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-- Evaluating the Forecast Accuracy of Policymakers, Private Banks and Exchange Rate Forecasting Models --

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Abstract

This paper compares the out-of-sample forecast accuracy of policymakers, private banks and three classes of exchange rate models in predicting the yearly Norwegian kroner/Euro, I-44 and KKI exchange rate. The three classes are time series models, fundamental models, and general models (simple models that combine various variables that in the literature have found to hold predictive power on exchange rates). My findings support the evidence of Meese and Rogoff (1983) that the naïve random walk model is difficult to outperform out-of-sample. Further, I find that Policymakers and Nordic Banks are reliable forecasters producing stable and precise forecasts. Finally, I find evidence for the stable and accurate forecasting power of the Taylor Rule and the output gap differential between Norway and the Euro-zone.

Preface and acknowledgements

This thesis has been an ambitious and rewarding task; it has given rise to curiosity and knowledge to the author. Many hours spent on studying the vast field of research on exchange rates and exchange rates forecasting, much more research have been read than what is cited in this paper.

I would like to thank my thesis supervisor, Associate Professor of Econometrics at BI Norwegian Business School, Genaro Sucarrat. I have been fortunate to have him as supervisor. Always was he willing to meet at short notice, answer questions and provide much valued feedback.

Finally, I would like to thank Magne Østnor at DnB Markets for providing me with DnB "Økonomiske Utsikter" series, allowing me to gather sufficient observations and a consistent time series from DNB.

Oslo, 26 August 2016

Contents

Definitions and Notations

Δ	Difference operator
σ	Standard deviation
(x.x)*	Equations followed by *, implies that this equation is the respective model used in creating forecasts
BOA	Bank of America
ECB	European Central Bank
F	Forecast of S. In section/equation x.x F is referred to as the forward rate
NCB	Norwegian Central Bank
e	Forecast error, difference between actual and forecasted value
$i^{n,eu}$	Government bond, 1-year maturity, for Norway and Euro-area, respectively. In the appendix it is reffered to as RN and REU
OP	Brent crude oil price per barrel in US dollars (yearly average of daily notations
op	Natural log of OP_t
PN, PEU	Norwegian and Euro-area price indexes, respectively. Represents the adjusted harmonized consumer price index of Norway and the Euro-area.
pn, peu	Natural logs of PN and PEU, respectively
RBS	Royal Bank of Scotland
S^{aug}	Norwegian kroners per unit of Euro (August average of daily notations)
S^{4Q}	Norwegian kroners per unit of Euro (fourth quarter average of daily notations)
S^{I-44}	Nominal exchange rate index calculated as a geometric weighted average of Norway's 44 most important trading partners (yearly average of daily notations)
S^{KKI}	Nominal exchange rate index calculated as a geometric weighted average of Norway's 25 main trading partners (yearly average of daily notations)
s	Natural log of S
SN	Statistics Norway
t	Year, time index
$X^{S,F}$	Net Foreign Exchange Purchases for spot and forward rates respectively. Also referred to as NFEP-S and NFE
$Y^{n,eu}$	Output gap for Norway and the Euro-zone, respectively. In the appendix it is referred to as GAPN and GAPEU

I. Introduction

In the well cited paper, "*Empirical Exchange Rate Models of The Seventies – Do they fit out of sample?*" from 1983, the authors Richard A. Meese and Kenneth Rogoff analyse the out-of-sample forecasting ability of fundamental models linking exchange rates to interest rate differential, inflation differences, relative industrial production, relative money supplies and the difference in cumulated trade balances[1]. Using the root mean squared error (RMSE) as measure for forecasting ability over various time horizons, Meese and Rogoff find that the wide range of exchange rate models were unable to outperform a simple random walk model. Most surprising was that fundamental models performed poorly even at long horizons.

