A Brief Report on Norwegian Business Cycles Statistics, 1980-2006.[1]

- *Preliminary draft*

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Introduction

When we study growth and/or business cycle fluctuations we will always face the problem of how to separate those features of the data that are associated with long-run growth from those that are associated with business cycles. In this paper, we we have chosen to use the Christiano-Fitzgerald Band-Pass filter to empirically describe Norwegian business cycle flucutations in the period 1980 to 2006. Usually, business cycles are defined as fluctuations with frequencies from about 1.5 and to about 8 years. For the set of key macroeconomic variables that we have chosen to analyze we have therefore filtered out time-series components with higher frequency than 1.5 years and with lower frequency than 8 years.

The time series for the price index and all real variables were downloaded from Statistics Norway.[2] The NIBOR rates were downloaded from Norges Bank. All variables, except inflation rates and NIBOR rates, are expressed in log levels.

First we will give a short presentation of the methods we have used, then we will present our results, and finally we will present what

[1] This report was written for ECON4325 "Monetary Policy and Business Cycle Fluctuations" at the University of Oslo, Spring 2008. We thank Espen Henriksen for feedback and guidance.

[2] http://statbank.ssb.no/statistikkbanken

we believe are our key findings for Norwegian business cycles from 1980 to 2006.

The Band Pass (BP) filter

The BPfilter is based on spectral analysis of time series. It uses econometric techniques to eliminate both the low-frequency (trend) components and the high-frequency (seasonal, etc.) components of GDP. The filter only leaves the middle-frequency part that is typically associated with business cycles.

Spectral analysis decomposes an economic variable into regular periodic components with wave length of 2 quarters, 3 quarters, etc. As mentioned, business cycles are usually defined as having a wave length of somewhere between 1.5 and 8 years. Therefore the business-cycle component is usually defined as the spectral components with wave length between 6 and 32 quarters.

The BPfilter decomposes the data in to three parts. Some economists prefer a two-part classification, where the highest frequencies also count as part of the business cycle. The Hodrick Prescott-filter only filters away the lower frequencies, and is therefore by some preferred over the BP-filter. We use the BP-filter because, as opposed to the HP-filter, you don't need properly season adjusted data in order to filter out the components of business cycle frequency.

The correlation table

First we will present our results in a correlation table. The table gives the correlation between GDP in period *t* with the other variables in period *t*, plus five preceeding and five succeeding quarters. This means that the column *x(t+1)* gives the correlation between GDP in period t and the variable x in period t+1.

A procyclical series has a positive contemporaneous correlation coefficient in period *t*. In other words, the movements of the series are posetively correlated with GDP.

The opposite of a procyclical variable is a countercyclical variable. The contemporaneous correlation coefficient of a countercyclical series is negative. The series are moving in the opposite direction of GDP in period *t*. Series where the contemporaneous correlation coefficient is close to zero does not vary with the cycle. We say that these series are uncorrelated with the business cycle.

A series leading the business cycle has the highest correlation in one of the quarters preceeding period *t*. This also explains the use of different quarters (*t+/-i*) in our table. We are able to find that, for example, exports have its highest correlation coefficient in period (*t-1*). This means that it is procyclically leading the business cycle by one quarter. The case of a lagging series is the opposite. A series that lags the cycle has its highest correlation with GDP in (*t+i*). Public consumption is an example of a variable that lags the cycle. Its highest correlation coefficient is in period (*t+2*).

A variable's volatility is measured by the standard deviation of its cyclical component. The variable with the highest standard deviation is the one that varies the most. Voltatility is often reported relative to that of GDP.

		Cross correlation of GDP with										
Variable x	**stdev**	**x(t-5)**	**x(t-4)**	**x(t-3)**	**x(t-2)**	**x(t-1)**	**x(t)**	**x(t+1)**	**x(t+2)**	**x(t+3)**	**x(t+4)**	**x(t+5)**
GDP	1.12 %	0.038	0.165	0.375	0.656	0.904	1.000	0.904	0.656	0.375	0.165	0.038
Man hours worked												
-mainland	0.93 %	-0.526	-0.428	-0.313	-0.159	0.041	0.262	0.502	0.650	0.701	0.687	0.648
-total industry	0.90 %	-0.515	-0.412	-0.288	-0.126	0.078	0.296	0.533	0.672	0.712	0.687	0.641
-general government	1.06 %	-0.204	-0.188	-0.190	-0.164	-0.082	0.037	0.248	0.306	0.238	0.164	0.176
Employment												
-mainland	0.93 %	-0.613	-0.505	-0.363	-0.183	0.029	0.248	0.468	0.633	0.731	0.768	0.756
-total industry	0.91 %	-0.609	-0.496	-0.348	-0.160	0.056	0.276	0.495	0.654	0.745	0.775	0.757
-general government	0.60 %	-0.536	-0.442	-0.308	-0.146	0.025	0.179	0.340	0.464	0.554	0.612	0.634

