bjørnland (2002). She studies the cyclical behaviour of 8 macroeconomic time series data of the Norwegian economy between 1865 and 1995 (annual data).

and financial technologies have changed and economic policy and financial regulations are different. Another argument is that the early data have significant deficiencies and in general are not comparable to the more recent data. Finally, whereas Bjørnland (2000) utilises a range of methods to obtain robust business cycle components, we focus on one methodology.

Our findings suggest that the stylised facts about the Norwegian business cycle are fairly similar to foreign empirical studies: consumption and investment are strongly procyclical and broadly contemporaneous with the business cycle. Imports are procyclical and lead the cycle. The correlation between labour market indicators (hours worked, the number of people employed and unemployment) and GDP is strikingly high. The labour market indicators lag output by 2 quarters. Domestic inflation is strongly procyclical and lags output by around 5 quarters. Consumption and real wage income are strongly and broadly contemporaneously correlated. The most striking deviations from the literature are the findings of acyclical labour productivity and procyclical real wages within the sample period examined. We discuss these findings in some detail.

The paper is structured as follows. Section 2 outlines the details of the empirical technique we apply and discusses briefly its advantages and disadvantages. Section 3 reports the main conclusions regarding the volatility of individual series and correlations between them. Section 4 take a closer look at some of the evidence that might be of particular interest for monetary policy in Norway. Section 5 concludes.

2 Measuring business cycles: Empirical issues

Most macroeconomic variables grow over time. Consequently, the statistical measurement of business cycles must involve some method of making the series stationary. First differencing the series is one simple technique. However, as pointed out by Stock and Watson (1998), first differencing typically amplifies the high frequency noise, which obscures the cyclical fluctuations that are of primary interest. Moreover, unit root tests typically indicate that most macroeconomic time series in Norway contain a stochastic rather than deterministic trend (Bjørnland 2000). That is, shocks can have permanent effects on the levels of series, a fact that cannot be analysed using differenced data. Making time-series stationary, therefore, is most commonly done by the removal of a (possibly) time-varying trend. However, there are several approaches in the literature and there is no consensus regarding the optimal technique. The technique used in this paper is to de-trend the variables using the

well-known Hodrick-Prescott (HP) filter.²

The HP filter is an algorithm for choosing smoothed values of a time series. The cyclical component of the time series can then be defined as the observed value of the series less the smoothed value (trend):

$$y_t^c = y_t - y_t^* \quad (1)$$

where y_t^c represents the cyclical component, y_t is the actual (observed) series and y_t^* is the time-varying trend. The smoothness of the trend is specified by a parameter called lambda. A larger value of lambda makes the resulting trend smoother (less high-frequency noise), while a smaller lambda means the trend follows the data more closely. Equivalently, a high lambda therefore implies a more volatile cyclical component and vice versa. The HP filter is easy to use and improves upon the first differencing filter in that it eliminates less of the cyclical component and it does not amplify the high frequency noise. However, there are three major caveats associated with the HP filter method:

- The estimated trend values at the beginning and end of the sample period are less reliable, as these values tend to be relatively more affected by fluctuations in the actual, observed, time series.³
- The smoothness parameter, lambda, has to be chosen prior to estimation and is to some extent arbitrary. Using quarterly data for the US economy, Kydland and Prescott (1990) suggested that a lambda equal to 1600 would imply a cyclical GDP series that is reasonable, but this is likely to depend on the economy under review.
- The HP filter can generate business cycle periodicity even if none is present in the original data (King and Rebelo, 1993).

In order to address the uncertainty associated with the choice of the smoothness parameter lambda in the HP filter, we apply three different values: 1600, 6400 and 10000. We find that a lambda smaller than 1600 results in unreasonably volatile trend values as Norwegian macro-economic data are more volatile than those of the US and the euro area. Furthermore, to mitigate the difficulties presented by short-run noise in the time series, we first run X12 ARIMA, subtracting both the estimated

²See Hodrick and Prescott (1980) for details.

³See Bernhardsen, Eitrheim, Jore and Røisland (2004) for a more comprehensive discussion of this problem.

seasonal and irregular components of each original series, which obscure the cyclical fluctuations of primary interest.

An alternative technique popular in the business cycle literature is Baxter and King's (1999) bandpass filter. This filter was applied by Stock and Watson (1998) on US data and Agresti and Mojon (2001) on euro area data. The cyclical component resulting from the bandpass filter can be thought of as those movements in the series associated with periodicities within a specified range of business cycle durations. However, analogously to choosing the lambda in the HP filter, the business cycle duration has to be defined rather arbitrarily in advance. While the two filter techniques may in principle may lead to slightly different conclusions, these differences are likely to be considerably less pronounced in practice when the correlations between GDP and the variables being studied are high. In fact, testing the two methodologies on Norwegian data, we get very similar results.⁴

Figure 1 shows the cyclical component of quarterly real GDP in Norway derived with the HP filter using three different values of lambda as described above. A lambda equal to 1600 results in the greatest fluctuations in the trend component and, accordingly, the smallest fluctuations in the cycle. In the figure we also show a bandpass measure of cyclical output.⁵ The figure shows that the difference between the bandpass cyclical measure and the HP filter cyclical measure (lambda equal to 1600) is minor.⁶

The alternating periods of positive and negative values in cyclical output in the figure represent economic booms and recessions respectively. The figure confirms that the business cycle is an enduring feature of the Norwegian economy. It is also evident that the amplitude of the booms and recessions depends on the lambda chosen in the HP filter. However, the signs of the cycles and the duration of the booms and recessions appear to be fairly robust to the value of lambda.

⁴Additional filtering techniques to estimate the cyclical component of a time series are discussed in Bjørnland (2000) and the box "Norges Bank's estimate of the output gap" in Inflation Report nr. 2/2004 available at www.norges-bank.no. The reported evidence indicates that the various calculations generally show the same broad movements. This implies that when the correlation between individual series and GDP is high, different filter techniques should not bring about very different results.

⁵The bandpass filter defines the cyclical component of output as that with periodicities between 6 and 40 quarters.

⁶King and Rebelo (2000) also find that the difference between the cyclical measures implied from the HP filter and the bandpass filter is very small when applied on US output data.

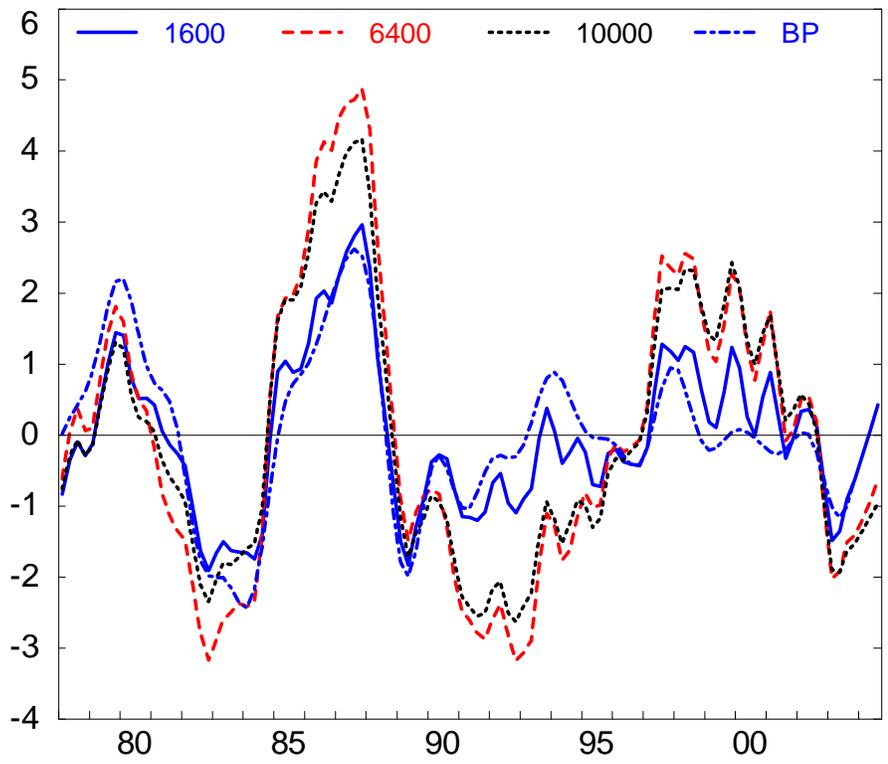


Figure 1: The cyclical component of real GDP Mainland Norway. HP-filter detrended with lambda of 1600, 6400 and 10000, and bandpass filter (periodicity 6-40 quarters)

3 Stylised facts about the Norwegian business cycle

This section summarises stylised facts about the Norwegian economy based on the results reported in table 1 and 2 below and the charts in the appendix. The data cover a total of 84 quarterly observations between 1982q1 and 2003q4.

We are particularly interested in examining the cyclical co-movements between each series and real GDP, since cyclical output is commonly considered to be a useful proxy for the overall business cycle. In the charts in the appendix, each of the 30 variables included in the study is described by four types of empirical evidence. First, the actual time series and its trend component are plotted in the top left chart. The actual series is adjusted for seasonality and irregular components using X12-Arima, while the trend component is obtained by running the HP filter on this adjusted series. For the sake of readability, only one lambda smoothing parameter (6400) is shown, whereas the tables report the range of estimates applying three different lambdas (1600, 6400 and 10000).

Second, the cyclical component of each series (the difference between actual and trend in the first chart) is plotted against the cyclical component of output (the top right chart). Third, the correlation coefficients shown in the lower left chart indicate the lead, lag or coincident properties of the individual cycles with respect to cyclical GDP. A large positive correlation indicates procyclical behavior of the series, whereas a large negative correlation indicates countercyclical behavior. A correlation coefficient close to zero indicates acyclical behavior. A maximum correlation at, for example $t=+2$ indicates that the cyclical component of the series tends to lead the overall business cycle by 2 quarters. A variable may exhibit negative correlation at a lag, but positive correlation at a lead, and vice versa. However, in practice common sense and the idiosyncrasies of the data generally make interpretation straightforward. Finally, to examine the stability of the correlations we use a rolling window of 40 quarters to examine how contemporaneous and ± 6 quarters correlations have evolved over time (lower right chart).

We compare our results with those from the comprehensive analysis of Stock and Watson (1998) on US data. We also compare, where available, with the results of Agresti and Mojon (2001) and Bjørnland (2000) for the euro area and Norway respectively.

3.1 Volatility of the series

3.1.1 GDP

The standard deviation of the cyclical component of real GDP in mainland Norway (henceforth output) is estimated to be 1.1, 1.6 and 1.8 using a lambda equal to 1600, 6400 and 10000 respectively (See table 1). These estimates are at the lower end of the range of estimates reported in Bjørnland (2000) using a slightly different sample period (1967 to 1994), suggesting that business cycle fluctuations may have diminished somewhat over the past 20 years. The standard deviation of the aggregate cycle in the euro area is estimated to be slightly lower (0.8), while Stock and Watson's (1998) estimate for the US economy (1.66) is well within the range of our results for Norway.

3.1.2 Consumption, investment, exports and imports

The estimated standard deviations of the cyclical components of private consumption, private investment (excluding oil and shipping), exports and imports are broadly within the range of the estimates reported in Bjørnland (2000) for a slightly different sample period. One exception is private investment, which seems to have become more volatile over the past 20 years. With the exception of public consumption, all individual demand components of GDP are more volatile than the aggregate cycle. The cyclical components of the investment variables are clearly the most volatile series in Norway, with private investment 5 to 6 times more volatile than output. This number is considerably higher than in the euro area (2.2 times) and the US (3 times). Investment in oil and shipping is 10 to 15 times more volatile than output. Exports excluding oil are 1.8 to 2.6 times more volatile than output, somewhat lower than in the US (2.9), whereas imports are 3.0 to 3.8 times more volatile than output, a little higher than the US estimates (2.7). Interestingly, private consumption in Norway is 1.2 to 1.4 times more volatile than output. In the euro area and the US, in contrast, private consumption is smoother than output and estimated to be, respectively, 0.7 and 0.8 times as volatile than output. The large volatility in private consumption relative to output in Norway over the sample is due in particular to the consumption boom of the mid-1980s, following the de-regulation of financial markets.

3.1.3 Capital, labour, productivity and real wages

A striking result reported by Stock and Watson (1998) for the US was that total hours worked had practically the same volatility as output.

Table 1: Standard deviations of the cyclical components of time series

	Norway				Euro area		USA	
	Husebø & Wilhelmsen ¹		Bjørnland ²		Agresti & Mojon ³		Stock & Watson ⁴	
	absolute	rel/GDP	absolute	rel/GDP	absolute	rel/GDP	absolute	rel/GDP
Gross Domestic Product⁵(Y)	1.11-1.84	1	1.45-3.13	1	0.84	1	1.66	1
Private Consumption (C)	1.58-2.22	1.21-1.42	1.26-3.45	0.83-1.40	0.55	0.70	1.26	0.76
Public consumption⁶(G)	1.24-1.41	0.77-1.12					2.49	1.50
Private Investment (I)	6.22-10.72	5.60-5.83	2.30-6.89	1.52-3.51	1.85	2.20	4.97	2.99
Housing Investment (IH)	6.55-10.62	5.77-5.90					10.04	6.05
Public Investment (IG)	5.54-7.04	3.83-4.99						
Oil Investment (IOS)	16.37-18.21	9.90-14.75						
Exports (X)	2.86-3.36	1.83-2.58	2.23-5.93	1.16-2.36			4.77	2.87
Imports (M)	4.17-5.44	2.96-3.76	2.81-7.31	1.86-3.42			4.42	2.66
Unemployment Rate⁷ (UR)	0.73-1.18	0.64-0.66	0.18-0.62	0.12-0.25			0.76	0.46
Hours Worked (L)	1.13-1.83	0.99-1.02					1.61	0.97
Employment, people (NP)	1.08-1.82	0.97-0.99					1.39	0.84
Labour force (LF)	0.77-1.25	0.68-0.69						
Labour Productivity (ZL)	0.79-0.89	0.48-0.71	1.00-2.61	0.52-1.08			1.05	0.63
Unit Labour Costs (ULC)	1.19-1.34	0.73-1.07						
Average working time (AWT)	0.50-0.60	0.33-0.45					0.37	0.22
Capital Stock (K)	0.50-0.98	0.45-0.53						
Capital Utilisation (KU)	0.95-1.15	0.63-0.86					3.07	2.44
Consumer Price Index (CPI)	0.94-1.37	0.73-0.85	0.51-4.55	0.34-2.26	0.68	0.80	1.35	0.81
CPI Domestic (CPII)	1.07-1.63	0.87-0.96						
Real wage costs (RWCL)	0.81-1.24	0.67-0.73						
Real wage income (RWI)	0.75-1.01	0.55-0.68	0.70-2.96	0.36-1.01			0.64	0.39
CPI, annual growth (PIE4)	1-1.19	0.65-0.90			0.31	0.40	1.44	0.87
CPI, quarterly growth (PIE1)	1.34-1.49	0.81-1.21						
Domestic Inflation (PIE4I)	1.06-1.33	0.72-0.95						
Imported inflation (PIE4M)	1.94-2.07	0.90-1.94						
Real wage growth (PIE4RW)	0.81-0.93	0.51-0.73					1.10	0.66
Nominal interest rates (RN)	0.88-1.07	0.58-0.79			1.09	1.30	1.47	0.89
Real interest rates (RR)	0.97-1.07	0.58-0.87			0.76	1.38	0.71	0.43
Real Exchange Rate (Q)	2.59-2.84	1.54-2.33			3.58	4.30		

1) Numbers calculated using the HP filter with different smoothing parameters. Sample period: 1982q1-2003q4

2) Numbers calculated using a variety of filtering techniques. Sample period: 1967q1-1994q1

3) Numbers calculated using the Baxter & King band pass filter. Upper bound on the length of the cycle is 40 quarters
Sample period: 1970q1-1999q4

4) Numbers calculated using the Baxter & King band pass filter. Upper bound on the length of the cycle is 32 quarters
Sample period: 1953q1-1996q4

5) For Norway this number refers to Mainland Norway

6) For the US this number refers to Government purchases

7) In Bjørnland (2002) this number is the percentage point change

As evident in table 1, this is also true for Norway. Interestingly, the number of people employed also has about the same volatility as output. In the US, in contrast, employment is less volatile than output. Labour productivity in Norway (output per worker-hour) is less volatile than output (0.5 to 0.7 times output volatility), about the same as for the US (0.6). The labour force is also somewhat less volatile than output (about 0.7 times output volatility) and the capital stock is about half as volatile as output.

Real wage costs per hour and real wage income per hour are less volatile than output (0.6 to 0.7 times output volatility), broadly in line with Bjørnland (2000). In the US, the standard deviation of real wage income per hour is reported to be only 0.4 times output. The volatility of real wage growth in Norway is about 0.5-0.7 times the volatility of output, practically identical to the US results.

3.1.4 Prices

Overall consumer prices in *levels* are less volatile than output (0.7 to 0.9 times output volatility). This conclusion is very similar to the results for the US and the euro area (0.8 in both economies). Bjørnland (2000), in contrast, reports mixed evidence and shows that consumer prices are more volatile than output under some filtering techniques.

Overall consumer price *inflation* (annual growth) is also less volatile than output (between 0.6 and 0.9 times output volatility). The inflation rate for imported goods and that for domestically produced goods and services are both more volatile than the aggregate inflation rate. In the US, overall consumer price inflation is estimated to be 0.9 times as volatile as output, whereas in the euro area this number is only 0.4. The very low volatility of price inflation relative to output in the euro area seems to support the commonly held view that inflation persistence is particularly high in the euro area.

3.2 Cross-Correlations

3.2.1 Consumption, investment, exports and imports

Private consumption is strongly pro-cyclical and broadly leads output over the sample by one quarter, with a maximum correlation coefficient of 0.77 to 0.85 depending on the value of the lambda. Private investment and housing investment also exhibit strong positive correlations with output, lagging by one and two quarters respectively. These results are practically identical to those for the euro area and the US and in line

with the estimates reported for Norway in Bjørnland (2000). Public consumption and public investment are, on average, virtually acyclical. Oil investment appears to be virtually acyclical over the sample as a whole, in contrast to the consensus view on the role of oil investments for the business cycle in Norway.⁷ However, as evident from the rolling correlation coefficients, oil investment has been contemporaneously procyclical since 1998.