The findings of Meese and Rogoff over 30 years ago appears to be the consensus amongst researchers. Sarno and Taylor (2002, pp. 136-37) state:
"*Overall, the conclusion emerges that, although the theory of exchange rate determination has produced a number of plausible models, empirical work on exchange rates still has not produced models that are sufficiently satisfactory to be considered reliable and robust. In particular, although empirical exchange rate models occasionally generate apparently satisfactory explanatory power in-sample, they generally fail badly in out-of-sample forecasting tests in the sense that they fail to outperform a random walk.*"
Bacchetta and Wincoop (2006) found similar result. They argue that the major weakness of today's international macroeconomics is the poor explanatory power of existing theories of the nominal exchange. Additionally, in the recent comprehensive study of the out-of-sample performance of interest rate parity as well as other well-established models, the authors Cheung, Chinn and Pascual (2005) concludes the failure of all models to consistently outperforming the random walk in at any horizon.

A wide grasp of inspiration and motivation for this paper is drawn from the above research as well from my supervisor's dissertation "*A Survey of Exchange Rate Forecasting Models*". In his survey he use monthly data ranging from 1994:1 to 1999:12 for the Euro/Norwegian kroner exchange rate to compare the out of sample forecasting accuracy of five different groups of models; time series, oil demand models, price models, financial return models and general models. They

[1] The difference in cumulated trade balances represents the level of net foreign assets.

are evaluated both by their one-step-forecasts and by multi-step-forecast. Sucarrat's results support the historical empirical evidence that the random walk model is difficult to outperform. More specific, he concludes that in one-step-ahead forecasts time series models and models with few fundamental variables and without cointergration relations perform best. Whilst general and oil demand models with cointergration relations tend to perform better in multi-step forecasting.

There is no doubt that there are many questions that remains to be studied in the field of exchange rate forecasting. This paper will not try to take on the most challenging questions and the unknown. Nevertheless, I hope this will be a solid contribution to the field of research on exchange rate forecasting. The main objective for this paper is to assess the forecasting accuracy of policymakers, private banks and three classes of exchange rate models. The three classes are time series models, fundamental models, and general models (simple models that combine various variables that in the literature have found to hold predictive power on exchange rates). The main question addressed is whether policymakers, private banks and the three classes of models are able to forecast better than the famous random walk model.

The rest of this thesis is structured in the following way: next subsection provides a brief literature review in the field of exchange rate forecasting. The third section describes the data, methodology and how to evaluate out-of-sample accuracy. Flowingly, four sections is devoted to the candidates and the different classes of models and their out-of-sample performance. Finally, the conclusion.

II. Literature Review

After the striking findings of Meese and Rogoff (1983), it has been a vast acceleration in research on exchange rate forecasting. On the one hand, many researchers find evidence that support the result of Meese and Rogoff, whilst on the other hand, there are several evidence on the predictive power of exchange rate models. In this section, I provide a brief literature review on the most relevant research in the field of exchange rate forecasting.

The failure of fundamental models to create accurate exchange rate forecasts in the short run has gained acceptance amongst researchers. Evans and Lyons (2002) find that macroeconomic models of exchange rates perform poorly at frequencies higher than one year. A result that is reinforced by Rime (2006), who argue that in the short run, it may seem that exchange rates move freely without correlation to its macro-fundamentals, a phenomenon referred to as the exchange rate determination puzzle. Rime impose that order flow can be used to account for short run exchange rate movements. The results of Rime is supported by Meese and Prins (2011) who emphasise the importance of order flow in the short-run and fundamentals in the long-run for exchange rate determination.

Amongst fundamental exchange rate models the most common are the Interest Rate Parity and Purchasing Power Parity (PPP). The first parity relates interest rate differential to the exchange rate, whilst the latter relates the exchange rate to relative price levels. Bjørnstad and Hungnes (2006) argue that interest rate differential and relative prices are the most reliable fundamentals for long run exchange rate forecast[2]. Flatner, Tornes and Østnor (2010) argues that the interest rate differential is the best variable for accounting for exchange rate movements, both in the short and the long run. The forecasting power of the PPP has been extensively studied. Clements, Yihui and Shi Pei (2010) find that deviations from the PPP can forecast nominal exchange rates in medium and long horizons when defining a theoretical real exchange rate using the Big Mac index. Wu and Hu (2009) prove that the random walk model is outperformed by a PPP model adjusted for the Harood-Balassa-Samuelson effect in out-of-sample forecasts in medium and long forecasting horizons. The relative PPP hypothesis has been regarded not only a proposition in positive economics, but also a policy guideline in normative economics[3] (Isard 1995). Akram (2000) and (2006) studies the Norwegian krona and the PPP. He test for PPP between Norway and its trading partners for the post Bretton Woods period, using quarterly data. Despite the numerous real shocks to the Norwegian economy during this period, Akram finds support for the PPP, he state:

"In particular, the behaviour of the Norwegian real and nominal exchange rates appears remarkably consistent with the PPP theory. Moreover, convergence towards PPP is relatively rapid; the half-life of a deviation from parity is just about 1.5 years."

[2] For more evidence on fundamentals and exchange rates, see for example Mark (1995) and Engel, Nelson and West (2007).

[3] Positive economics uses objective analysis and facts when explaining economic phenomenon, whilst normative economist on the other hand, rely on subjectivity in its analysis.

In the work from Akram (2004), the author finds a negative non-linear relationship between the Norwegian Krona and the oil price. A result that is not surprising for a small open oil exporting economy like Norway[4].

In the recent decade, the use of the famous Taylor Rule, have received more attention from researchers. The Taylor Rule, which in general is a monetary policy rule, states that the interest rate should be adjusted to even out the inflation and production gap[5]. Wang and Wu (2009) debates that variations of the Taylor Rule model outperform the random walk and PPP models, especially at longer horizons. Molodtsova and Papell (2008) states: "*The evidence of predictability is much stronger with Taylor rule models than with conventional interest rate, purchasing power parity, or monetary models.*"

III. Data and Methodology

This section include comments on the data, how and where it were detained and different statistics measures of out-of-sample accuracy.

Data

All the series used in this paper are yearly, range from 1999 to 2015, and been provided by the Norwegian Central Bank (NCB), Statistics Norway (SN), Norwegian Department of Finance (NDF), European Central Bank (ECB), OECD, International Monetary Fund (IMF), Den Norske Bank (DNB), and Bloomberg Professional. In this section, the main series and their sources are presented. For a full overview of graphs, data and sources, see appendix II and IV.

S_t^i, source NCB, denotes the spot exchange rate in year t between Norwegian kroner and Euros. That is, the number of kroner per unit of Euro. Notice that i refer to the different exchange rates series investigated in this paper. The four series are NOK/EUR (aug), NOK/EUR (4.Q), I-44 and KKI. I-44 is a nominal

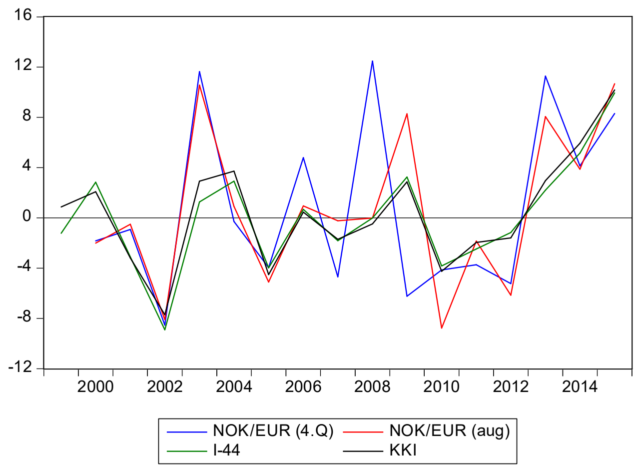
[4] The intuition behind this relationship is that increased oil price results in increased oil revenues which can be used to increase imports and therefore allow sheltered industry to grow at the expense of competitive industry. The wealth transfer we experience demand a real appreciation of the exchange rate. In addition, a pure psychological effect might occur; increased oil price will in theory increase the demand for oil investment and oil related stocks, hence increased demand for Norwegian currency. On the other hand, the relationship can be/is destabilised due to two factors. First, the Norwegian fiscal rule that allows for 4 percent of revenues from the Government pension fund to be injected into the economy limit the need for a real appreciation (Fidjestøl, 2007). Second, the demand for Norwegian currency are reduced by NCB foreign investment to build up the pension fund.