		Cross correlation of GDP with										
Variable x	**stdev**	**x(t-5)**	**x(t-4)**	**x(t-3)**	**x(t-2)**	**x(t-1)**	**x(t)**	**x(t+1)**	**x(t+2)**	**x(t+3)**	**x(t+4)**	**x(t+5)**
GDP	1.12 %	0.038	0.165	0.375	0.656	0.904	1.000	0.904	0.656	0.375	0.165	0.038
Final consumption expenditure of households	1.65 %	0.032	0.163	0.311	0.478	0.625	0.702	0.690	0.608	0.495	0.385	0.292
-Goods	2.58 %	0.053	0.191	0.346	0.515	0.658	0.733	0.719	0.643	0.535	0.421	0.307
-Services	0.85 %	-0.028	0.052	0.156	0.282	0.388	0.424	0.376	0.275	0.175	0.126	0.138
Final consumption general government	0.95 %	-0.419	-0.340	-0.202	-0.006	0.210	0.388	0.516	0.560	0.546	0.505	0.460
Gross fixed capital formation	5.74 %	-0.088	-0.008	0.078	0.123	0.111	0.068	0.037	0.056	0.094	0.112	0.103
Total imports	3.20 %	0.074	0.126	0.201	0.309	0.418	0.477	0.440	0.372	0.313	0.270	0.216
Total exports	2.35 %	0.397	0.449	0.508	0.567	0.576	0.486	0.240	-0.053	-0.299	-0.453	-0.519
-Traditional goods	2.53 %	0.363	0.181	0.057	0.033	0.064	0.055	-0.078	-0.269	-0.455	-0.578	-0.612
-Services	4.55 %	-0.164	-0.107	-0.024	0.121	0.298	0.435	0.504	0.489	0.424	0.359	0.316
-Crude oil and natural gas	4.43 %	0.116	0.164	0.223	0.290	0.329	0.295	0.099	-0.150	-0.356	-0.448	-0.431

		Cross correlation of GDP with										
Variable x	**stdev**	**x(t-5)**	**x(t-4)**	**x(t-3)**	**x(t-2)**	**x(t-1)**	**x(t)**	**x(t+1)**	**x(t+2)**	**x(t+3)**	**x(t+4)**	**x(t+5)**
GDP	1.12 %	0.038	0.165	0.375	0.656	0.904	1.000	0.904	0.656	0.375	0.165	0.038
CPI	1.09 %	-0.621	-0.659	-0.674	-0.678	-0.648	-0.564	-0.391	-0.179	0.022	0.178	0.288
Inflation	113.50 %	-0.609	-0.394	-0.195	-0.051	0.050	0.157	0.349	0.540	0.674	0.717	0.663
NIBOR	104.50 %	-0.211	-0.258	-0.333	-0.346	-0.241	-0.046	0.137	0.315	0.462	0.567	0.619
NIBOR index, =100 in 1978	0.79 %	-0.228	-0.337	-0.465	-0.586	-0.658	-0.661	-0.621	-0.523	-0.377	-0.195	0.000

Labour input

We have only examined how labour input in production varies with business cycles. Measures of capital stocks are published once a year. To find the quarterly numbers we could have used a method based on implicit rates of depreciation. We have left this for further, later analysis.

From the Figures 1-3 and the standard deviation reported in the table we see that both total employment and total hours used in production are less volatile than GDP. If we analyze labour input in industry and in general government separately, we see that the labour input is more volatile in the industry sector than in the public sector. Especially we notice that employment in the public sector has the lowest volatility of the production input factors we have examined. According to Figure 2, the use of *hours* in general government vary more. This is a distinct difference from the industry variables, where the cyclical behaviour of employment and hours are almost identical.

Figure 3 shows that both total hours and total employment are variables with a low degree of contemporaneous co-movement with GDP. We also see this from column *x(t)* in the correlation table. If we look at the decomposed numbers, we find that hours used in general government are the least correlated with GDP. Both total hours and total employment are procyclical variables, but the series lag the cycle by respectively three and four quarters. The correlation coefficient is the highest in *(t+3)* and *(t+4)*. Figure 1 also shows this clear pattern. This is contrary Kydland and Prescotts (1990) findings in US data. They find that both total man hours and employment has a high contemporaneous correlation with GDP, and are strongly procyclical. Hours per worker even has a slight lead in the US data.

Expenditure components

Contrary to what we expected to find given US studies, privat consumption is slightly more volatile than GDP. When we investigate column *x(t)*, we see that private consumption is clearly procyclical. Figure 4 confirms this. From the correlation table we see that most of the volatility in private consumption is driven by the volatility in consumption of goods, which is about three times as volatile as that of consumption of services. Consumption of goods follows almost the same correlation pattern as total private consumption (see Figure 6). Consumption of services is more stable and has a smaller correlation coefficient than consumption of goods at its peak, but it is also contemporaneously procyclical. Public consumption is less volatile than GDP, it is procyclical, and lags the cycle by two quarters. This finding is interesting given the notions of and discussion about countercyclical fiscal policy.

Investment is the most volatile series in the table; it is nearly 6 times as volatile as GDP. Still, the correlation table shows little correlation between investment and GDP, but column (*t-2*) indicate that investment is leading the cycle by two quarters. The lack of correlation is really puzzling.

Import is almost three times as volatile as GDP, and is contemporaneously correlated with GDP; i.e neither leading nor lagging the cycle. Export is also more volatile than GDP, and it leads the cycle by one quarter. When we decompose export into three main categories, we see that services are the one that has the highest correlation coefficient of the three and it lags the cycle by one quarter.

Nominal series

The contemporaneous correlation coefficient between GDP and the CPI is negative, i.e. price level is countercyclical. We also see that the association with GDP is at its highest at (*t-2*). The volatility is not particularly high given a standard deviation at 1.09%. From

Figure 7 it looks like the fluctuations decreases as the series approach present time.