Imports are procyclical (0.61 to 0.78) and lead output by two quarters. Exports appear to be acyclical, thus leaving the trade balance countercyclical.⁸ However, the rolling coefficients suggest that exports have been strongly and contemporaneously procyclical since 1998.

3.2.2 Capital, labour, productivity and real wages

Total hours worked, employment and unemployment are correlated with output, as expected. All three variables lag output by 2 quarters over the sample. The correlation coefficients are in the range of 0.83 to 0.95 (absolute values), with unemployment countercyclical whereas employment and hours are procyclical. The correlation coefficients, which are very high, are broadly in line with the US estimates. Moreover, the cyclical component of the labour force series is also substantially correlated with output and lags output by 3 quarters. Output and the capital stock are positively correlated, with capital lagging the business cycle by around 10 quarters. Capital utilisation is also procyclical and leads the business cycle by around 1 quarter.

With respect to labour productivity, most business cycle studies find a strong positive relationship with lagged output. Such a relationship was also identified in Norwegian data by Bjørnland (2000). We find, in contrast, that labour productivity is virtually acyclical over the sample. However, as evident from the rolling coefficient estimates, this result may be sample dependent. In the 1980s, there was a strong positive relationship between labour productivity and lagged output. In the 1990s, this relationship vanished and, eventually, became negative. This finding is discussed further in section 4.

Real wage costs per hour and real wage income per hour exhibit a strikingly strong procyclical relationship with output and are broadly contemporaneous with the business cycle. This result contrasts with the results for the euro area and the US, and is also different from the re-

⁷See for example Eika and Johansen (2000)

⁸A countercyclical trade balance is in line with the results reported in Bjørnland (2000) and is also found for the US by Stock and Watson (1998).

Table 2: Cross autocorrelations with lag(-) and lead(+) with respect to GDP¹

	Norway				Euro area		USA	
	Husebø & Wilhelmssen ²		Bjørnland ³		Agresti & Mojon ⁴		Stock & Watson ⁵	
	t=0	max corr.	t=0	max corr.	t=0	max corr.	t=0	max corr.
Private Consumptions (C)	0.77-0.84	0.77-0.85 (+1)	0.45-0.72		0.79	0.80 (-1)	0.90	
Public consumption⁶(G)	-0.09-0.21						0.15	0.30 (+6)
Private Investment (I)	0.63-0.83	0.7-0.85 (-1)	0.28-0.84	0.76-0.88 (+2)	0.86		0.89	
Housing Investment (IH)	0.43-0.73	0.51-0.76 (-2)					0.62	0.78 (-2)
Public Investment (IG)	0.19-0.22	0.39-0.46 (-5)						
Oil Investment (IOS)	-(0.24-0.3)							
Exports (X)	0.01-0.15		-0.08-0.31	0.3-0.44 (-2)			0.27	0.50 (+3)
Imports (M)	0.63-0.72	0.61-0.78 (+2)	0.13-0.77				0.78	
Unemployment Rate⁷ (UR)	-(0.73-0.85)	-(0.86-0.94) (-2)	-(0.23-0.8)	-(0.33-0.81) (+1)			-0.89	-0.93 (+1)
Hours Worked (L)	0.74-0.87	0.83-0.92 (-2)					0.88	0.94 (+1)
Employment (NP)	0.76-0.85	0.89-0.95 (-2)					0.81	0.92 (+1)
Labor force (LF)	0.55-0.76	0.71-0.88 (-3)						
Labor Productivity (ZL)	0.14-0.2	0.33-0.35 (+5)	0.5-0.83				0.53	0.72 (-2)
Average working time (AWT)	0.04-0.08	0.13-0.38 (+4)					0.82	
Capital Stock (K)	0.04-0.19	0.75-0.88 (-10)						
Capital Utilisation (KU)	0.43-0.52	0.43-0.56 (+1)					0.93	
Consumer Price Index (CPI)	-(0.19-0.32)	-(0.61-0.72) (+5)	-0.53-0.23	-(0.32-0.62) (-5)	-0.26	-0.72 (-3)	-0.51	-0.68 (-2)
CPI Domestic (CPII)	-(0.38-0.5)	-(0.61-0.75) (+4)						
Real wage cost (RWCL)	0.72-0.84							
Real wage income (RWI)	0.58-0.72	0.63-0.73 (+1)	-0.14-0.35	-(0.27-0.3) (-4)			0.16	
CPI, annual growth (PIE4)	0.4-0.48	0.57-0.67 (-4)			0.20	0.35 (+4)	0.35	0.64 (+3)
Domestic Inflation (PIE4I)	0.31-0.38	0.6-0.7 (-5)						
Imported inflation (PIE4M)	0.49-0.55	0.51-0.56 (-1)						
Nominal interest rates (RN)	0.01-0.1	0.17-0.25 (-2)			0.61	0.73 (+2)	0.38	0.63 (+2)
Real interest rates (RR)	-(0.08-0.12)	-(0.37-0.44) (+4)			0.26	0.68 (+2)	-0.28	-0.38 (-2)
Real Exchange Rate (Q)	0.11-0.25	0.3-0.37 (+2)			0.17	0.36 (+2)		

1) The first column gives the contemporaneous cross correlation between GDP and the individual series

The second column contains the maximum correlation (if different from the contemporaneous correlations) with the applicable number of quarters lead(+)/lag(-) for each series with respect to GDP in the parentheses below

2) Numbers calculated using the HP filter with different smoothing parameters. Sample period: 1982q1-2003q4

The lead/lag number in parentheses refers to the highest correlation coefficients for each individual series with GDP

3) Numbers calculated using a variety of filtering techniques. Sample period: 1967q1-1994q1

The lead/lag number in parentheses refers to the highest correlation coefficients for each individual series with GDP

4) Numbers calculated using the Baxter & King band pass filter. Upper bound on the length of the cycle is 40 quarters

Sample period: 1970q1-1999q4

5) Numbers calculated using the Baxter & King band pass filter. Upper bound on the length of the cycle is 32 quarters

Sample period: 1953q1-1996q4

6) For the US this number refers to Government purchases

7) In Bjørnland (2002) this number is the percentage point quarterly change

sults reported in Bjørnland (2000)⁹. We discuss this finding in section 4.

3.2.3 Prices

As for the euro area and the US, and consistent with the findings of Kydland and Prescott (1990), output and consumer prices in *levels* are negatively correlated, with prices leading output. The correlation between prices and output reaches its maximum at a lead of 4 quarters for prices on domestically produced goods and 6 quarters for the overall CPI index. This result is also in line with those reported by Bjørnland (2000).

Overall consumer price *inflation* is, in contrast, strongly procyclical and lags output by around 4 quarters. While inflation for domestically produced goods and services lags output by 5 quarters, imported inflation lags output by only 1 quarter. Hence, imported inflation leads domestic inflation by approximately 4 quarters. The positive relationship between price inflation and output is also found in the euro area and US data.

4 A closer look at the evidence

4.1 Procyclical real wages. Countercyclical prices?

Stylised facts analyses have been influential in shaping the views of economists about how economies operate. In particular, the work of Kydland and Prescott (1990) on US data contributed to changing some commonly held beliefs often stated in the literature in the 1980s. An important example was the presumption that the price level is procyclical. In their influential paper, Kydland and Prescott (1990) demonstrated, in contrast, a strong countercyclical relationship. Moreover, Kydland and Prescott (1990) also found that the real wage level is procyclical in the US. This is somewhat more controversial as some recent studies support the view of acyclical behavior.¹⁰

Interestingly, our findings support the main conclusions in Kydland and Prescott (1990), namely that the price level is countercyclical and the real wage level procyclical. These facts can easily be accounted for by a real business cycle model like that of Kydland and Prescott (1982), a dynamic stochastic general equilibrium (DSGE) model subject to per-

⁹Bjørnland (2000) finds that real wages are acyclical using most filtering techniques. However, using a very low lambda in the HP filter, real wages are slightly procyclical.

¹⁰See for example Stock and Watson (1998)

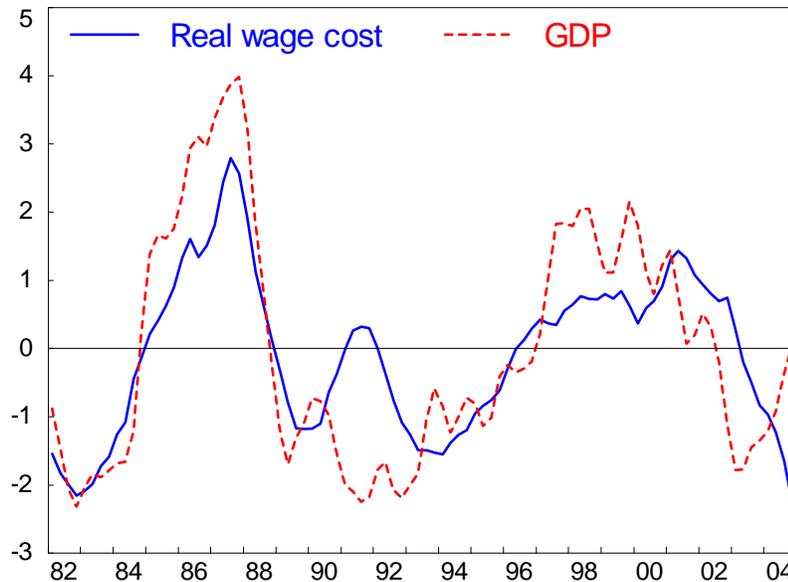


Figure 2: The cyclical component of real wages and output. Detrended using the HP filter, $\lambda=6400$

sistent technological shocks and fully flexible prices. For example, if productivity were to increase, prices would immediately fall and real wages rise. However, following new-Keynesian theory, procyclical real wages can also occur with sticky prices as a result of demand shocks for two reasons: First, a demand shock that boosts consumption will, under standard utility assumptions, increase the value of leisure and thereby put upward pressure on real wages. Second, a demand shock increases the demand for labour, which again tends to put upward pressure on real wages. As evident from figure 2, real wage costs per hour exhibited particularly strong procyclical behaviour during the consumption boom in the late 1980s, and the following recession.

While consumer prices (in levels) are negatively correlated with output at leads (in line with the results of Kydland and Prescott), an arguably more interesting finding for monetary policy is that they are positively correlated with output at lags (see charts 16-26 in the appendix). This implies that consumer price *inflation* is procyclical as well, in line with modern DSGE models that incorporates nominal rigidities. Figure 3 illustrates the very close positive relationship we find between the cyclical components of domestic inflation and GDP, with domestic inflation lagging the business cycle by around 5 quarters. This finding suggests that

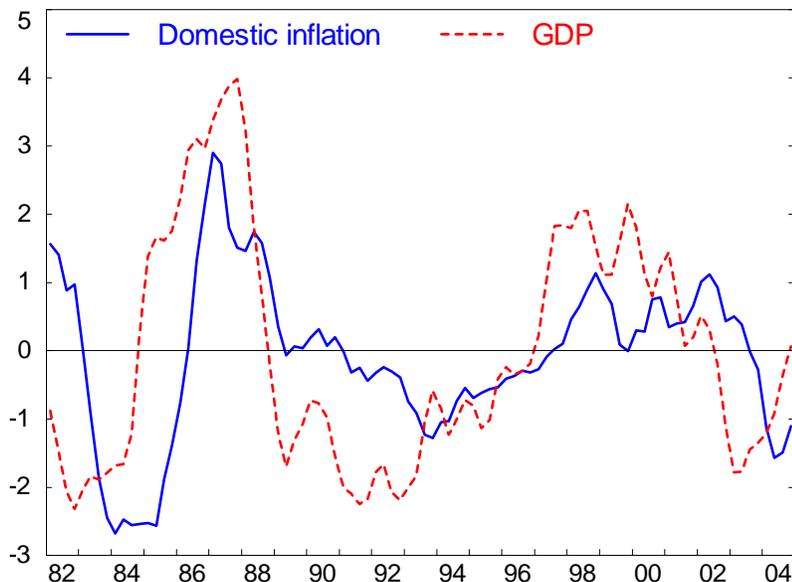


Figure 3: The cyclical components of domestic inflation and output. De-trended using the HP-filter, $\lambda=6400$

a standard Phillips curve may explain domestic inflation quite well.

4.2 Is productivity procyclical?

Procyclical productivity under both supply and demand shocks has become a widely accepted stylised fact. This finding is illustrated by the results of Stock and Watson for the US business cycle, and has become an essential feature of business cycle analysis in the recent macroeconomic literature. Basu and Fernald (2000) propose four main explanations for the observed procyclical productivity: First, procyclical productivity may reflect procyclical technology. Second, imperfect competition and increasing returns may cause productivity to rise whenever inputs increase. Third, factor utilisation may vary over the cycle. Fourth, reallocation of resources across uses with different marginal products may contribute to procyclical productivity.

Notwithstanding this common finding and its theoretical justifications, our results indicate that productivity in Norway is virtually acyclical. Investigating Figure 4 in detail, labour productivity was indeed procyclical and led output in the 1980s, in line with the commonly held view. In the 1990s, however, this correlation was no longer evident in

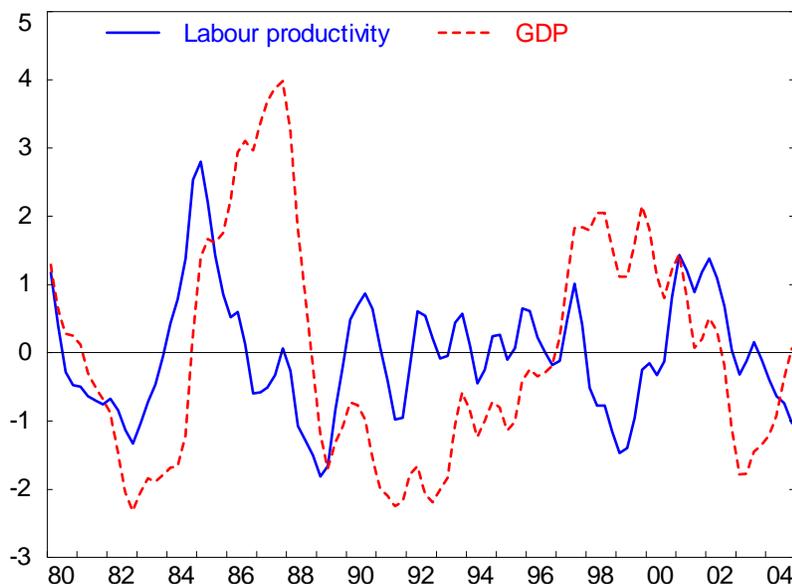


Figure 4: The cyclical components of labour productivity and output. De-trended using the HP-filter, $\lambda=6400$

the data. The impression of a declining correlation between productivity and GDP, with productivity leading the business cycle, is also supported by the rolling correlation coefficient shown in chart 13 in the appendix.

While caution is warranted over the interpretation of this evidence, the acyclical behaviour of productivity in the latter part of our sample might have been significantly influenced by special factors. Towards the end of the 1980s, the Norwegian economy was hit by positive productivity shocks. Labour productivity rose in several sectors, due partly to deregulations and structural changes, and partly to a restructuring of the banking sector during and after the banking crisis. Theory would suggest that this relatively large shift in productivity should have been accompanied by a recovery of the economy from the recession. A closer look at Figure 4 indeed indicates that the economy did recover somewhat in 1990, but that from 1991 the economy again deteriorated. One reason for this could be the German reunification and the tight monetary policy in Europe in the early 1990s. In Norway, monetary policy at the time comprised a fixed exchange rate. Higher interest rates in Europe therefore required higher interest rates in Norway as well in order to defend the peg. The monetary tightening thus counteracted the positive stimulus from the productivity shock. So, while productivity went up,

the economy slowed further.

Procyclical monetary policy stimulus may also have had an impact on the correlation between productivity and the business cycle in the latter half of the 1990s. In late 1997, interest rates were lowered to a very low level even though the economy was already in an upturn and operating above capacity. This behaviour of monetary policy again reflects the exchange rate regime and how it was interpreted by the monetary authority. As the economy reached capacity limits in more and more sectors, labour productivity went down in 1998 and 1999. Economic growth was, however, sustained by strong growth internationally and an investment boom just before and after the change to the new millennium. Capital deepening therefore probably increased productivity again. Thus, although the economy were operating continuously above capacity for several years, productivity was varying.

In sum, given the strong international evidence of procyclical productivity, which has also previously been found for Norway by Bjørnland (2000) over a different sample period, we tend to believe that the low comovement between labour productivity and output in the 1990s came about as a result of special factors. Looking ahead, we believe that labour productivity will again show procyclical behaviour. Indeed, it appears that from 2001, labour productivity may again be moving with the business cycle.

4.3 The labour market

The very strong correlation between cyclical output and various components of the labour market is striking (see figure 5 and 6). The latter chart also suggests that Okun's law accurately describes the strong negative relationship between output and unemployment in Norway and that understanding of the labour market is therefore key to understanding business cycle fluctuations. Moreover, hours worked, employment and unemployment data are almost perfect substitutes as indicators of developments in the labour market.