[5] Inflation gap is the difference between inflation target and actual inflation. Output gap is the difference between potential and output measured by GDP.

exchange rate index calculated as a geometric weighted average of Norway's 44 most important trading partners. KKI is a similar index but are calculated based on Norway's 25 main trading partners. Both indexes were set equal to 100 in 1995 and 1990 respectively. The NOK/EUR (aug) and (4.Q) series are the Norwegian krone/Euro exchange rate measured as an average of daily notations for August and the fourth quarter, respectively. The reasoning for the four series is that the NCB and SN forecast next year average of the I-44 exchange rate. NDF forecast the KKI[6]. DNB make their yearly forecasts in August and forecasts the level of the exchange rate in August next year. The rest of the bank forecasts the fourth quarter average. All four series are an average of daily notations, and are middle rates. i.e. the mid-point between buying and selling rates in the interbank market at a given time. As NCB do not keep quarterly exchange rate statistics, this was calculated by taking the average of daily notations of October, November and December.

In exhibit 3.1 we see a clear tendency to co-movement between the series, which is not surprisingly as the Euro are given an average weight if 35% and 40,5% in I-44 and KKI since the Euro were included in the two indexes. Notice that the fourth quarter series of the NOK/EUR is more volatile than the August series. More specific, they have a standard deviation of 7,1673 and 6,3284 respectively. This is somewhat surprising, as one would reasonably assume that a series containing of an average of fewer observation would have larger yearly fluctuations than one including numerous observations. I-44 and KKI are a lot smoother than the two NOK/EUR series, with a standard deviation of 4,2944 and 4,37 respectively.

Exhibit 3: Volatility in the respective exchange rate series. Logarithmic difference.



Source: NCB

[6] Also reffered to as Trade Weighted Exchange Rate (TWI)

Forecasts observations from candidates were obtained via publications and the use of Bloomberg Professional. Forecasts made by NCB and SN were found in their November/December publications “Monetary Policy Report” [7] and “Økonomiske Analyser”. For NDF forecasts were collected from the National Budget. The result is fifteen years of forecasts from NCB, a complete series for SN and for NDF I have eight observations lacking in consistent i.e. forecasts spared across the series.

In contrast to policymakers, forecasts from banks prove to be more difficult and time consuming than first expected. After several failed attempts to retrieve data from their respective webpage and e-mail correspondence, only DNB replied, forecasts were finally found using Bloomberg Professional. The choice of which banks to include, depended conclusively on data availability and consistency. Only banks with sufficient number of observations and consistent series are included. With the exception of Nordea and DNB, all bank forecast series consist of nine observations, as for Nordea seven observations were collected. DNB were helpful to provide me with their “Økonomiske Utsikter” publications, resulting in a series of eleven forecast observations.

All forecasts, with the exception of those from SN and some from NCB and NDF forecasts are reported in levels. These forecasts were transformed into percentage change forecasts by simply calculating the expected percentage change using the actual exchange rate as base value: $\Delta F_{t+1} = \frac{F_{t+1}-S_t}{S_t}$.

OP_t, source OECD, denotes Brent crude oil price in US dollars per barrel. It is the yearly average of daily notations. $i_t^{n,eu}$, source NCB and ECB, respectively, denotes the interest rate of 12 months government bonds for Norway and the Euro-zone. Note that these interest rates are in decimals. Hence, if the Norwegian interest rate of 12-month government bond were 2% in 2004 then $i_t^n = 0{,}02$. PN_t and PEU_t, source SN and ECB, in turn, denotes the adjusted Harmonised Consumer Price Index (HCPI) of Norway and the Euro-zone. Both indexes are set equal to 100 in 2015. Y_t^n, source NCB, represent the Norwegian output gap as the percentage deviation between actual and potential GDP. Y_t^{eu}, source ECB, is the European equivalent and thus denotes the percentage output gap for the Euro-zone. Notice that, similarly to the interest rate data, these series are in decimals. In addition, output gap observations used in this paper is reported by the end of the given year,

[7] Forecast dated back to 2006 were found in “Monetary Policy Report”, whilst forecast dated further back in time were found in the same publication-series but under the title “Inflation Report”.

hence the observations are not yet revised and may be considers as estimates of the output gap. X^S and X^F, source NCB, denotes the Net Foreign Exchange Purchases, for spot and forward rates respectively, and are the order flow variables. For the variables S_t, OP_t, PN_t and PEU_t lower-cases denotes their natural logarithmic transformation.