As a measure of a risk-free interest rate we will use NIBOR[3]-rates. We will use a constructed NIBOR-index in this analysis, except for when we compare the NIBOR-rate with inflation. Figure 9 show that the NIBOR-index has a negative contemporaneous correlation coefficient, i.e. it is countercyclical, the highest absolute value of the correlation coefficient is in period (t-1), it leads the cycle. From the correlation table we can see that the standard deviation of the NIBOR-index is 0.8%, which is low relative to GDP.

Inflation rate is procyclical and lags the business cycle with four quarters. Because the inflation rate is a relative number, the standard deviation is not comparable to the volatility of the other variables. Figure 9 shows us that the NIBOR-rate and the inflation rate often move in the same direction, but the NIBOR is lagging the inflation rate.

Figure 11 shows unfiltered inflation rate and NIBOR-rate. It looks like both variables has decreased substantially the last 20 years.

[3] http://www.dnbnor.no/markets/obligasjoner_sertifikater/hva_er_nibor.html

Business cycle facts and concluding remarks

We will now summarize some of our most interesting findings:

- There seems to be a remarkable difference between the co-movements of employment and hours in private industry and in the public sector. In private industry, hours worked and employment have almost identical business cycle properties. In contrast, in the public sector hours vary significantly more than employment.
- Private consumption follows GDP closely, in particular consumption of goods. Total private consumption is more volatile than GDP.
- Public consumption is procyclical and lags the business cycle.
- Investment is very volatile throughout the sample, but does not show a clear correlation pattern with GDP. This latter finding is puzzling.
- Exports have been leading the business cycle, while imports neither have neither been leading nor lagging.
- Both the price level and the NIBOR index have been strongly countercyclical. Inflation rates have been procyclical and lagged the cycle by about four quarters.

Finally, it is important to emphasize that correlation should not be mistaken for causality. We have only provided a statistical representation of a set of key macroeconomic time series. Without theory we cannot say anything about causation.