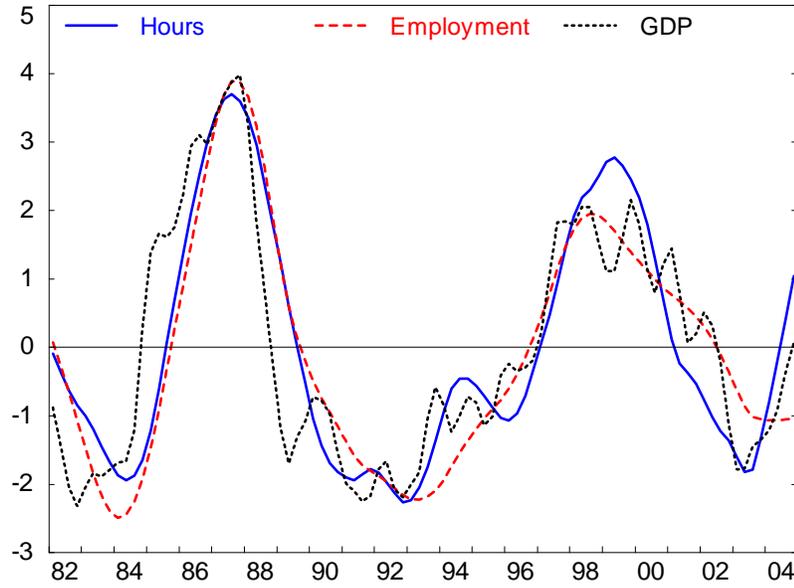


Figure 5: Hours, employment and output. De-trended by the HP-filter, $\lambda=6400$

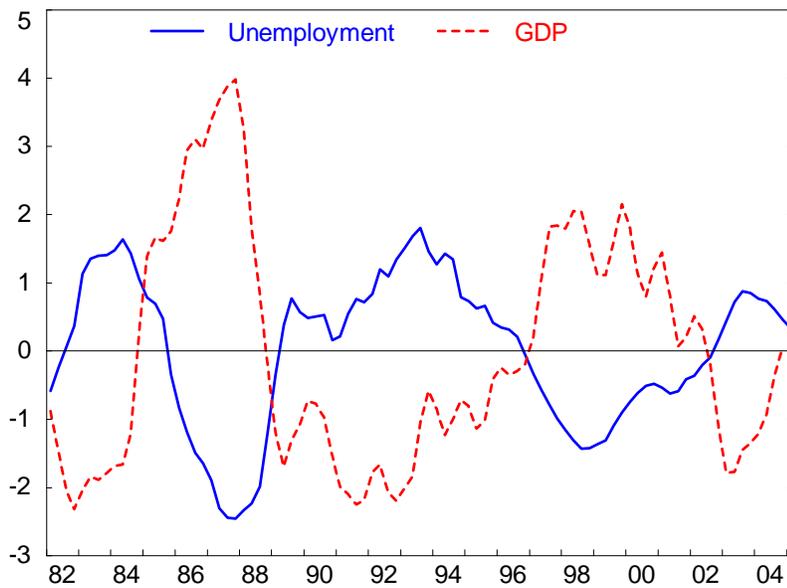


Figure 6: Unemployment and output. De-trended using the HP-filter, $\lambda=6400$

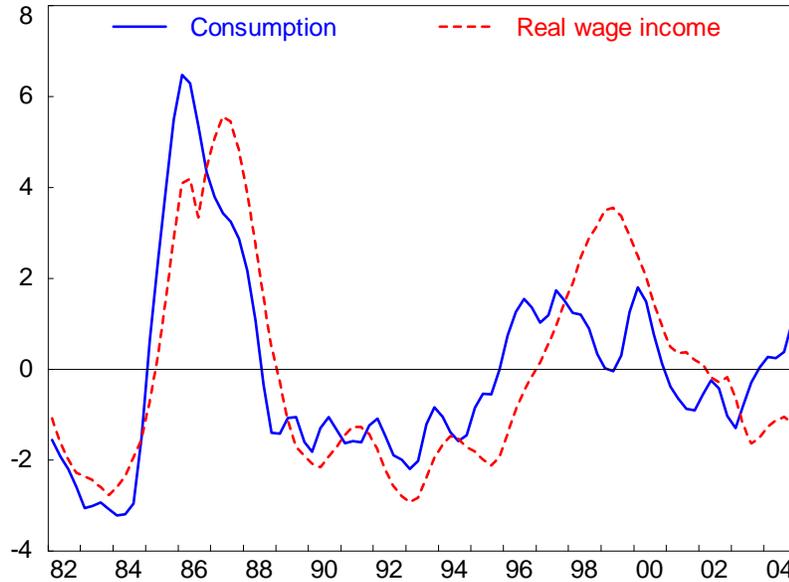


Figure 7: Private consumption and real wage income (total) De-trended using the HP-filter, $\lambda=6400$

4.4 Consumption and income

According to the permanent income/life-cycle hypothesis, the evolution of consumption should be shaped by tastes and life-cycle needs rather than by the business cycle. In new-Keynesian models for monetary analysis, this hypothesis is represented by the Euler equation for optimal intertemporal allocation of consumption. The hypothesis implies that there is no reason for consumption to track current income as consumers will borrow and save to smooth through income fluctuations. However, as illustrated in Figure 7, our results, which are consistent with standard findings, suggest that there is indeed a strong relationship between consumption and current income in data, sowing doubt about the empirical relevance of the Euler equation as it stands. An implication of this result is that consumption models that incorporate elements of the life-cycle hypothesis can better match data if they include a proportion of "rule-of-thumb" consumers with liquidity or lending constraints and/or some other form of real rigidity.

5 Conclusion

This paper has put together a set of stylised facts for 30 Norwegian economic variables and has examined how these compare to the US and the euro area. The results suggest that the stylised facts about the Norwegian business cycle are fairly similar to those for the US and euro area:

- Consumption, investment and imports are all strongly procyclical and broadly contemporaneous with the business cycle.
- Hours worked are strongly correlated with number of people employed and the unemployment rate, and the correlation between these variables and output is also very high. The labour market indicators lag output by 2 quarters.
- Domestic inflation is strongly procyclical and lags output by around 5 quarters.
- Consumption and real wage income are strongly correlated, indicating that some form of real rigidity should be incorporated in consumption models that incorporate elements of the life-cycle hypothesis.

The main discrepancies from the standard results in the literature were that real wages were procyclical and productivity is acyclical in Norway during the period under review. With respect to real wages, we have proposed two alternative explanations based on competing economic theories. First, procyclical real wages may occur due to technological shocks, in line with the Real Business Cycle hypothesis. Alternatively, and consistent with new-Keynesian DSGE models with sticky prices, procyclical real wages may be a result of demand shocks during the period under review. As regards the acyclical behaviour of productivity in the 1990s, we argue that special factors may have brought about the low comovement between productivity and output. Accordingly, we argue that productivity will again show procyclical behaviour in future in line with the stylised facts about most economies. However, caution is warranted over this interpretation.

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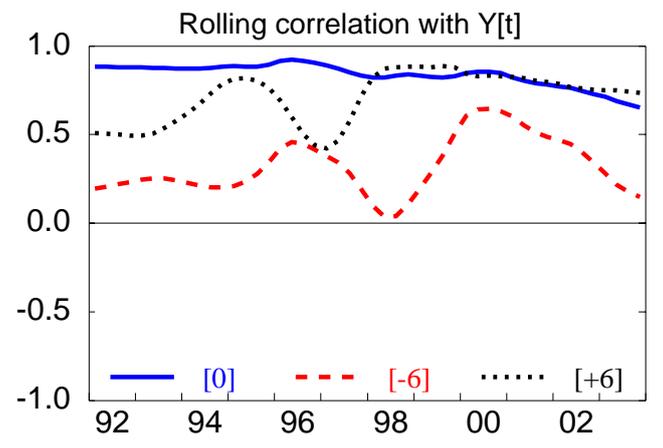
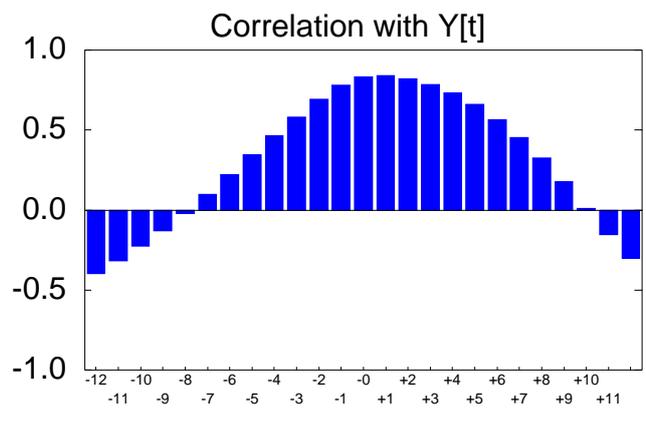
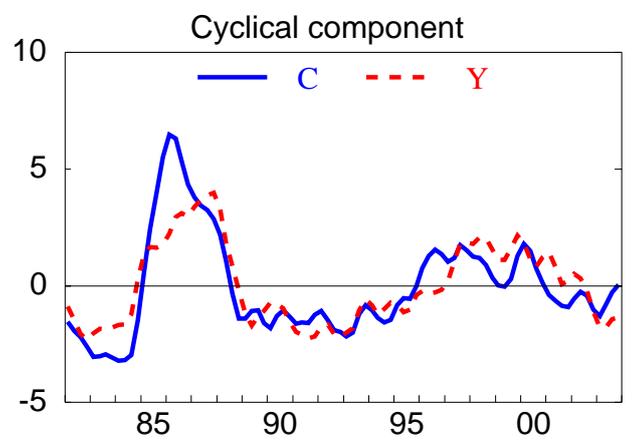
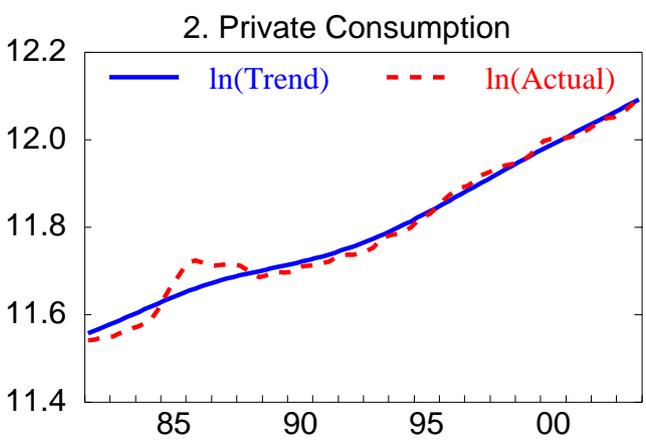
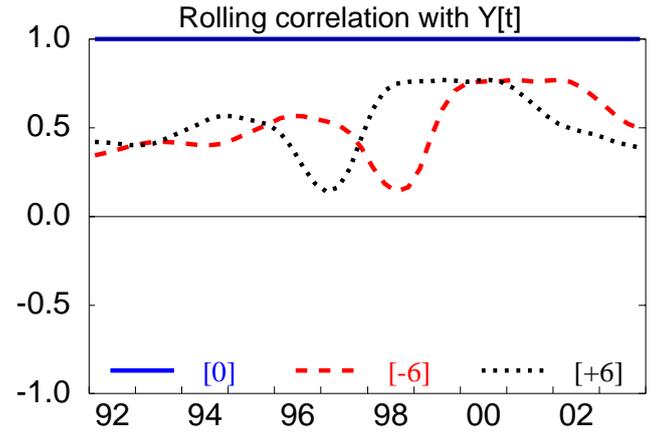
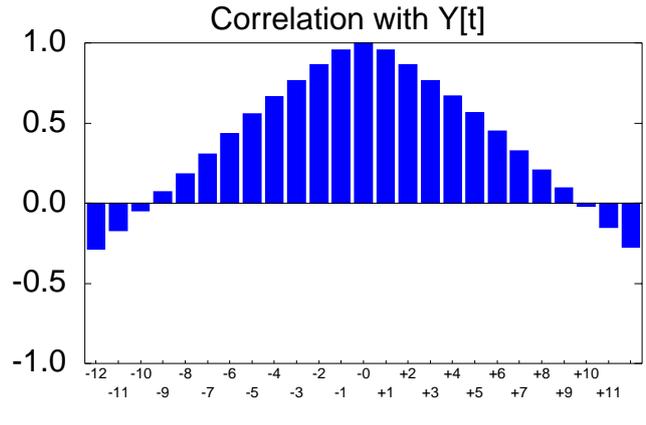
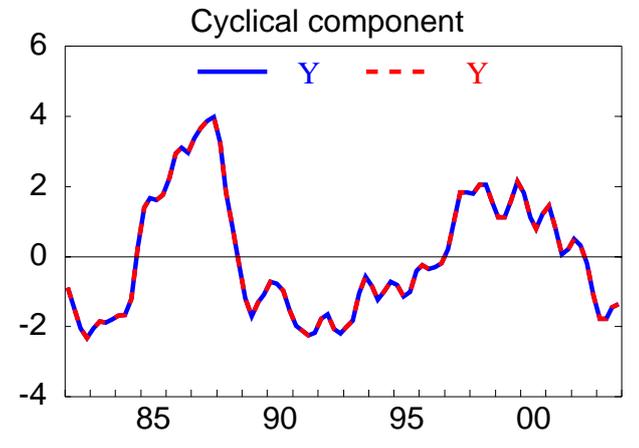
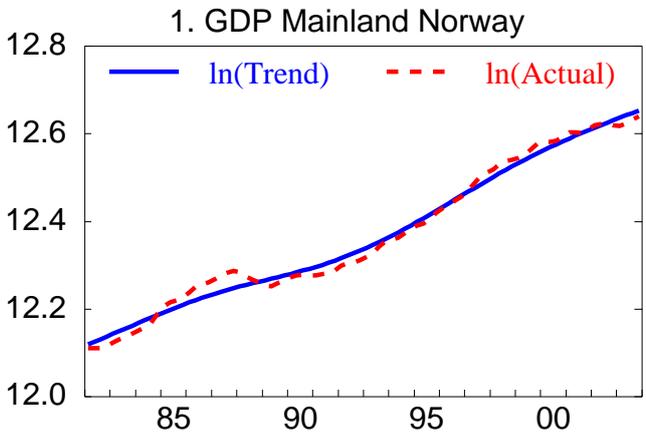
Appendix

Description of data series and sources:

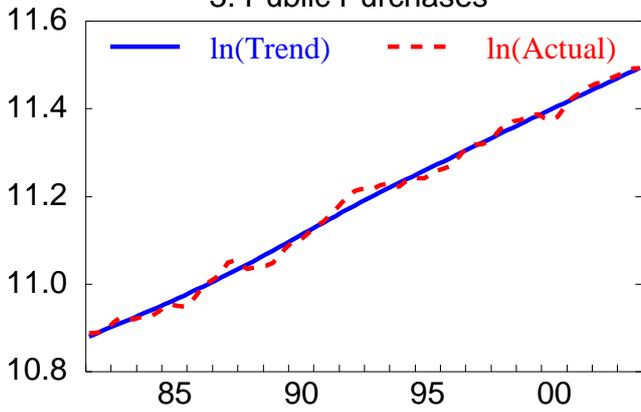
1. *GDP Mainland-Norway (Y)*: Gross Domestic Product excluding petroleum activities and ocean transport. Market values. Volume. Source: Statistics Norway (SSBKNRS database)
2. *Private Consumption (C)*: Household final consumption expenditures. Volume. Source: Statistics Norway (SSBKNRS database)
3. *Public Consumption (CG)*: Final consumption expenditures of general government. Volume. Source: Statistics Norway (SSBKNRS database)
4. *Private Investment (I)*: Gross fixed capital formation excluding petroleum activities, ocean transport and general government. Volume. Source: Statistics Norway (SSBKNRS database)
5. *Public Investment (IG)*: General government gross fixed capital formation. Volume. Source: Statistics Norway (SSBKNRS database)
6. *Oil Investment (IOS)*: Gross fixed capital formation "Oil and gas extraction, transport via pipelines and service activities incidental to extraction". Volume. Source: Statistics Norway (SSBKNRS database)
7. *Housing Investment (IH)*: Gross fixed capital formation "Dwellings (households)". Volume. Source: Statistics Norway (SSBKNRS database)
8. *Exports Mainland-Norway (X)*: Total exports excluding crude oil, natural gas, ships, oil platforms and aircrafts. Volume. Source: Statistics Norway (SSBKNRS database)
9. *Imports Mainland-Norway (M)*: Total imports excluding crude oil, natural gas, ships, oil platforms and aircrafts. Volume. Source: Statistics Norway (SSBKNRS database)
10. *CPI*: Consumer Price Index adjusted for tax changes and excluding energy products (CPI-ATE). Source: Statistics Norway
11. *CPI Domestic (CPII)*: Consumer Price Index adjusted for tax changes and excluding energy products and imported goods. Source: Statistics Norway and Norges Bank

12. *CPI Imported (CPIIMP)*: Prices for imported goods and services. Source: Statistics Norway
13. *Overall consumer price inflation (PIE4)*: Year on year changes in the consumer price index adjusted for tax changes and excluding energy products. Source: Statistics Norway
14. *Domestic inflation (PIE4I)*: Year on year changes in the consumer price index adjusted for tax changes and excluding energy products and imported goods. Source: Statistics Norway and Norges Bank
15. *Imported inflation (PIE4M)*: Year on year changes in prices for imported goods and services. Source: Statistics Norway
16. *Real wage costs per hour (RWCL)*: Total wage costs (million kroner) per total hours worked divided by CPI Domestic. Source: Statistics Norway and Norges Bank
17. *Real wage income pr hour (RWI)*: Total wage income (million kroner) divided by CPI. Source: Statistics Norway and Norges Bank
18. *Real wage income growth (PIE4RW)*: Year on year changes in real wage income pr hour. Source: Statistics Norway and Norges Bank
19. *Capital stock (K)*: Fixed capital excluding petroleum activities and ocean transport. Source: Statistics Norway (KVARTS database)
20. *Hours worked (L)*: Total hours worked per quarter in Norway. Source: Statistics Norway (KVARTS database)
21. *Employment (NP)*: Total employment in Norway. Source: Statistics Norway (KVARTS database)
22. *Labour force (LF)*: Total labour force in Norway. Source: Statistics Norway (Labour Force Survey)
23. *Labour Productivity (ZL)*: Real GDP Mainland-Norway divided by total hours worked. Source: Statistics Norway
24. *Unit Labour Cost (ULC)*: Real wage income per hour divided by labour productivity
25. *Average working time (AWT)*: Total hours worked divided by total employment. Source: Statistics Norway and Norges Bank
26. *Unemployment rate (UR)*: Total unemployment in per cent of the labour force. Source: Statistics Norway