In order to generate truthful out-of-sample forecasts, the sample was separated in two: An estimation sample consisting of 1999-2009, and a forecast evaluation sample consisting of 2010-2015. The reason for the twice as long estimation period in contrast to the evaluation period is due to shortages in the data set, causing the estimation period of some models to adjust its starting period. For example for X^S and X^F the data set starts in 2005, hence models containing of one of these two models start their estimation period in 2006[8].

Methodology

Out-of-sample accuracy cannot be measured by simply comparing the forecast error for each individual period, forecasters may be right for the right reasons, right for the wrong reasons, wrong for the right reasons or wrong for the wrong reasons. Therefore, we need to evaluate forecast performance over several periods and the three most common statistics for such purpose are *mean error* (ME), *mean absolute error* (MAE) and *mean squared error* (MSE).

These statistics can be expressed as scale-dependent (in levels) or as scale-independent (in percent). Scale-dependent statistics can provide interesting results when comparing forecasts within the same data set, i.e. for the same exchange rate. However, these measures is a poor choice when comparing forecasting performance between different data sets, forecasts of exchange rate at high levels, for example I-44 will get higher mean statistics than forecasts of the NOK/EUR exchange rate. To account for such differences, this paper focus on the percentage change in the exchange rate and the percentage forecasted change. The statistics are defined as followed:

$$ME = \frac{1}{n}\sum_{t=1}^{n} e_t \tag{3.1}$$

[8] The reason that the estimation period does not start in 2005 is because this paper use $t-1$ data to make exchange rate forecasts in time t.

$$MAE = \frac{1}{n}\sum_{t=1}^{n}|e_t| \tag{3.2}$$

$$MSE = \frac{1}{n}\sum_{t=1}^{n}e_t^2 \tag{3.3}$$

Where the term e_t is the forecast error, that is, the difference between the actual exchange rate change and its forecast; $e_t = \Delta S_t - \Delta F_t$.

As positive and negative numbers tend to offset one another, ME is likely to be small and the statistic do not contribute with valuable information about the forecast accuracy, however it contains valid information about robustness and if there is any systematic under- or over-forecasting i.e. *forecasting bias.* A positive ME implies that $\Delta S_t > \Delta F_t$, in other words an under-estimation, likewise, a negative ME implies an over-estimation, $\Delta S_t < \Delta F_t$. Since ME does not indicate the size of the errors, mean absolute error can be used for this purpose. MAE is the average of the absolute value of each forecast error. As with the ME, MAE is a linear score, which means that all the individual error terms are equally weighted in the average. Mean Squared Error on the other hand, is a quadratic loss function that is widely used and is similar to MAE in the sense that each individual error are made positive, whilst MAE take the absolute value of each term, MSE make errors positive by squaring them, this causes the statistic to emphasize large errors. The consequence are that a model that rarely misses but when it miss is miss by a lot can easily by outperformed by a model that frequently misses by small and medium deviations. Therefore, in situations where we observe fat-tailed distributions, the MAE would be the preferred measure as it is less sensitive to outlier observations (Meese and Rogoff 1983).

The three well established statistical measures above are widely used in forecast evaluation. They contain valuable information, but they do not account for the fact that that some exchange rates are harder to forecast than others. As we saw previously, the NOK/EUR exchange rate is much more volatile than I-44 and KKI, therefore, one will assume that with the measures above the NOK/EUR forecaster will perform worse than the I-44 and KKI forecasters. Thus, the need for a statistical measure the accounts for such differences between series:

$$AMAE = \frac{1}{n}\sum_{t=1}^{n}\frac{|e_t|}{\sigma_{\Delta S_t}} \tag{3.4}$$

Equation (3.4) express the adjusted mean absolute error. It is similar to the MAE equation, the difference present is that the expression divides the absolute error with the standard deviation of the percentage change in the exchange rate. Whilst the first three measures provide interesting information about forecasting bias, the size of the errors and forecast stability, AMAE is the only measure that is truly comparable across the four exchange rates series in this paper. Therefore, AMEA is considered as the main statistics and will be emphasised the most.