Figure 1: Labour input

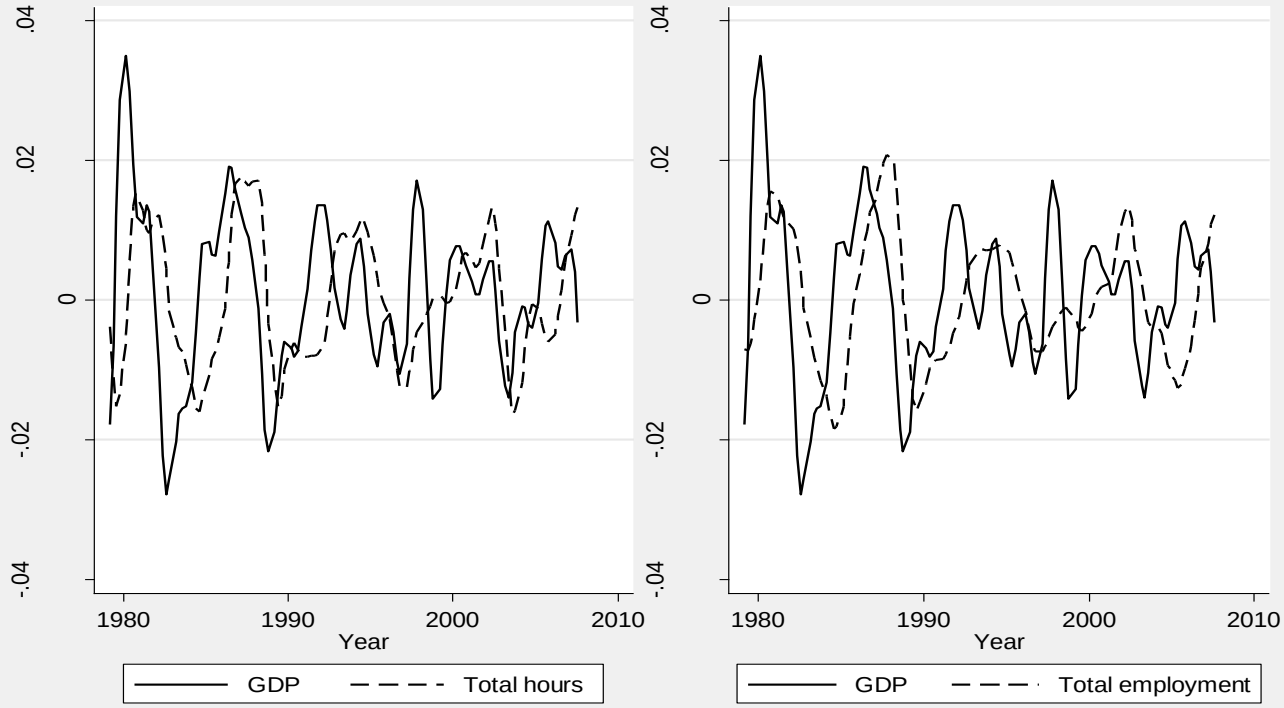

Figure 2: Labour input, decomposed

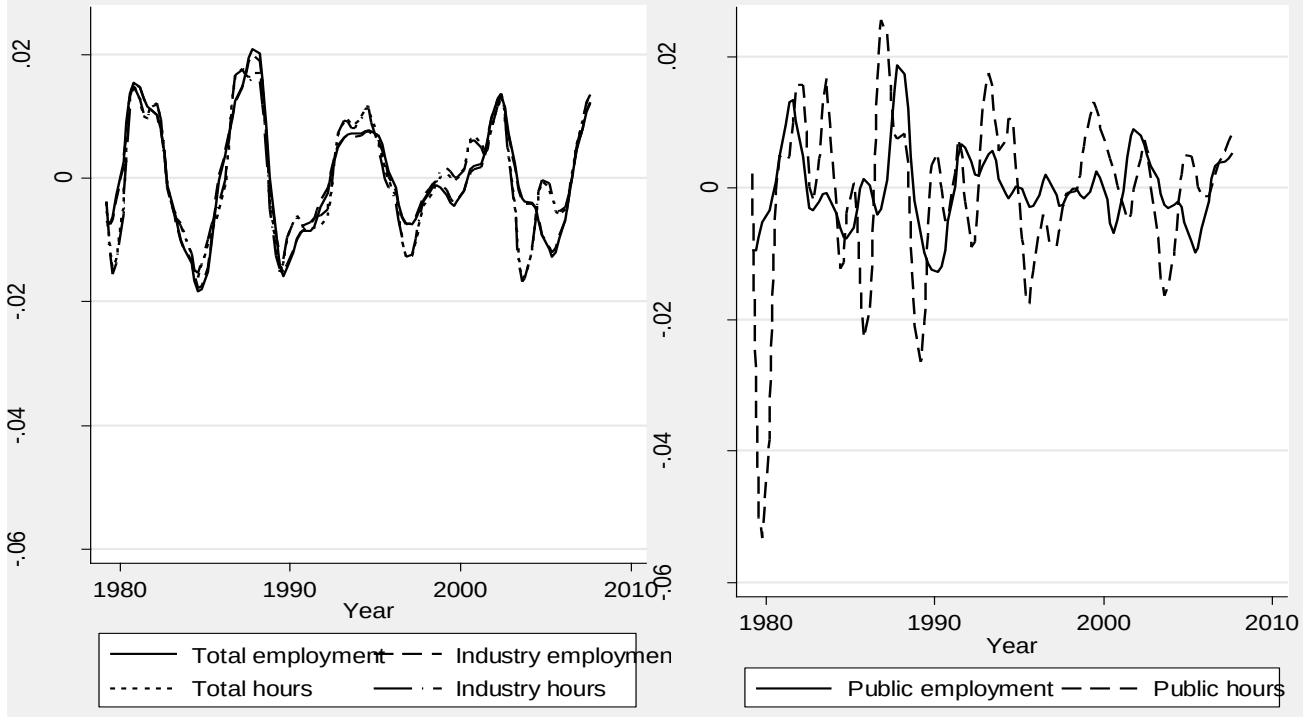

Figure 3: Labour input correlation with GDP