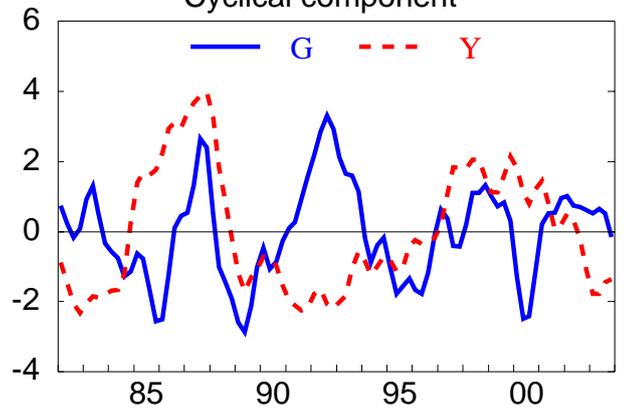
27. *Nominal interest rate (RN)*: Three month money market interest rate for Norway. Source: Norges Bank
28. *3 year real interest rate (RR)*: Effective yield representative 3 year government bond in Norway minus the inflation target . The yield is calculated by weighting one to two government bonds with time to maturity. Norges Bank and Statistics Norway
29. *Capital Utilisation (KU)*: Judgement on capital utilisation. Leading Indicators OECD. Quantum (non-additive or stock figures). Source: OECD Main Economic Indicators.
30. *Real Exchange Rate (Q)*: Import-weighted nominal exchange rate for 44 countries divided by import-weighted consumer price inflation for 23 countries



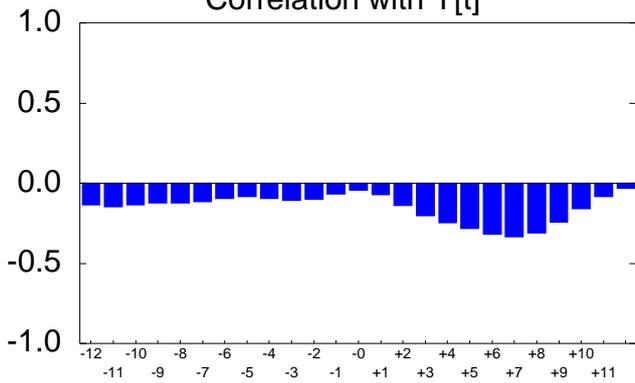
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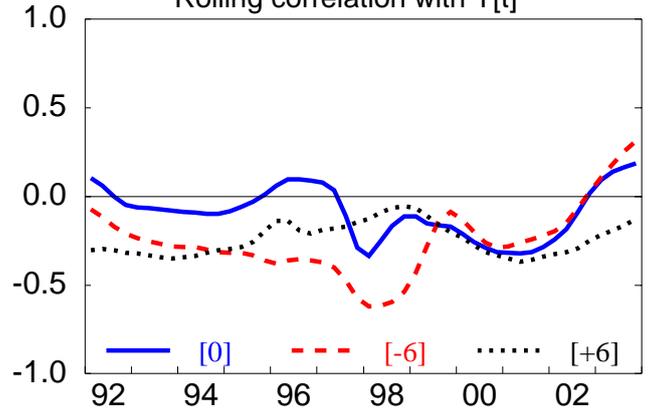
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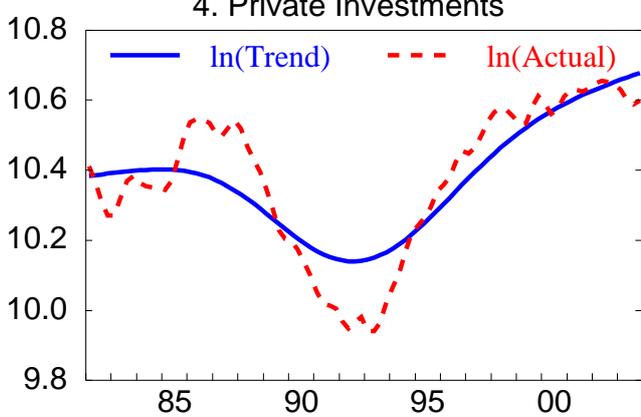
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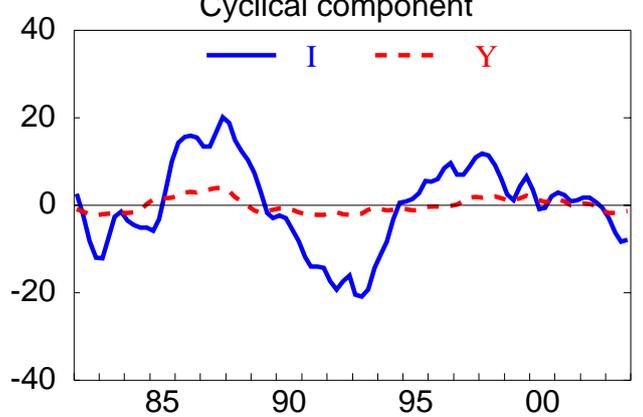
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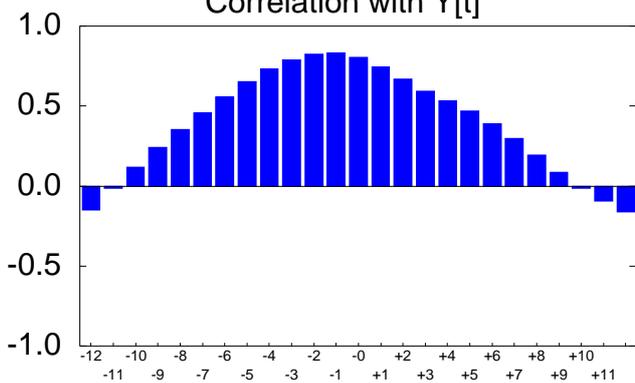
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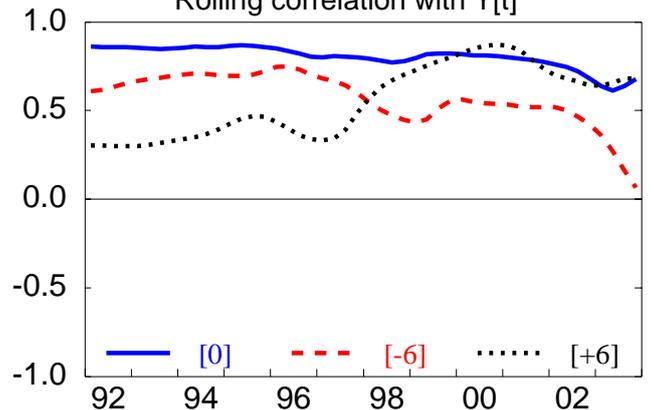
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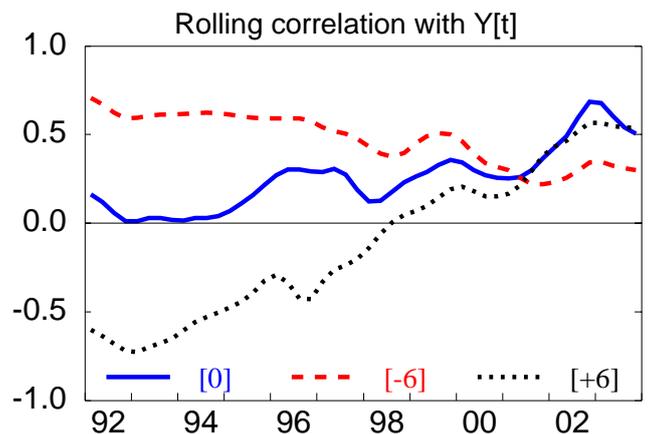
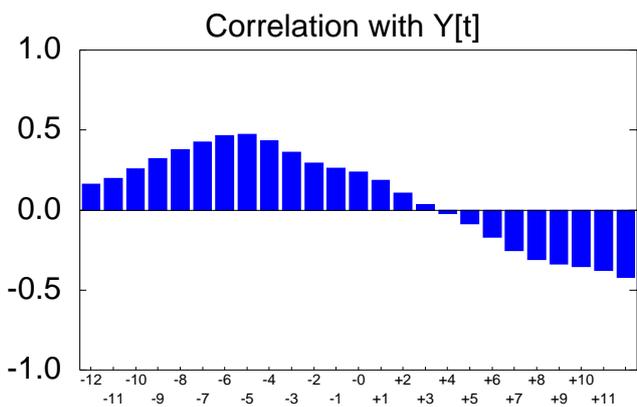
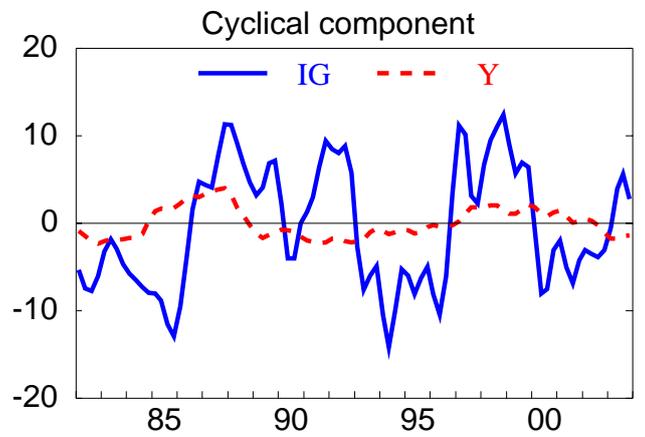
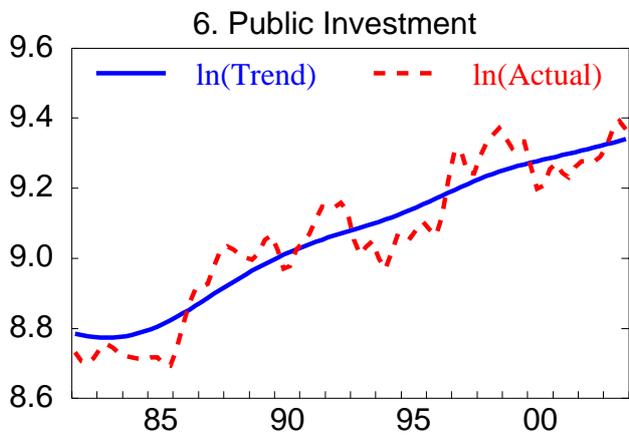
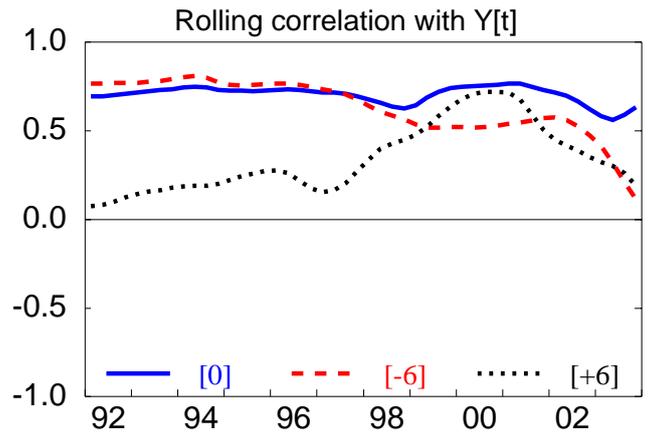
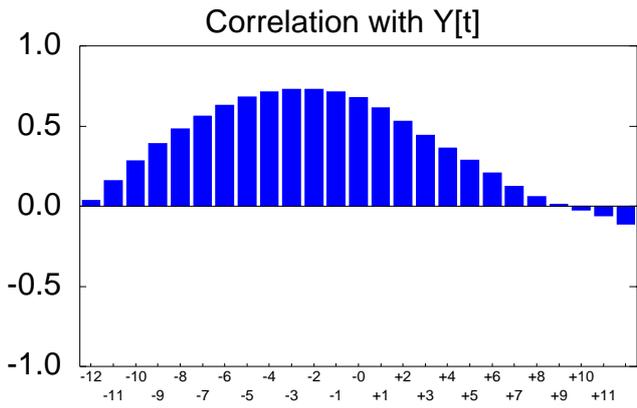
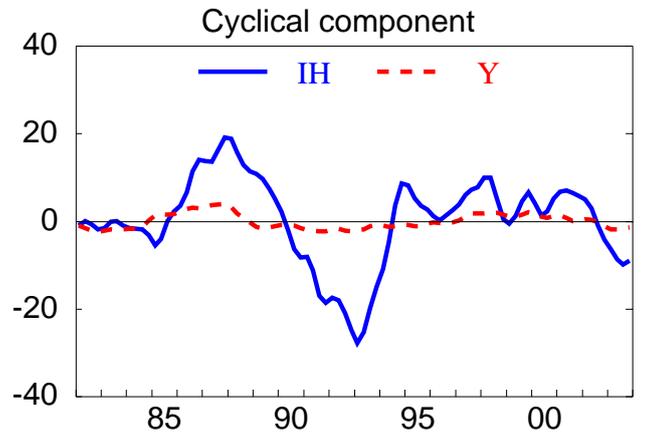
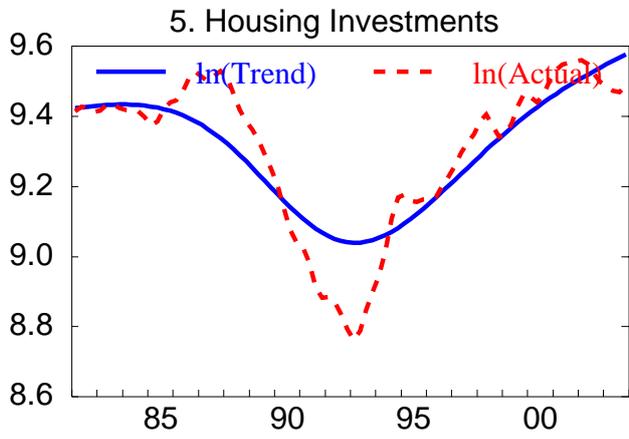


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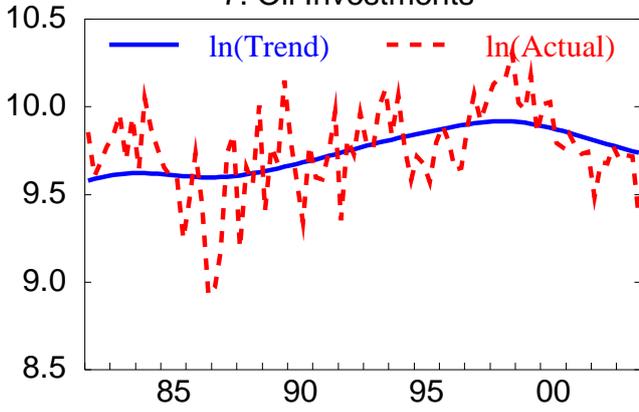


Rolling correlation with Y[t]

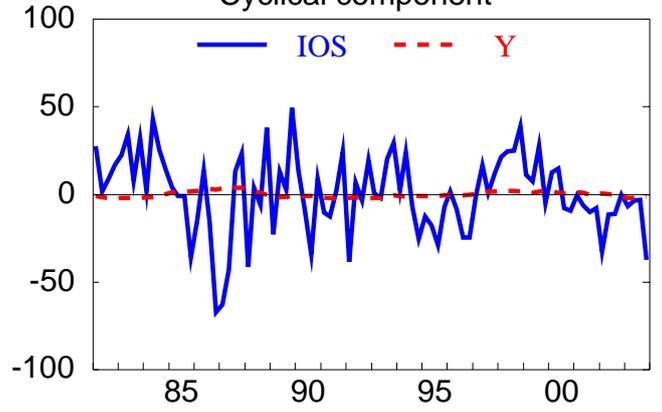




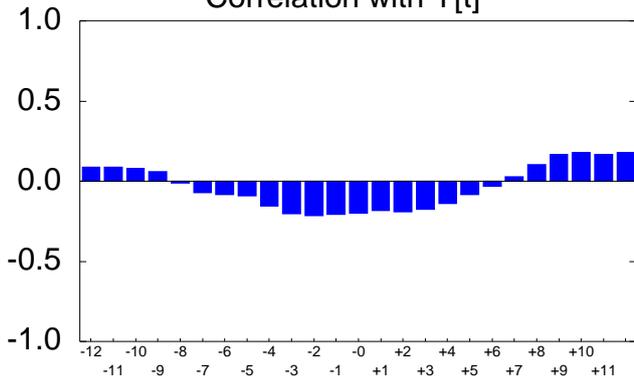
7. Oil Investments



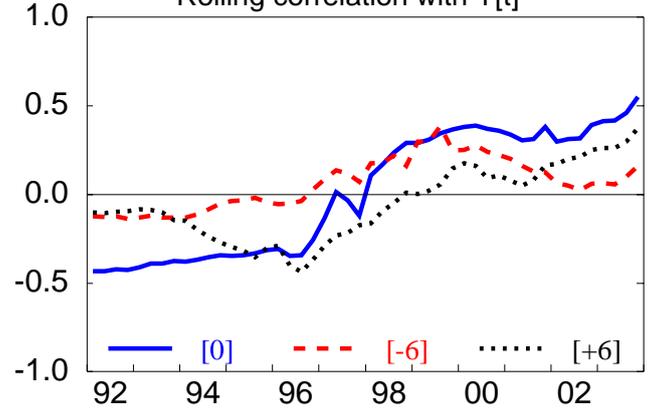
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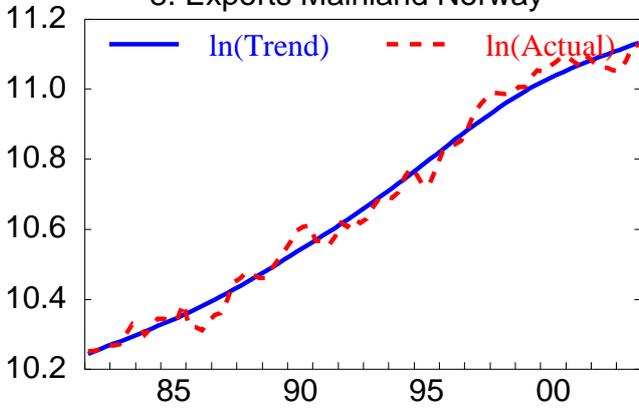
Correlation with $Y[t]$