In contrast to Meese and Rogoff (1983), this study will only impose genuine forecast, i.e. forecasts that exclusively take advantage of data that are available at time t when forecasting $t + 1$. Thus, I expect a more challenging task in creating impressive results in forecasting accuracy. On the other hand, the approached used will be more transferable into real world use and the forecasts generated by the models in this thesis will be comparable to forecasts made by the candidates evaluated.

Taylor Rule models in section VI and all models in section VII are estimated by OLS using EView. For estimation output, see appendix III.

IV. Candidates

In total, this paper evaluate the forecasts of sixteen candidates. The sixteen candidates are separated into four groups; *Policymakers*, *Nordic Banks*, *European Banks* and *American Banks*. The first group contains NCB, SN and NDF. Under Nordic Banks, which is defined as banks that operate in the Nordic region, we have Danske Bank, DNB, Nordea and SEB. The third group, European Banks, hold BNP Paribas, Commerzbank, Credit Suisse, HSBC Holdings, Royal Bank of Scotland and UBS. The last group holds Bank of America, Citigroup and Morgan Stanley. The reasoning for dividing the candidates into different groups is to evaluate if there is any structural differences in forecasting performance based on their geographical location.

Out-of-sample accuracy

Exhibit 4.1 shows the candidates forecasting accuracy. First thing to notice is that private banks in general are worse of on ME, MAE and MSE than policymakers. A result that are as expected as the NOK/EUR exchange rate is more volatile than the I-44 and KKI indexes. On the other hand, when compared to the results of the random walk benchmark, which can be seen in section V., private banks, have a much larger deviation from the random walk than policymakers. In addition, all banks have large and positive ME, even when compared to the random walk. This implies a forecasting bias in the sense that private banks tend to under-estimate i.e. forecast a stronger value of the krone than what is actually the case.

Further, it seem to exist a propensity that the "more important" the exchange rate is to the forecaster the better its forecast accuracy. Amongst the banks in the sample, Nordic banks perform the best in terms of all statistics, followed by European Banks except the two UK banks, RBS and HSBC. They are actually the candidates with the poorest out-of-sample accuracy. Between the American Banks, Morgan Stanley on the contrary to BOA and Citigroup, obtain a quite good forecasting accuracy, it is in fact the fourth best forecaster of the NOK/EUR.

According to the main statistics AMAE, the five best forecasters in ascending order are DNB, NCB, SN, SEB and Nordea. They all outperform the random walk model. In fact, these five candidates including NDF and Morgan Stanley are the only candidates that outperform the random walk model in terms of the AMAE.

Exhibit 4: Out-of-sample statistics, Candidates

	ME	MAE	MSE	AMAE
Policymakers				
Norwegian Central Bank	0,0806	3,0382	14,0173	0,7075
Norwegian Department of Finance	0,7458	3,3108	16,0218	0,7576
Statistics Norway	0,4082	3,0395	14,2617	0,7078
Nordic Banks				
Danske Bank	5,8276	6,2156	74,2710	0,8672
DNB	1,8021	4,4200	30,7098	0,6984
Nordea	3,1913	5,2581	49,5722	0,7336
SEB	4,5724	5,2467	55,5956	0,7320
European banks				
BNP Paribas	6,4792	7,7626	98,5968	1,0831
Commerzbank	5,0499	6,0904	64,3282	0,8497
Credit Suisse	3,0919	6,6221	89,2006	0,9239
HSBC Holdings	7,8750	7,9766	105,5725	1,1129
Royal Bank Of Scotland	7,0545	7,9395	109,3289	1,1077
UBS	7,6028	7,6028	90,4458	1,0608
American banks				
Bank of America	6,2906	7,6809	94,7991	1,0716
Ctigroup	6,4169	7,6640	95,5892	1,0693
Morgan Stanley	3,7393	5,7801	61,4472	0,8064

V. Time series models

Three approaches are explored in this section: the famous Random Walk model, the Mean Model and different variations of a simple Moving Average model. These are statistical or time series model that offer no economic exploitation or relations to fundamental values.