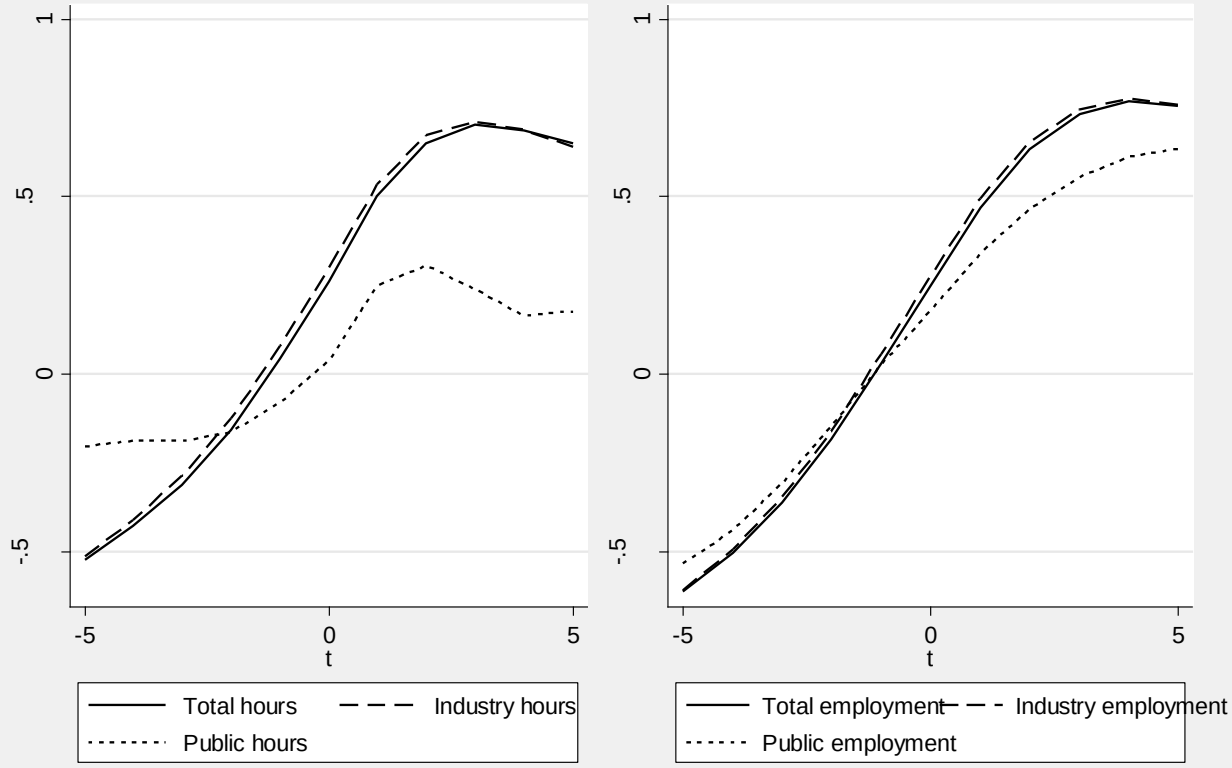

Figure 4: Private expenditure components

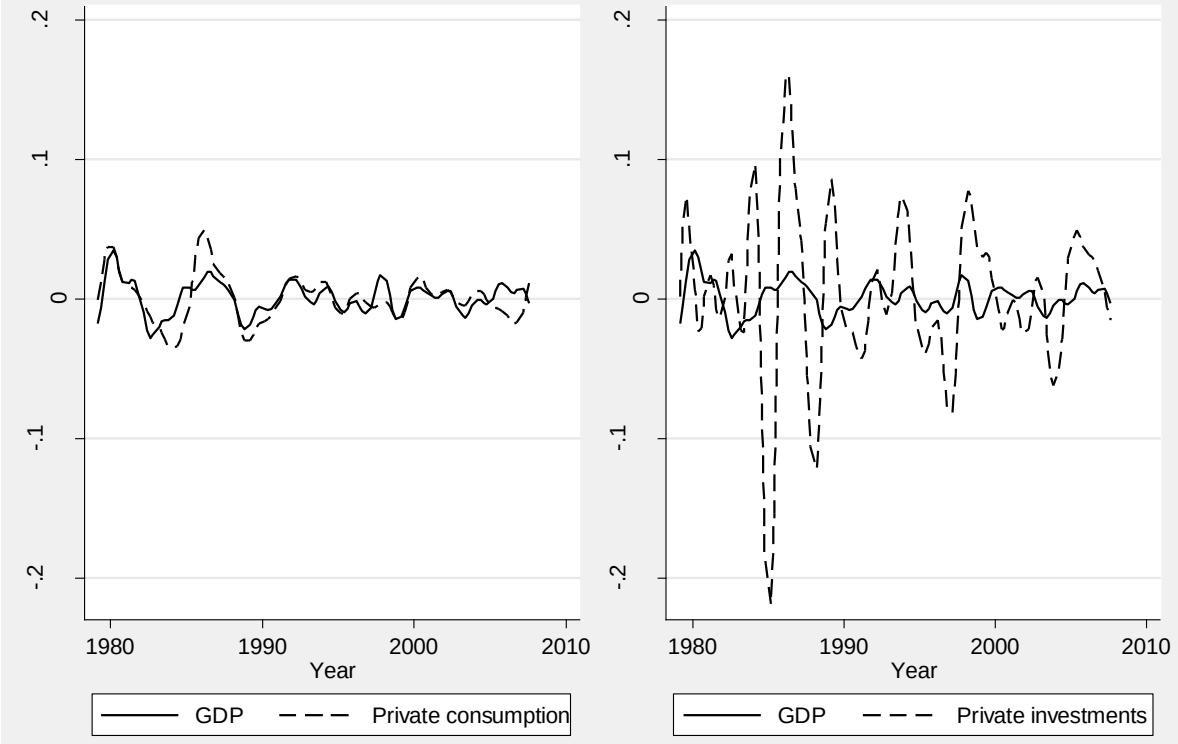

Figure 5: Import and export