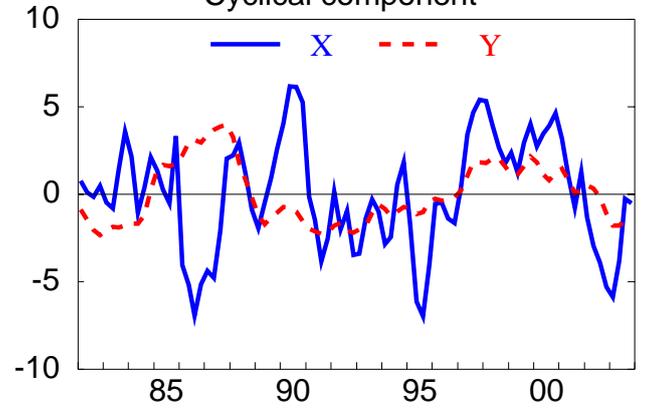
Rolling correlation with $Y[t]$



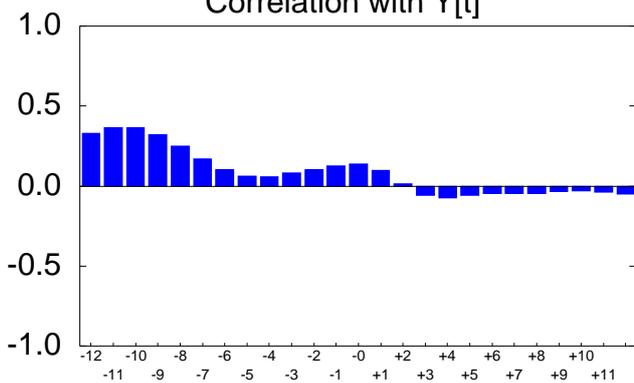
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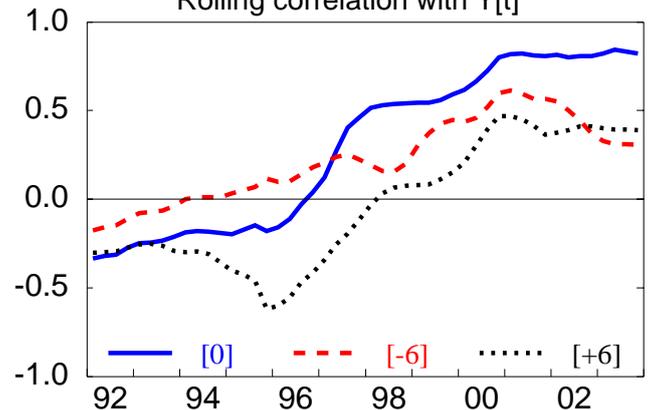
Cyclical component

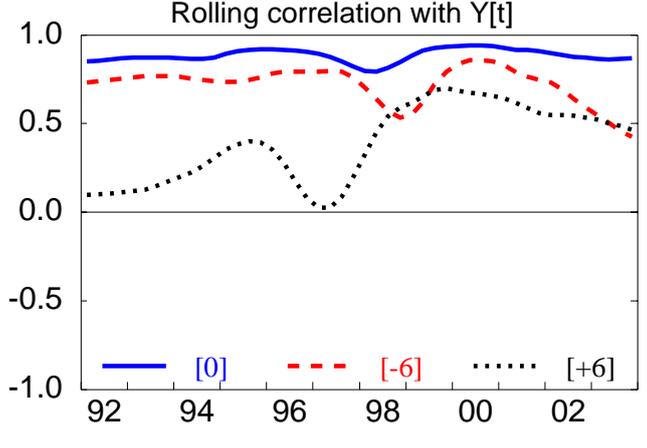
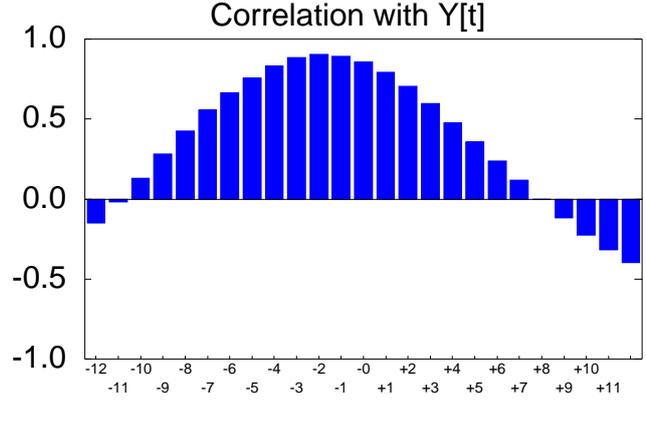
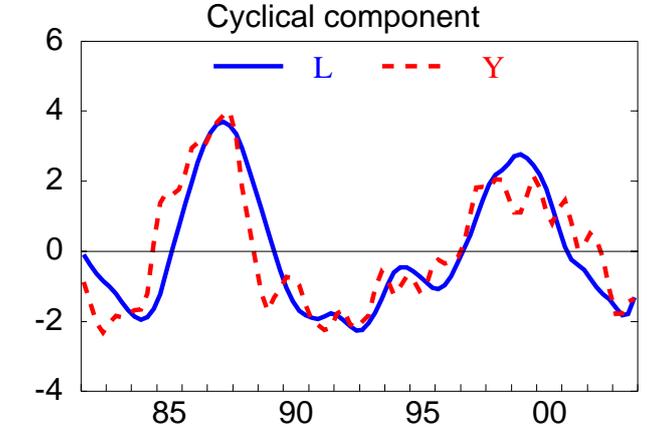
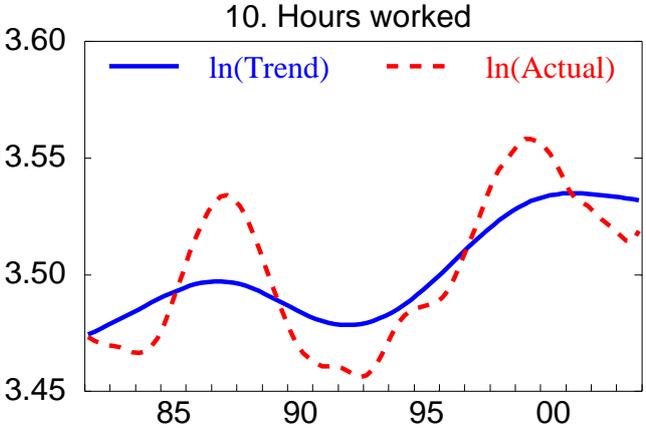
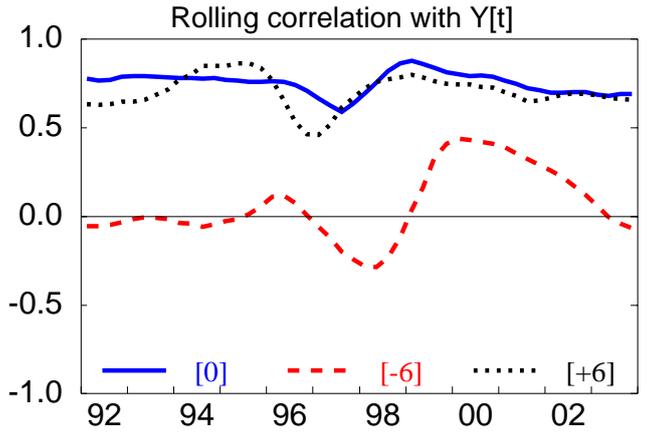
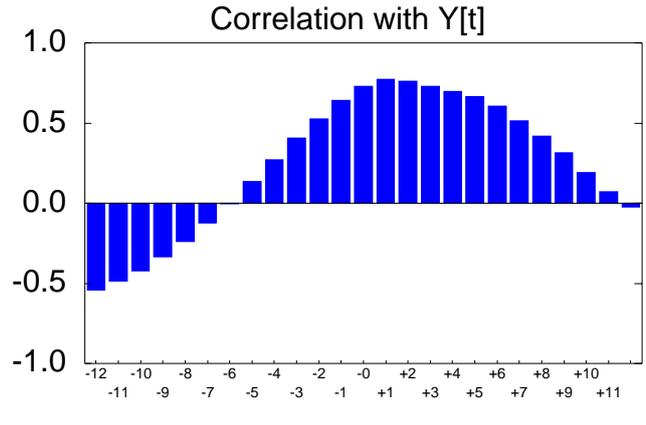
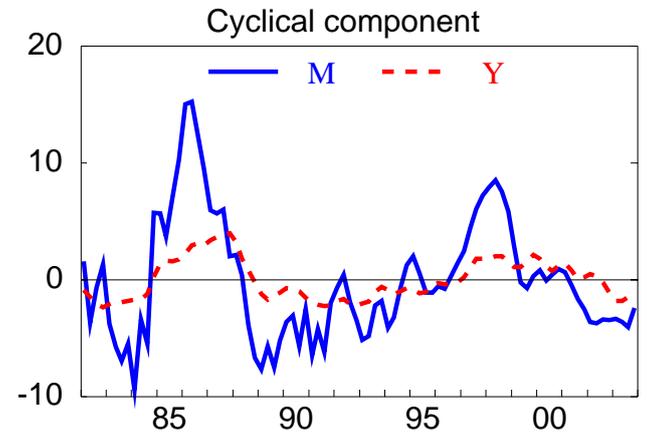
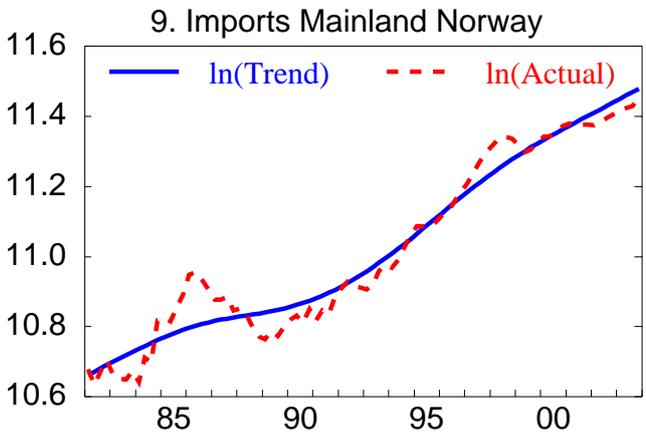


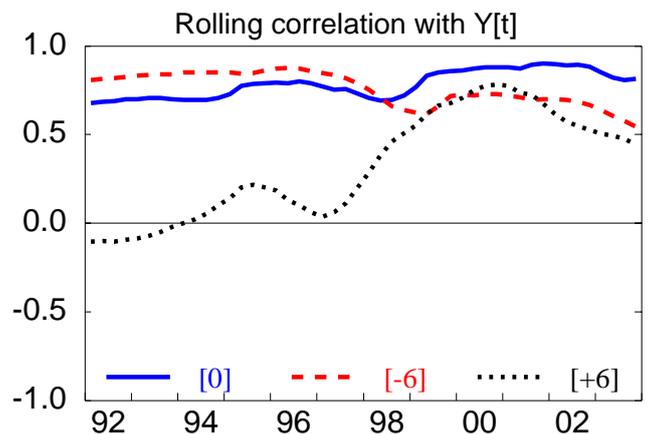
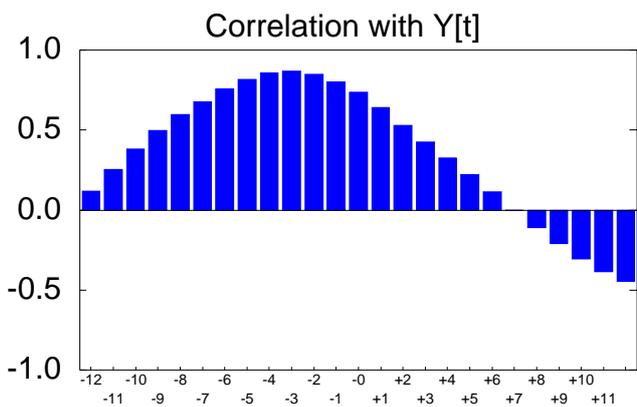
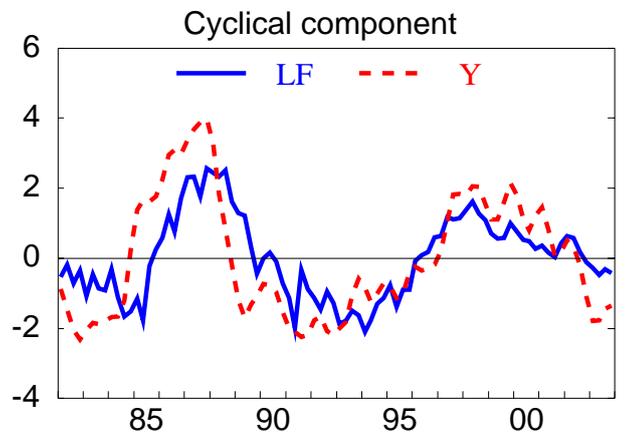
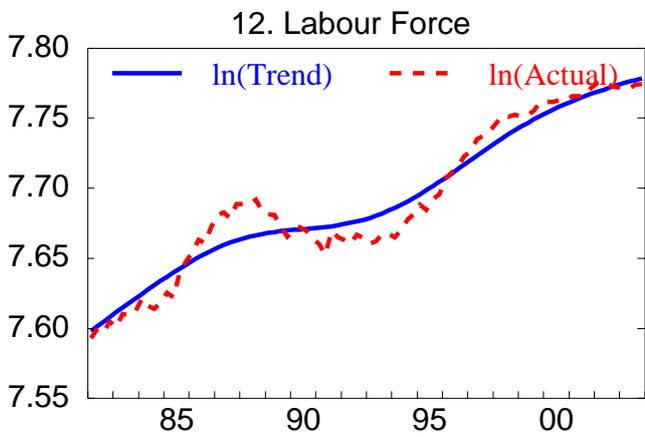
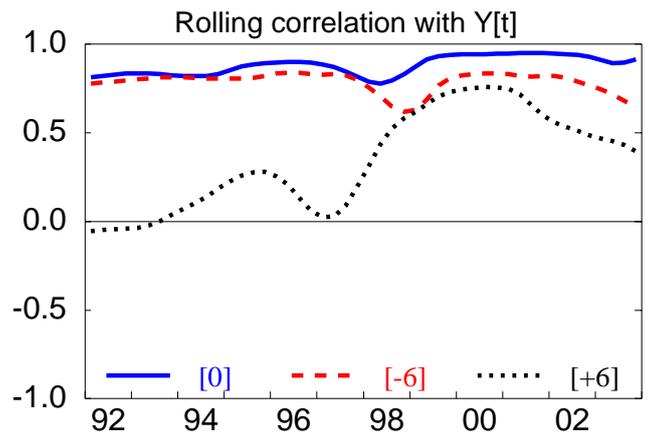
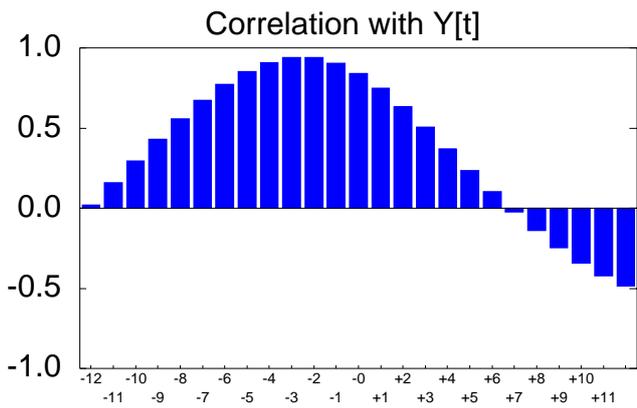
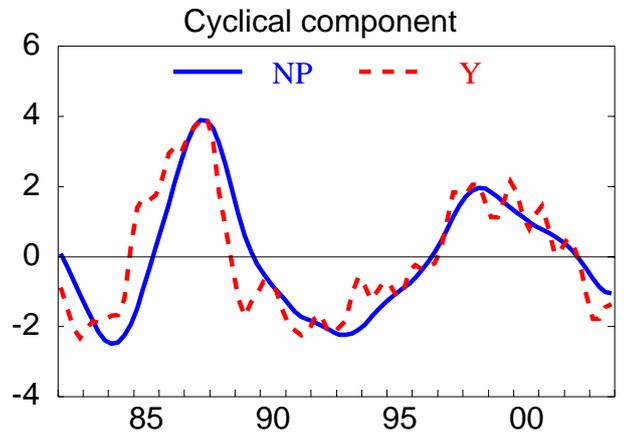
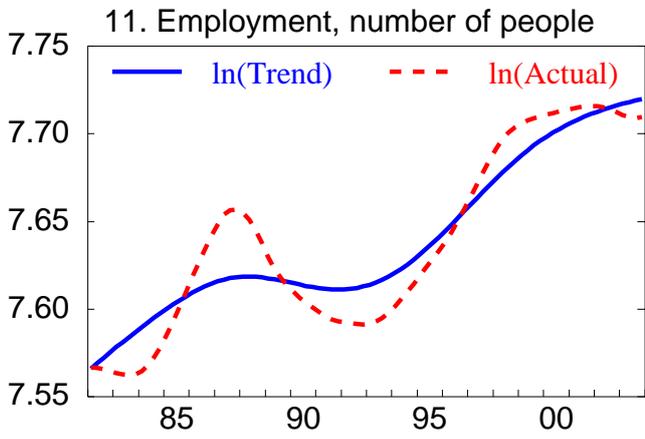
Correlation with $Y[t]$