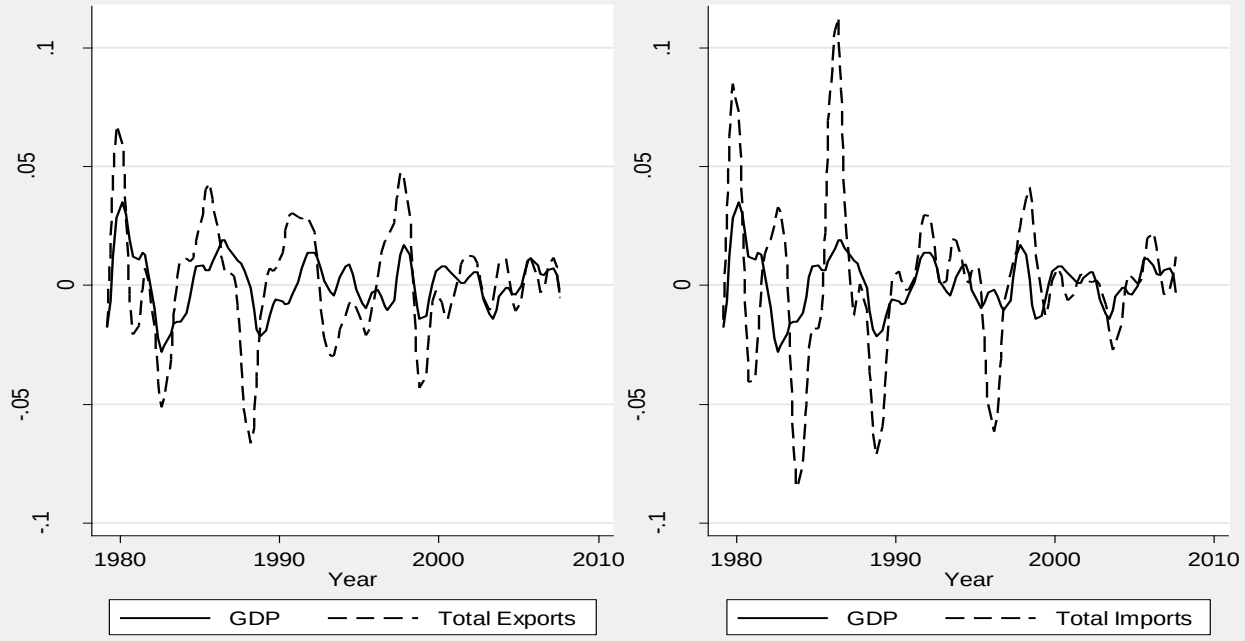

Figure 6: Consumption and investment correlation with GDP

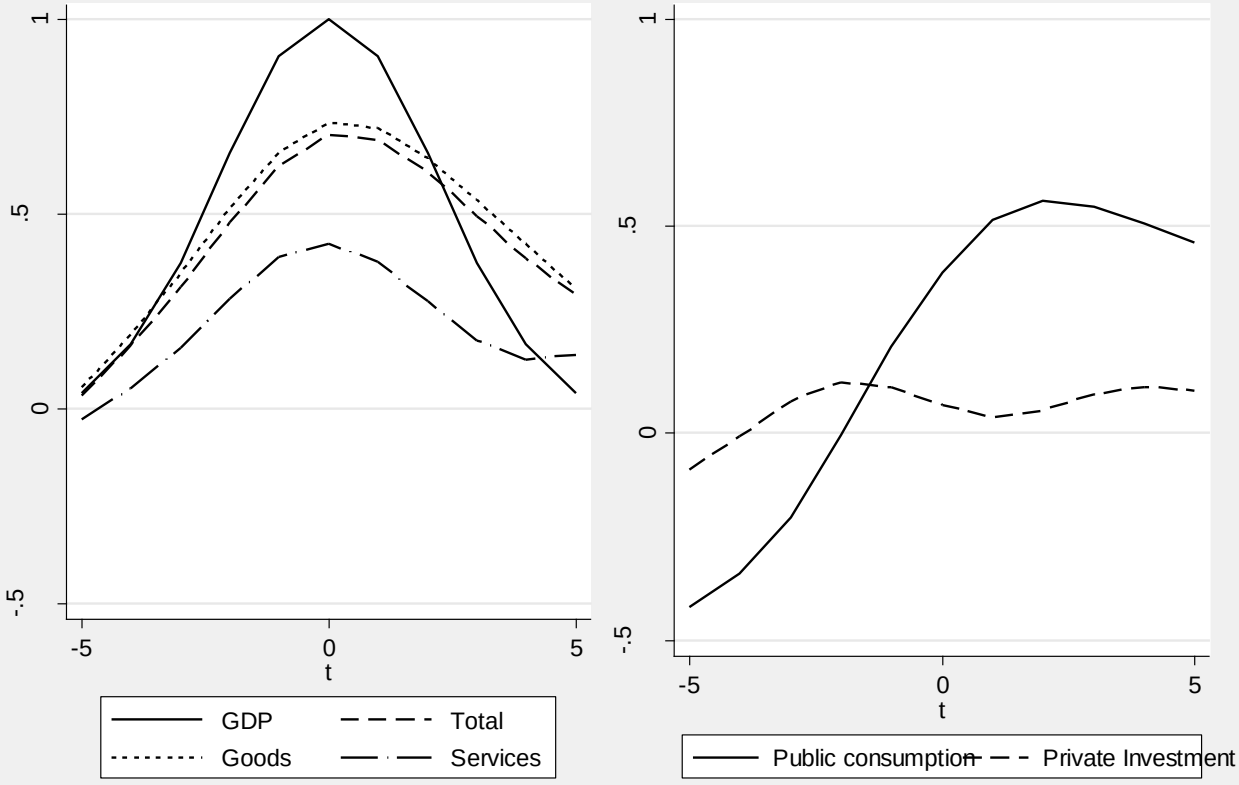

Figure 7: Export and import correlation with GDP

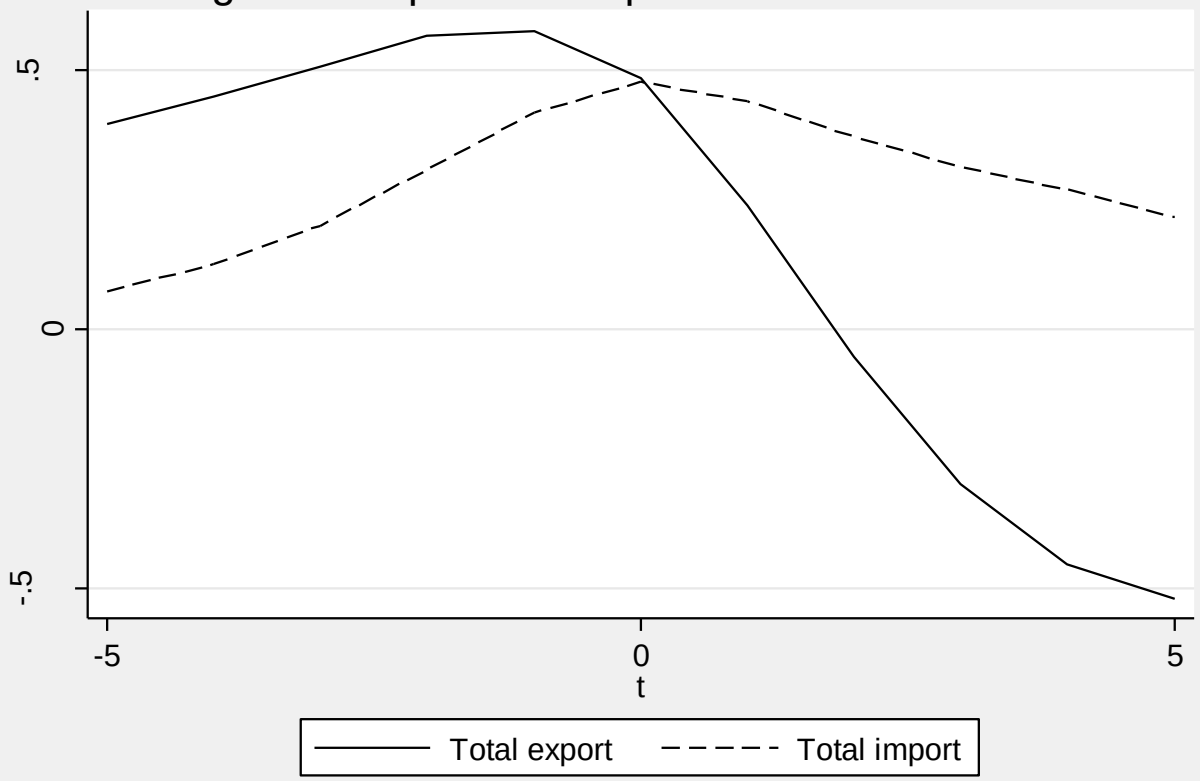

Figure 8: Prices and interest rate index

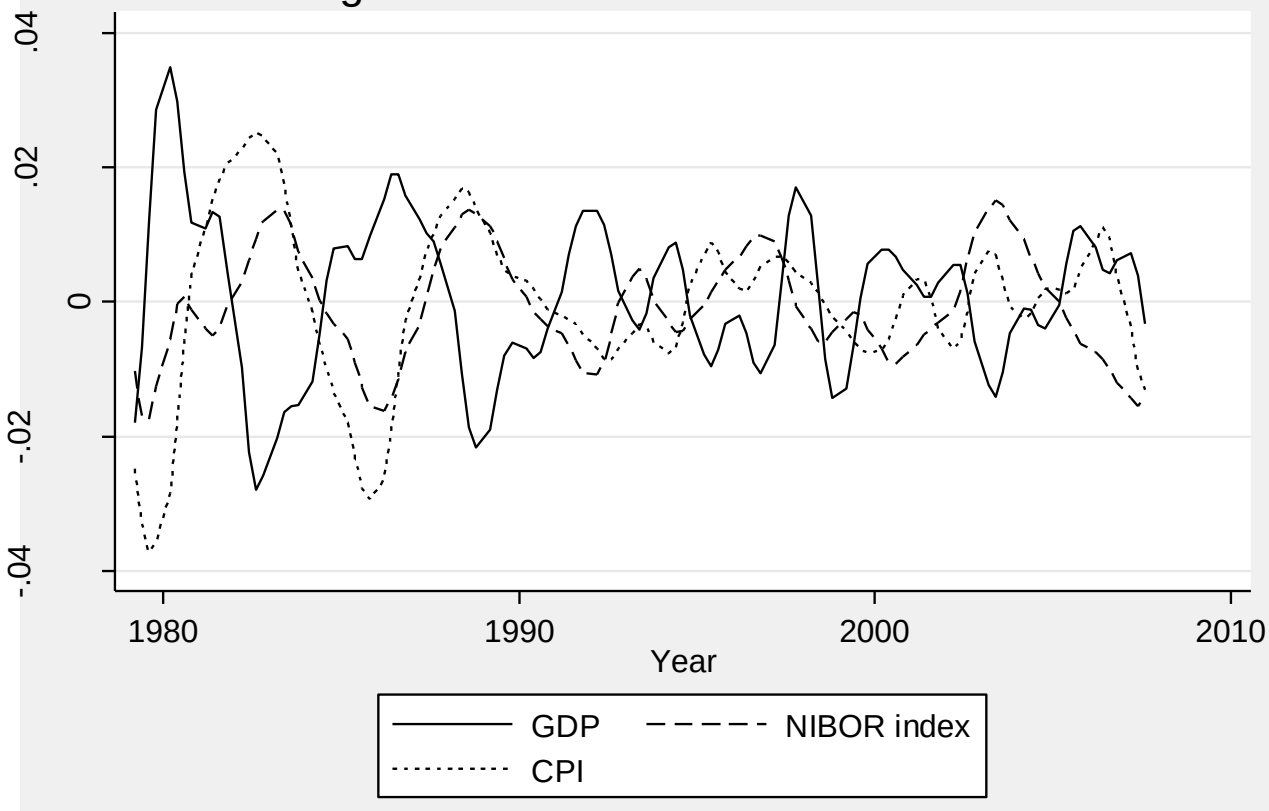

Figure 9: Inflation and interest rate