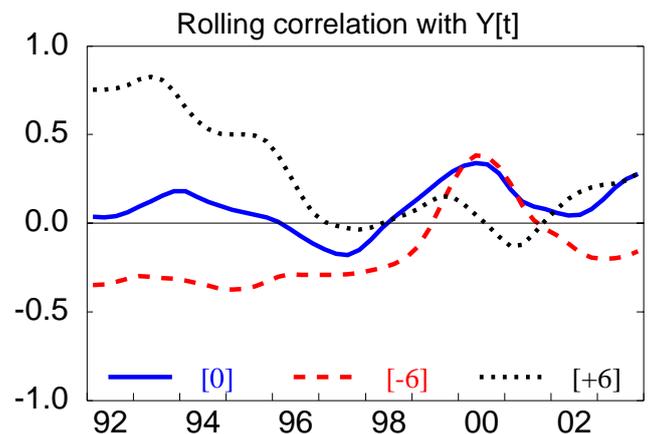
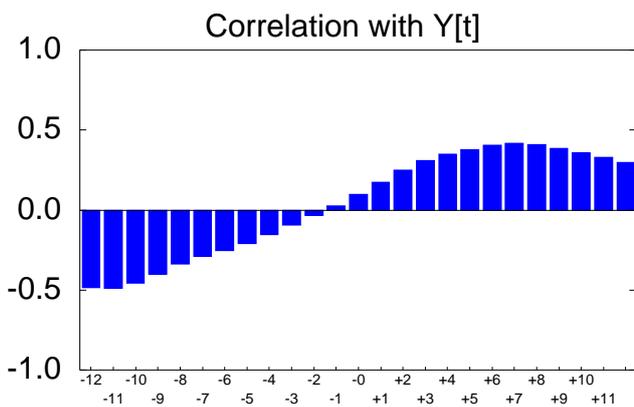
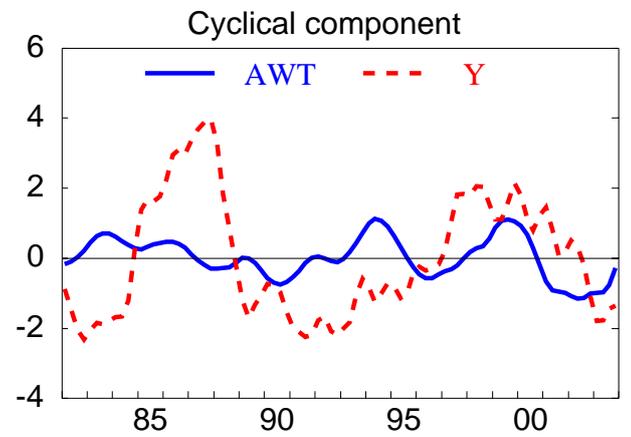
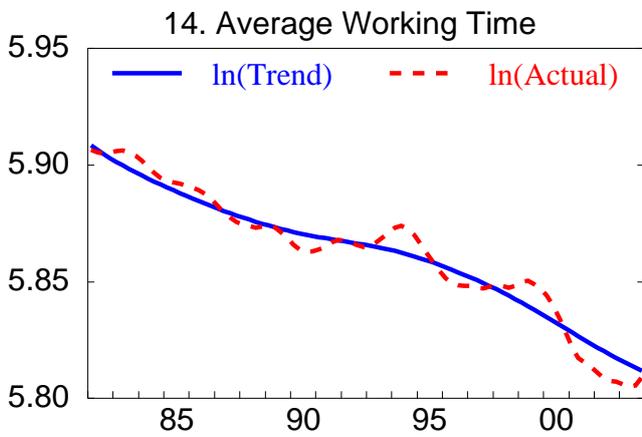
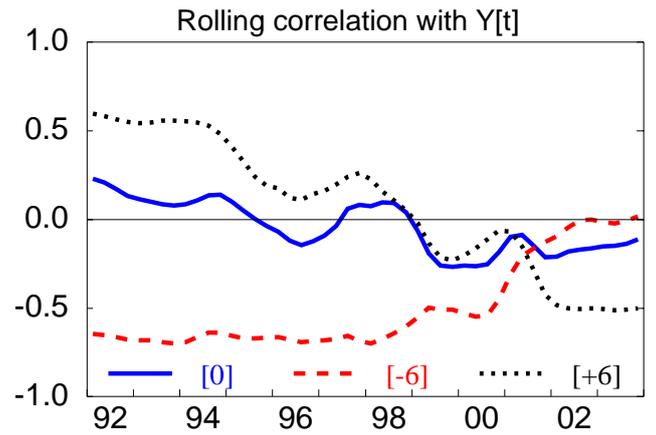
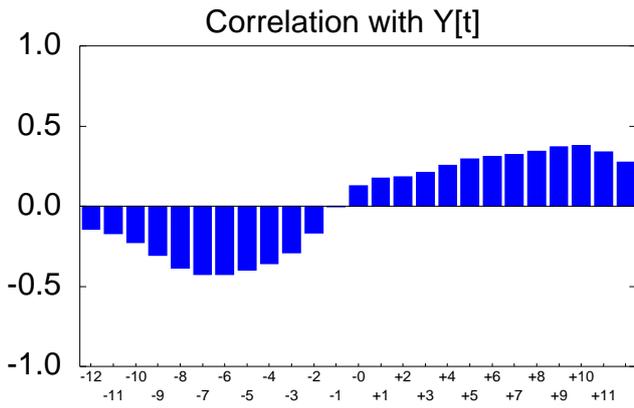
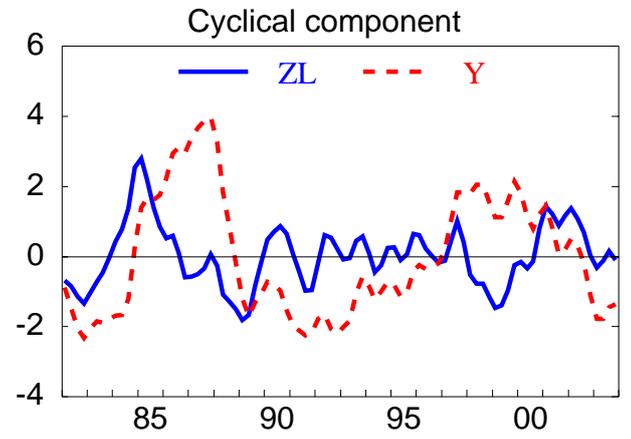
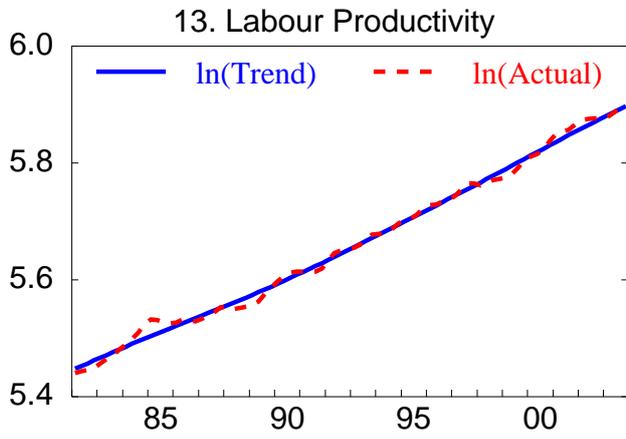


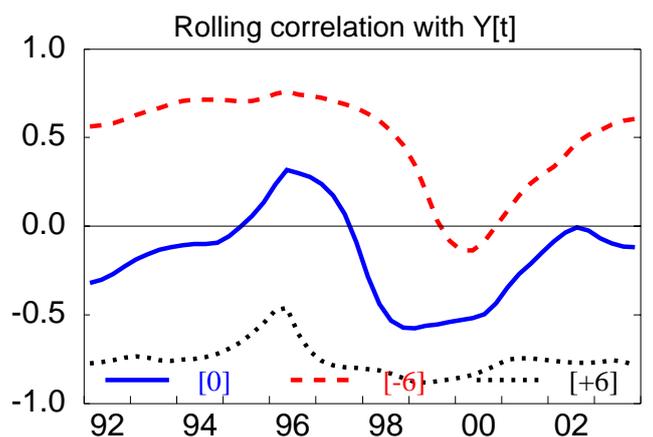
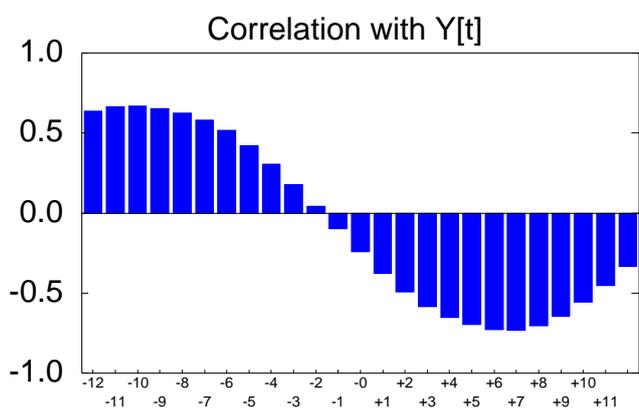
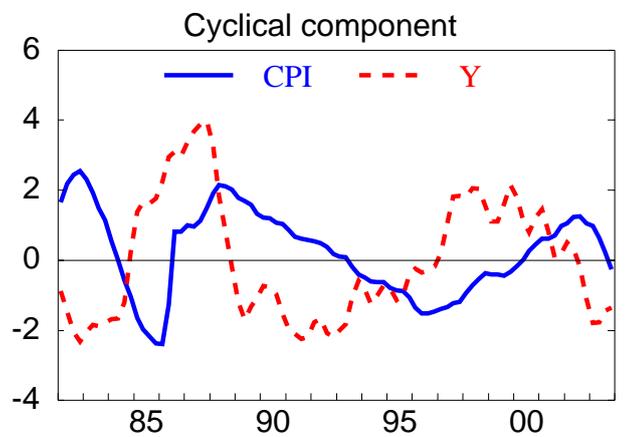
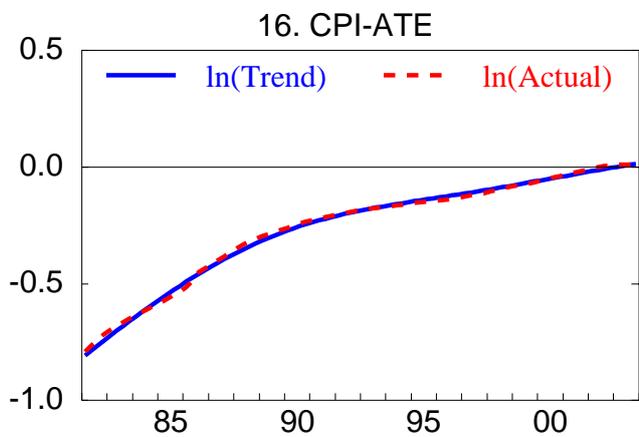
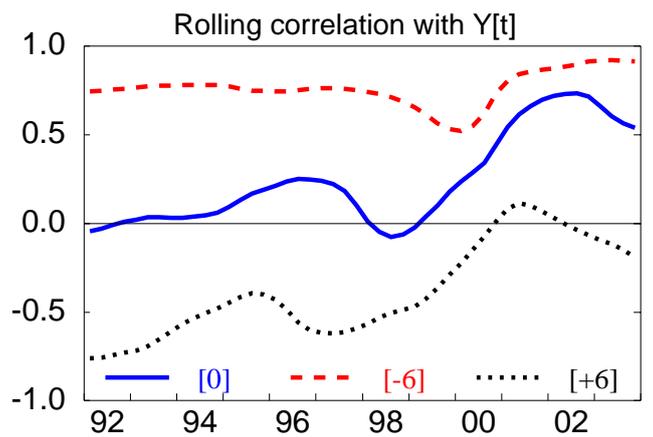
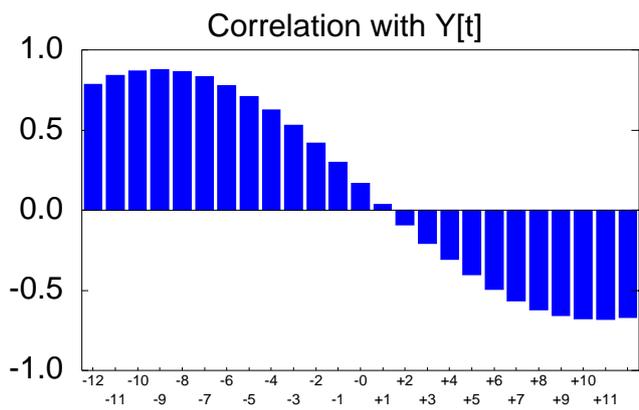
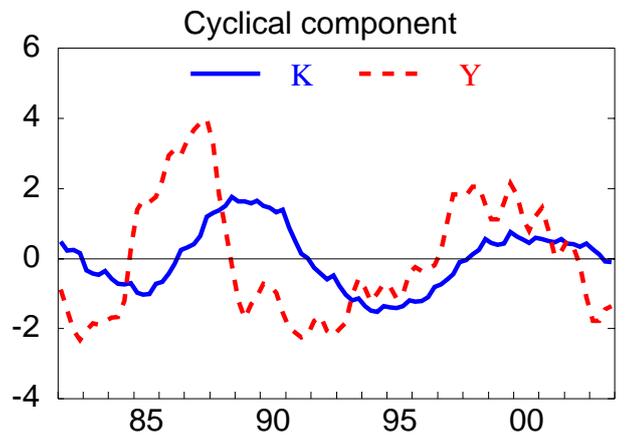
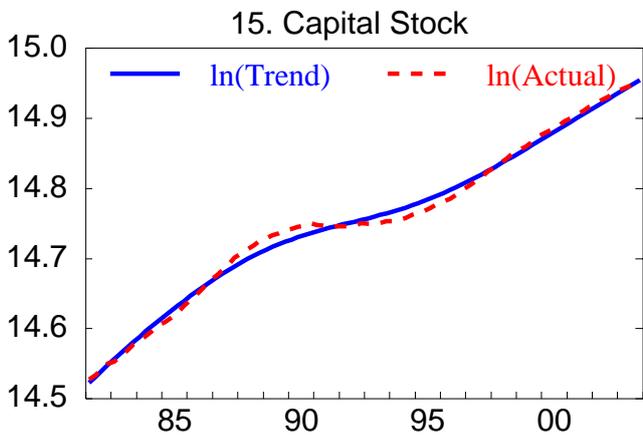
Rolling correlation with $Y[t]$

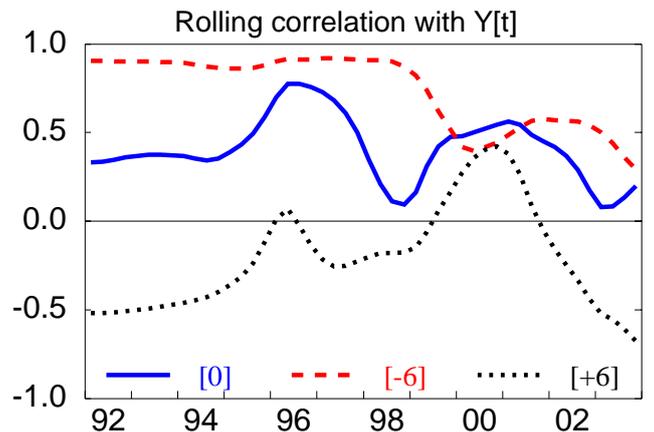
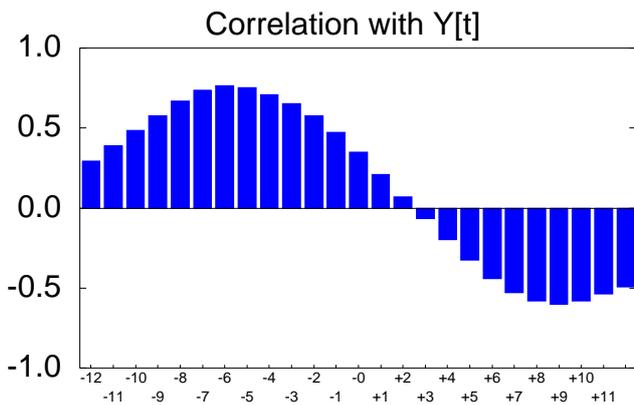
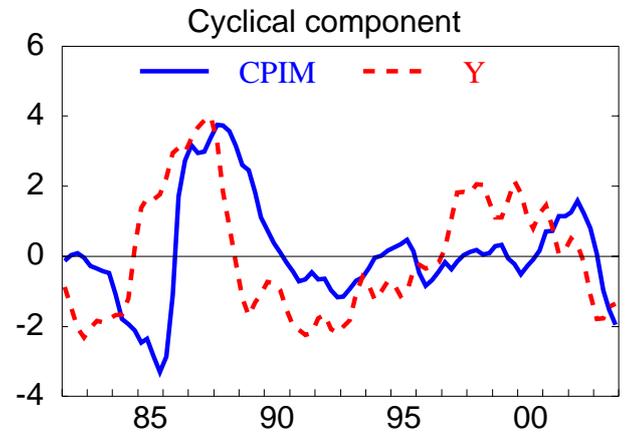
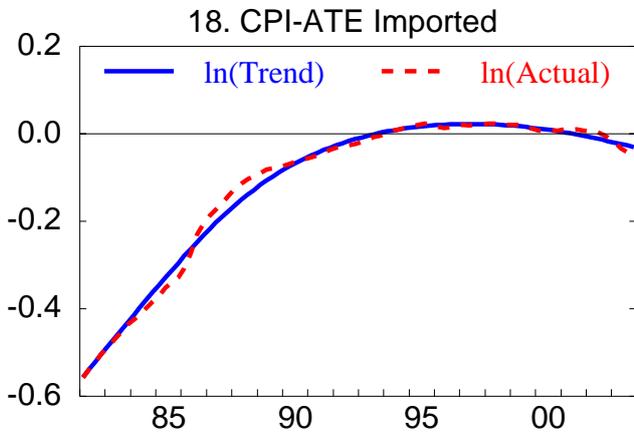
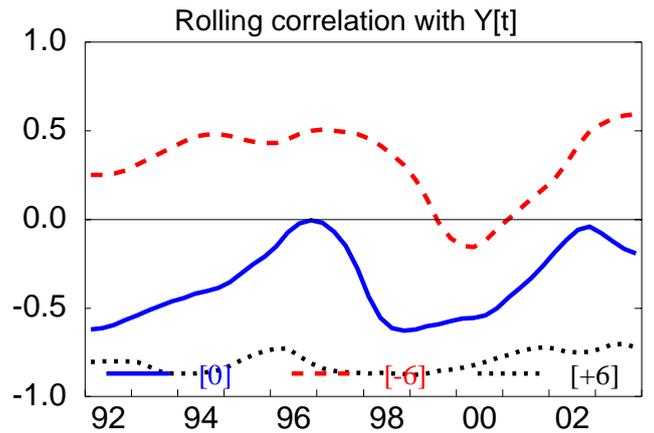
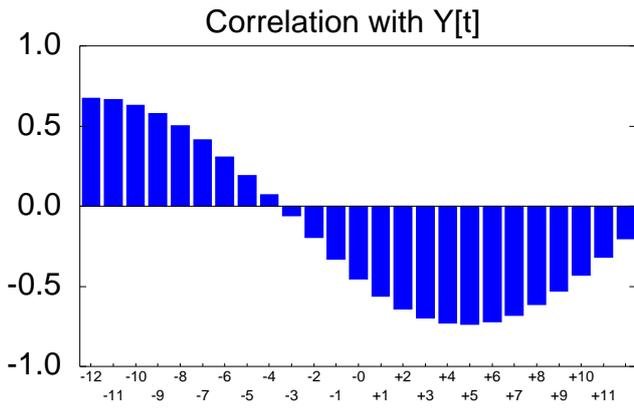
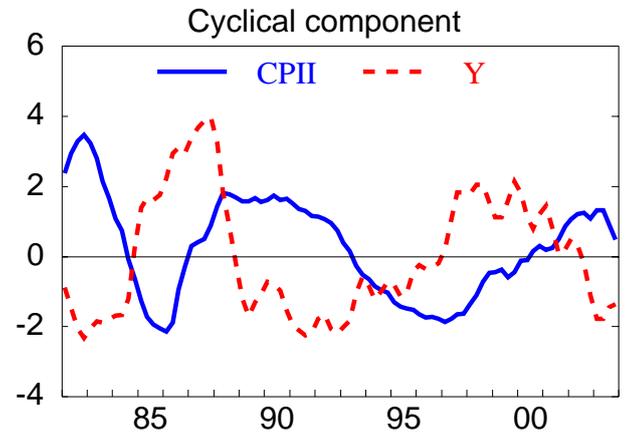
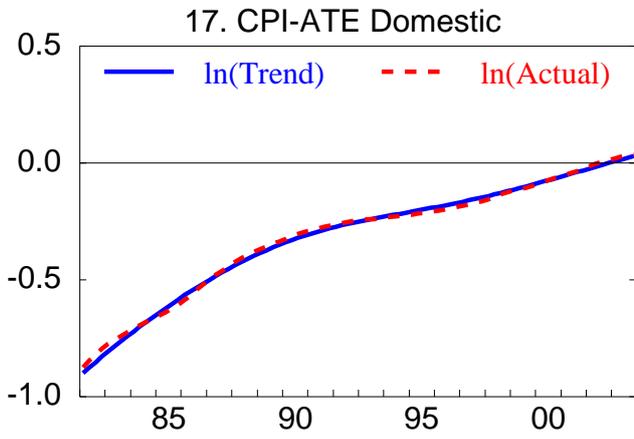