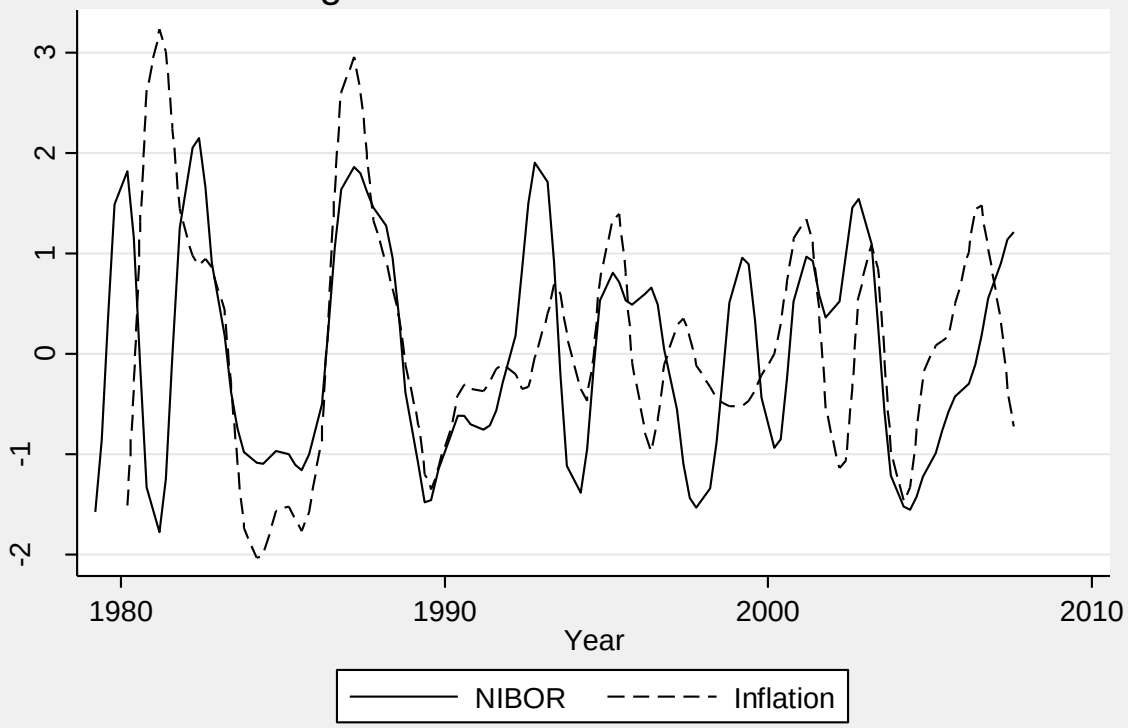

Figure 10: Nominal components' correlation with GDP

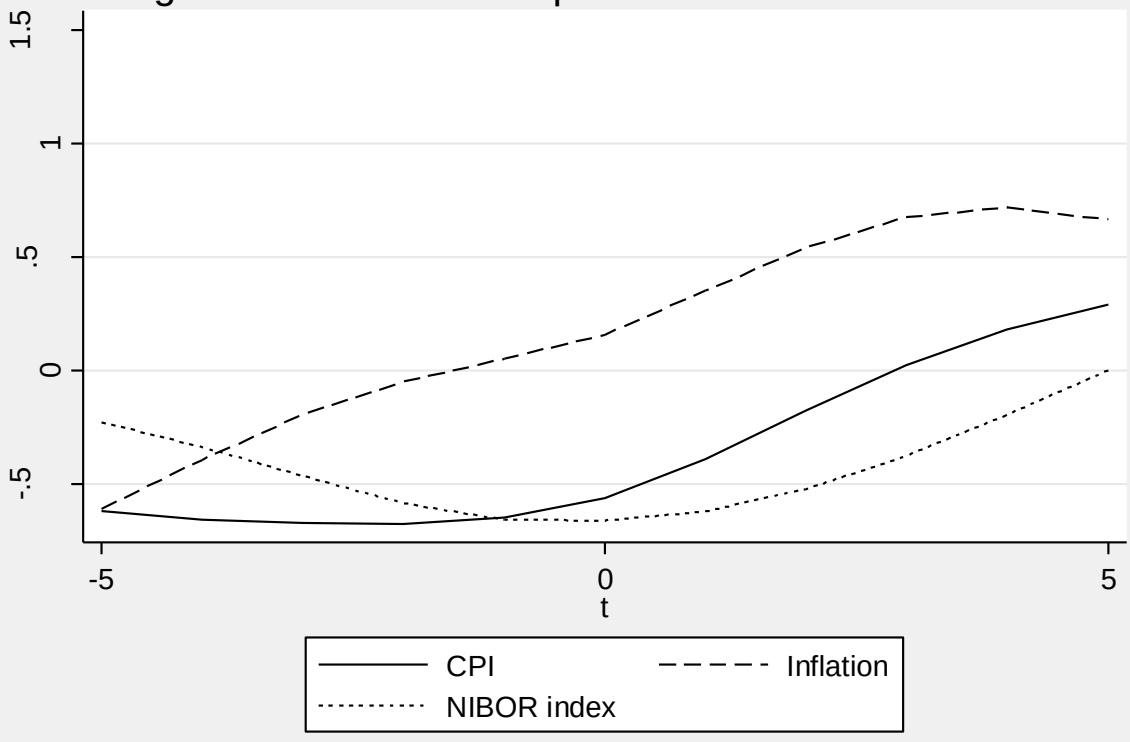

Figure 11: Unfiltered inflation rate and NIBOR-rate