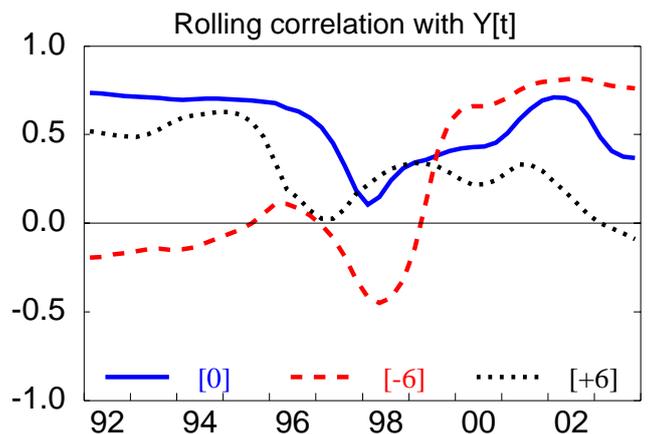
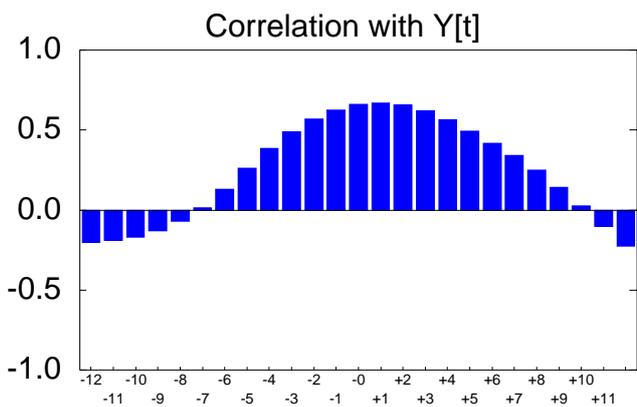
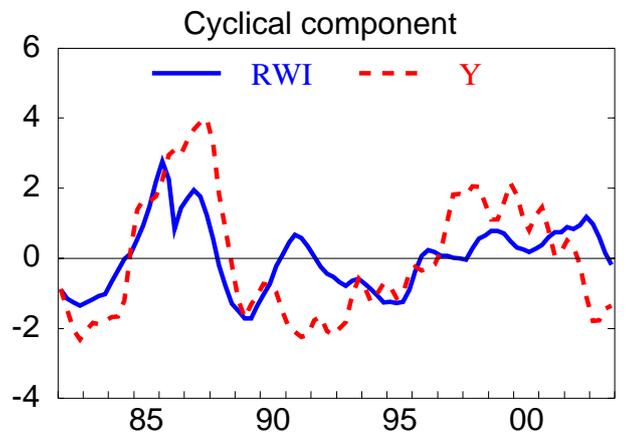
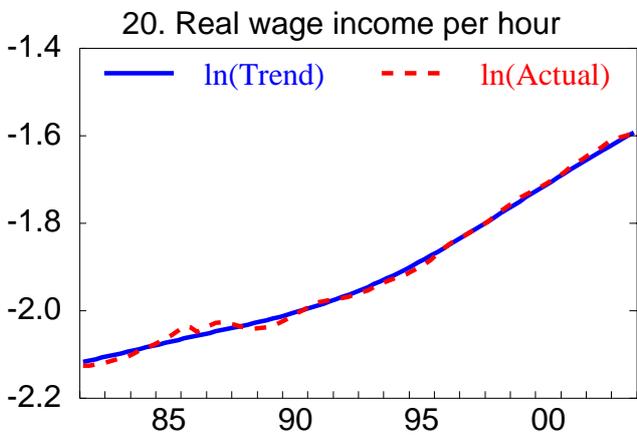
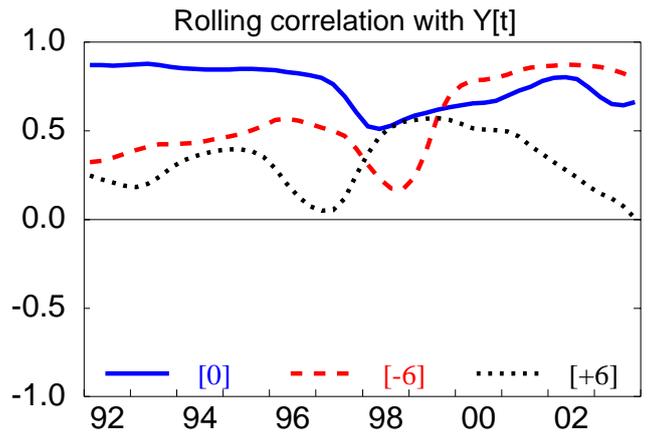
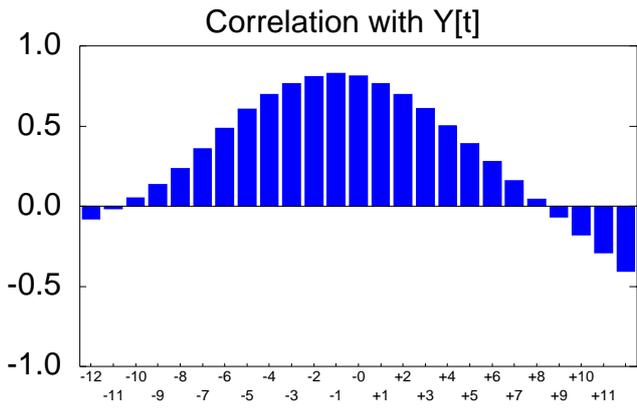
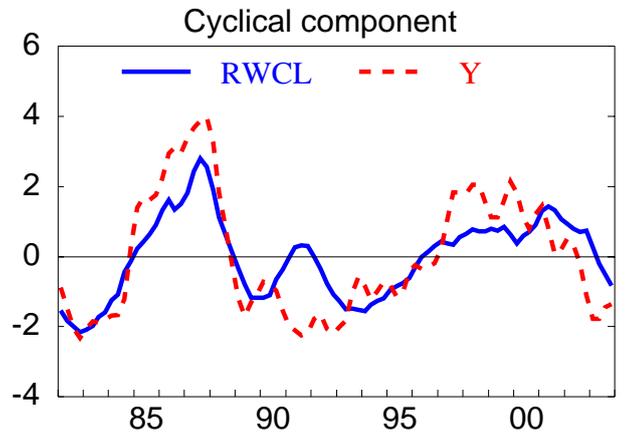
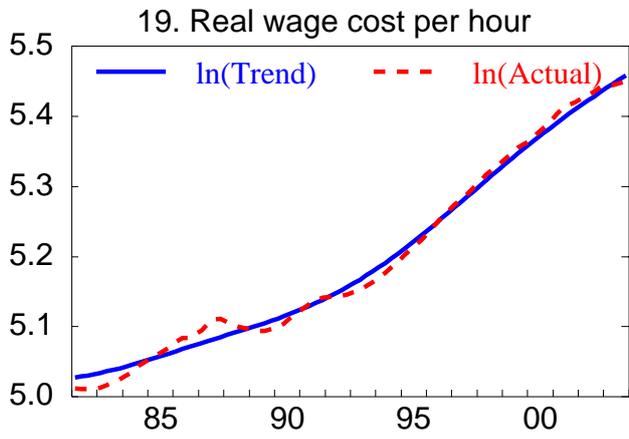


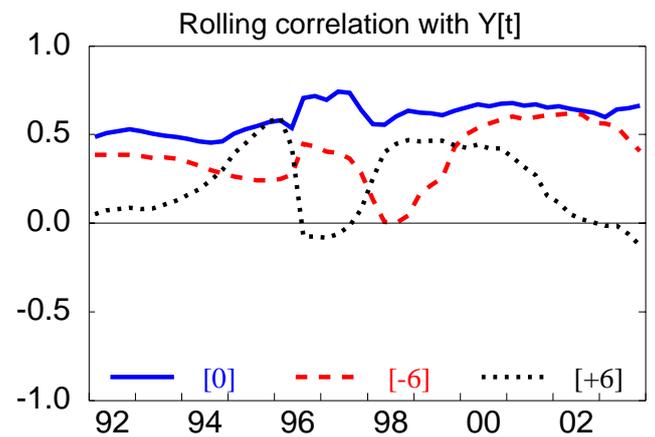
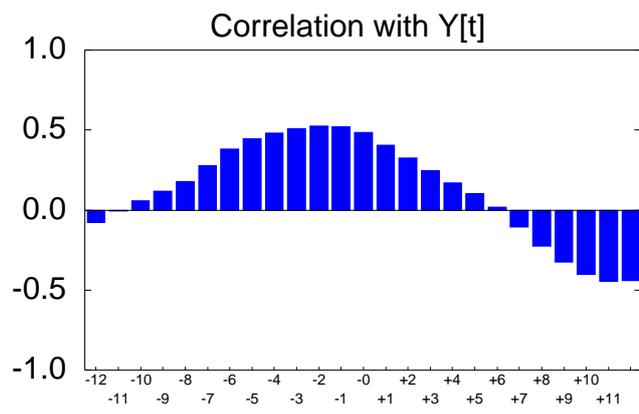
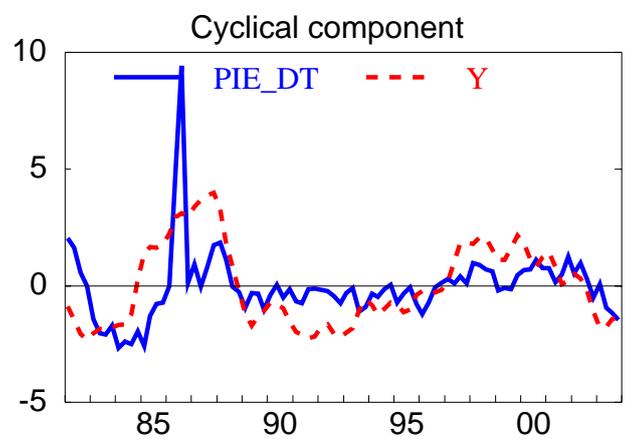
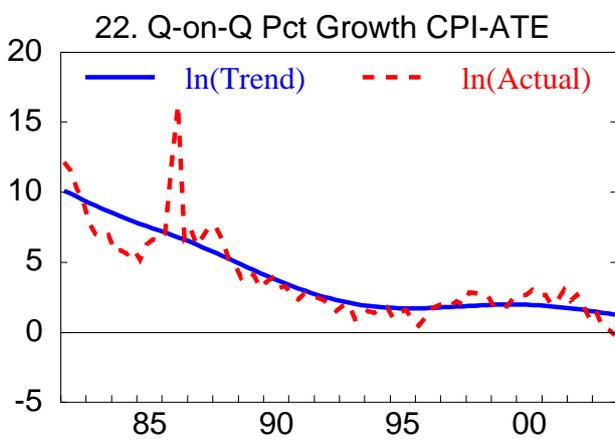
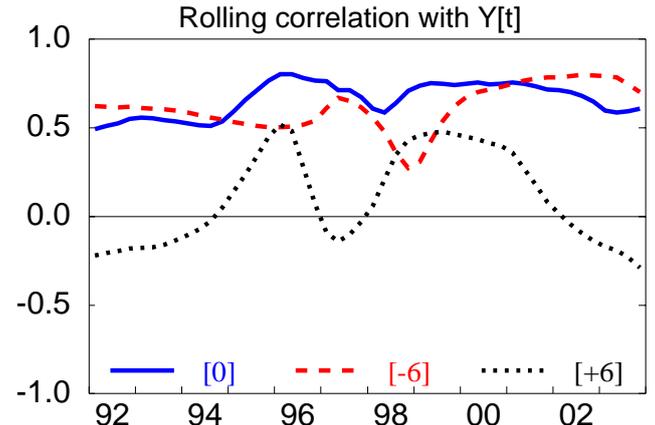
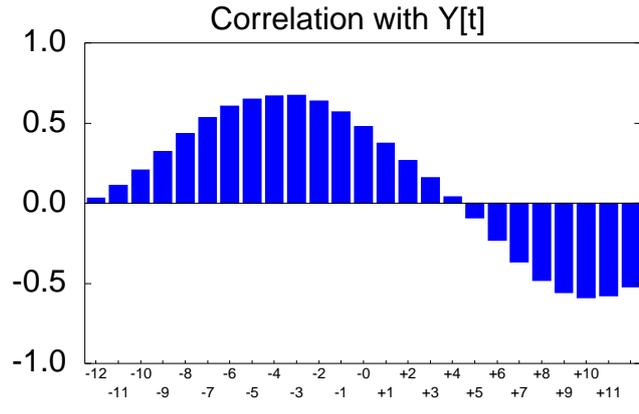
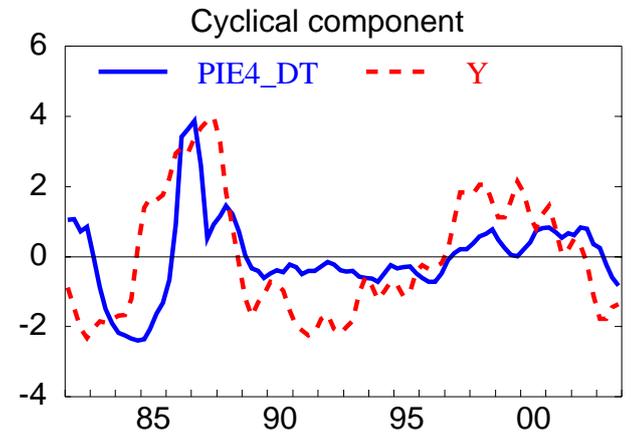
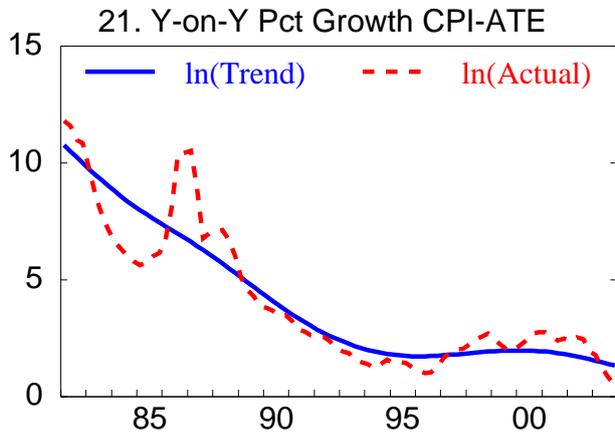


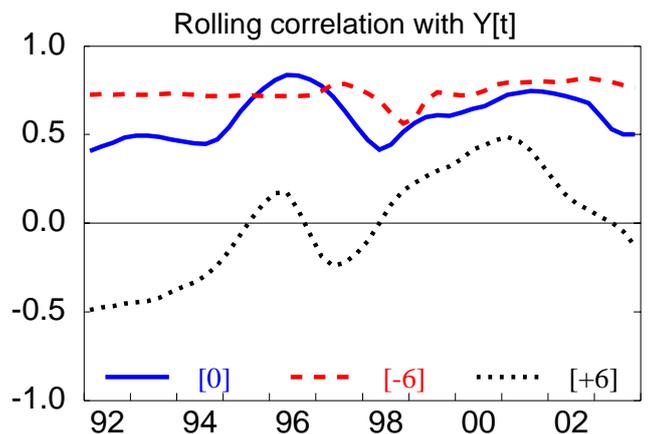
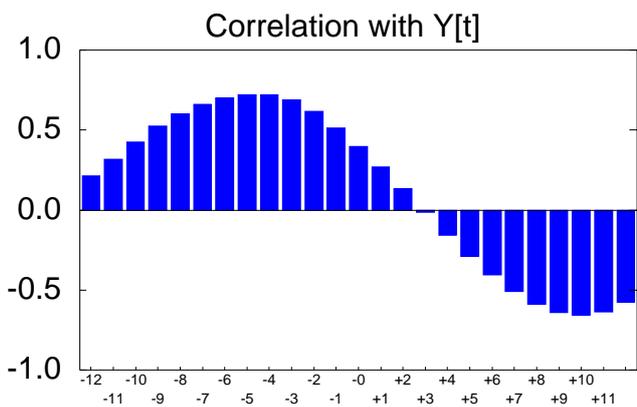
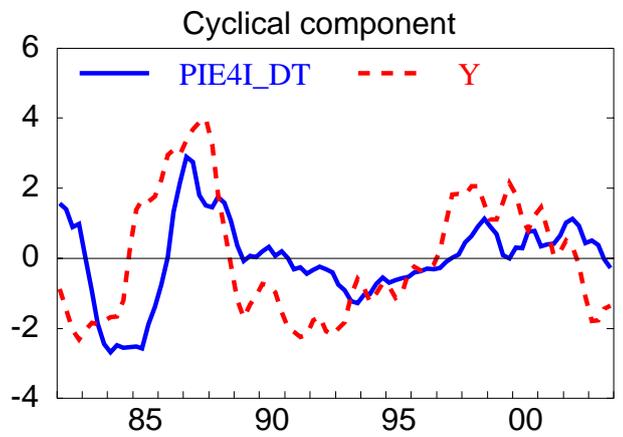
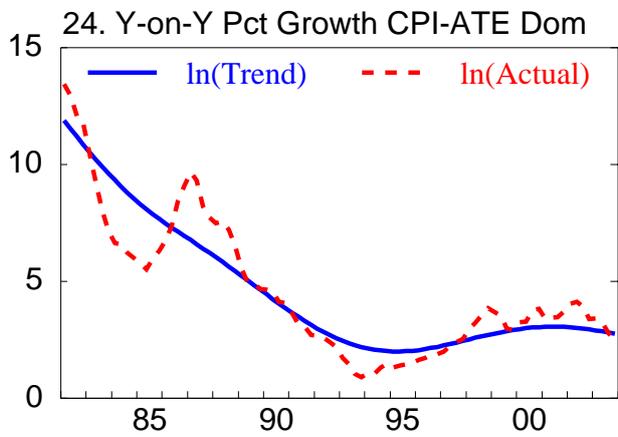
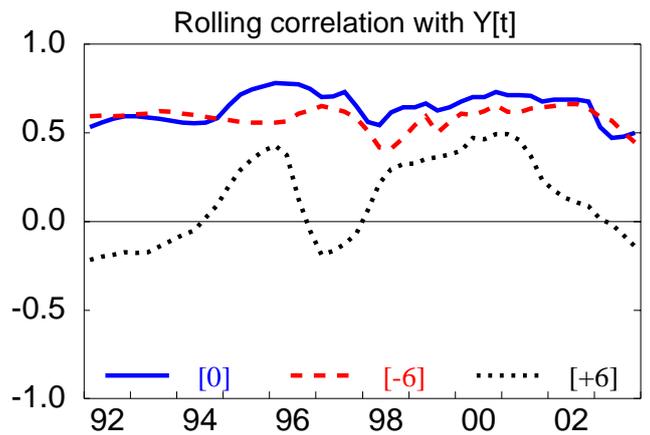
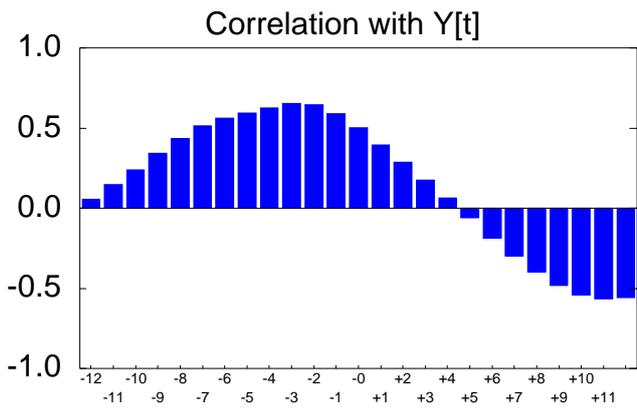
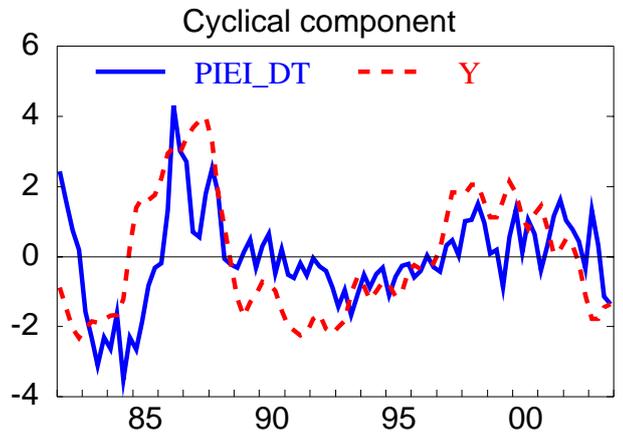
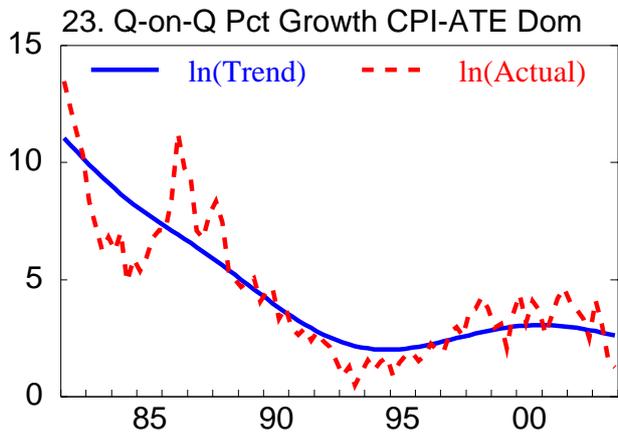


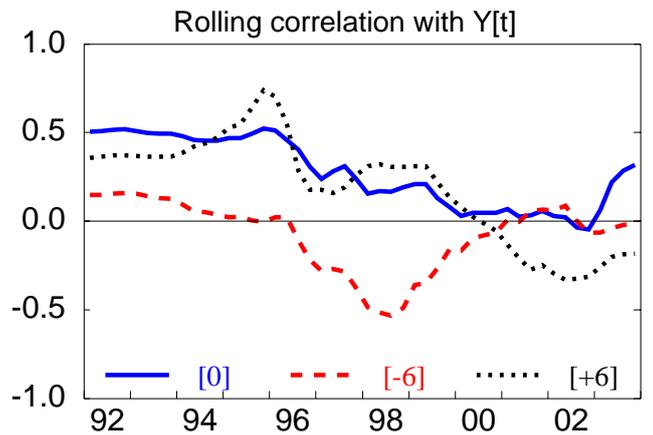
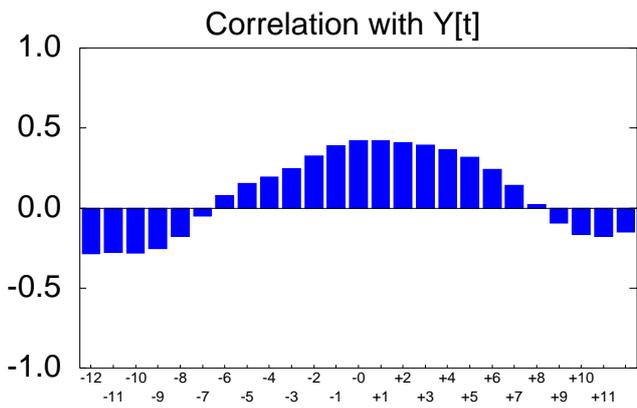
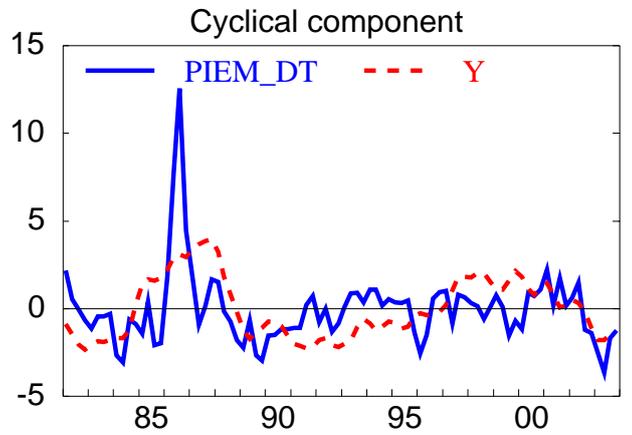
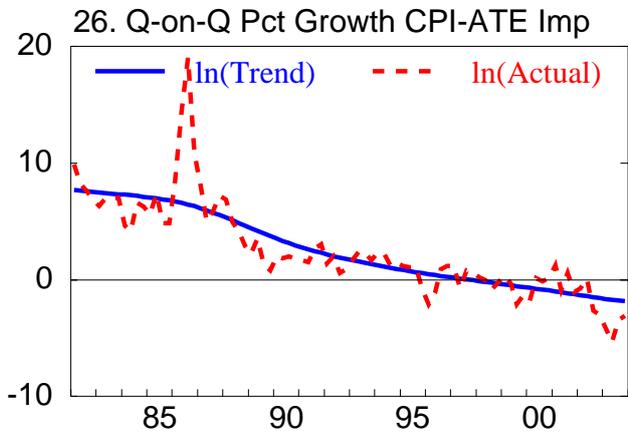
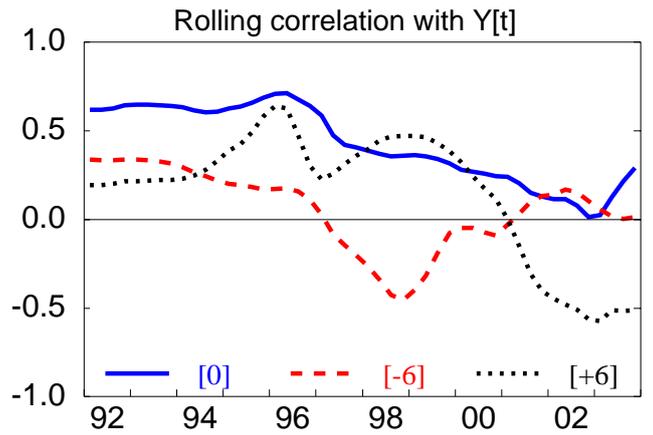
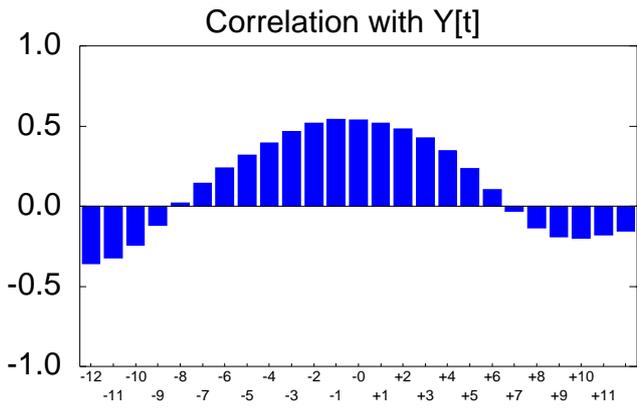
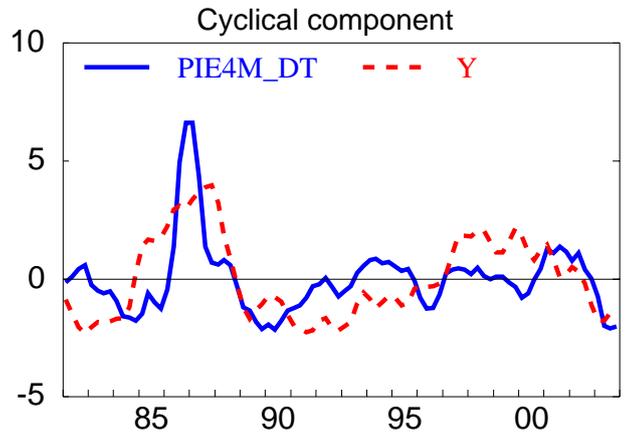
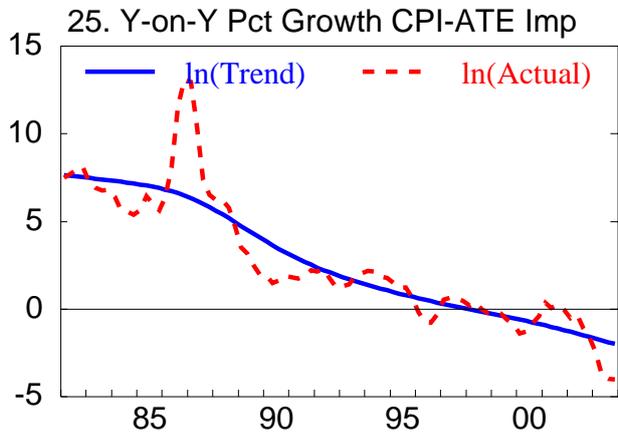




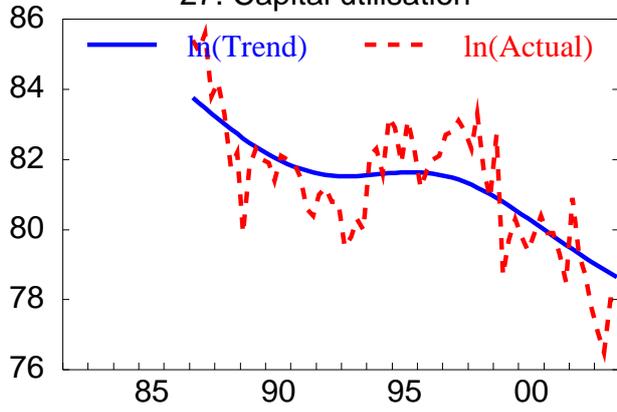




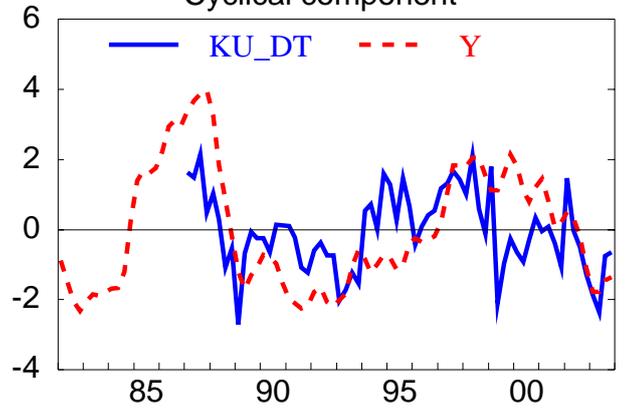




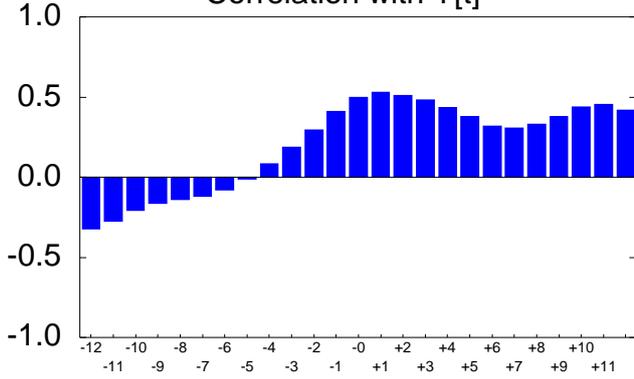
27. Capital utilisation



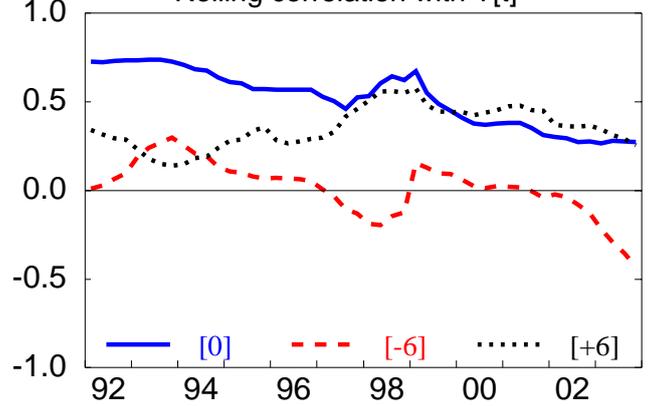
Cyclical component



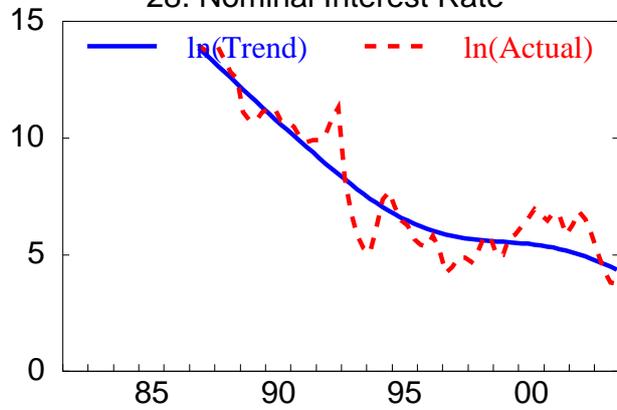
Correlation with Y[t]



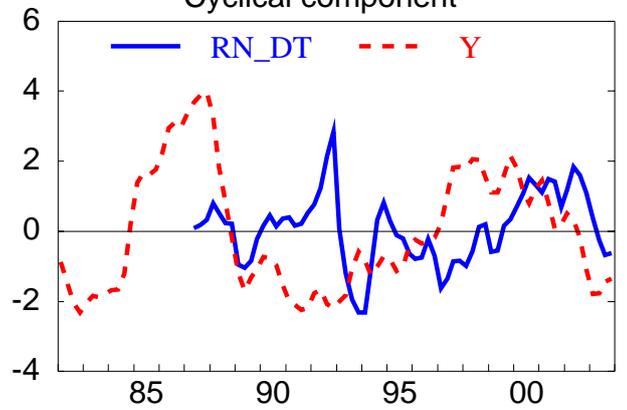
Rolling correlation with Y[t]



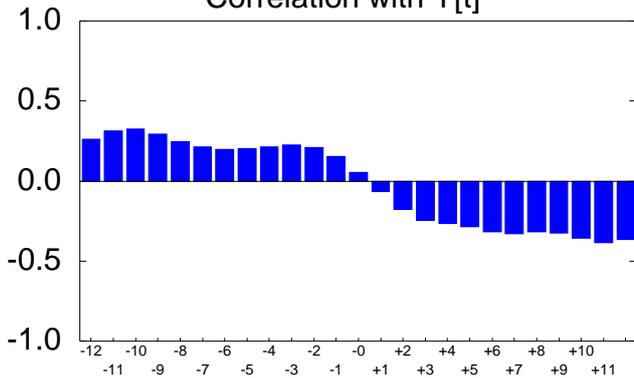
28. Nominal Interest Rate



Cyclical component



Correlation with Y[t]



Rolling correlation with Y[t]