Random Walk

The term *Random Walk* is often compared with a drunkard's walk. On leaving a bar, the drunkard moves a random distance u_t at time t and, continuing to walk indefinitely, will eventually ramble farther and farther away from the bar (Gujarati 2011). According to the random walk model, the same can be said about exchange rates. Tomorrow's exchange rate is equal to today's exchange rate plus some random shock.

One can state that the random walk model is closely linked to the efficient market hypothesis, which implies that all available information is priced in to the exchange rate, hence the only factor that will cause the exchange rate to change is new information i.e. white noise. In more academic terms, the random walk is a nonstationary autoregressive (AR) model of 1^{st} order:

$$S_t = S_{t-1} + u_t \quad \text{with} \quad u_t \sim i.i.d.N(0, \sigma^2) \tag{5.1}$$

where S_t is today's exchange rate and S_{t-1} is yesterday's exchange rate, and u_t is a white noise error term with zero mean and variance σ^2. The implication of the error term's conditional mean equalling zero, meaning that the expected value of u_t is equal to zero, $E(u_t|S_{t-1}, S_{t-2}, \ldots) = 0$, is that the expected value of the exchange rate at time $t + 1$ is equal to the value of the exchange rate at time t. Thus, the random walk forecast of the exchange rate is equal to today's value. Intuitively the forecasted change in the exchange rate is equal to zero.

$$F_{t+1} = S_t \tag{5.2}$$

$$\Delta F_{t+1} = 0 \qquad (5.3)*$$

To show this, let us take the expectation of equating (5.1):

$$E(S_t) = E(S_{t-1}) + E(u_t) \tag{5.1'}$$

Taking the expectation of a known value makes no sense, as we already know the actual value, and from earlier we know that the expected value of the error term is zero. Therefore, we get:

$$E(S_t) = S_{t-1} \tag{5.4}$$

We distinguish between two types of random walk, the first being a random walk without drift, which is the model derived above, the second is a random walk with drift. The only different between the models are that we include a drift parameter delta, δ:

$$S_t = \delta + S_{t-1} + u_t \tag{5.5}$$

To give a brief theoretical explanation of why the random walk works, let's think of the asset market approach to exchange rates that recognize the exchange rate is the relative price of two monies. Monies are assets, thus exchange rate are to be considered as an asset price. Therefore, exchange rates share the same features as an asset, implying that today's rate is a combination of its fundamental value and it future expected value:

$$S_t = (1-a)fund_t + aE_t[S_{t+1}] \tag{5.6}$$

Engel and West (2005) argue that the discount factor, a, is close to 1, implying that the term $fund_t$ is removed from the equation and thus, we have the random walk model. Further, the authors argue that fundamentals themselves follow a random walk, and because of the close relationship between fundamentals and exchange rates, the latter should follow a random walk process as well. However, for this to be the case then exchange rates should be able to predict the future value of fundamentals. Engel, Nelson and Kenneth (2007) states in a comprehensive study that this is in fact the case.

Mean Model

The mean model, which also referred to as the "constant model" or an "intercept-only regressions" generate forecasts based on the mean value of the observations in a time series.

$$F_{t+1} = \frac{1}{n}\sum_{t=1}^{n} S_t \tag{5.7}$$

The intuition for the mean model is that the exchange rate will not take on values far from its historical mean. A weak assumption as exchange rates usually characterize with frequent fluctuations.

Moving Average

While the mean model include all previous values in its forecasts, a moving average (MA) process, only include data from within a certain time period, for example 2 or 3 years back in time. In general, the moving average forecast model can be written as:

$$F_{t+1} = \sum w_i S_{t-1} \tag{5.8}$$

where w_i are weights corresponding to the current and lagged values of the exchange rate that sum to one. The motivation for the MA model is that the average of recent values should be a good predictor of the next. Due to the structure of the MA, numerous modifications can be made by adjusting the number of lags and changing the value of the weights. In this paper, I consider models with up to five lags and two alternatives for modelling the weights: One with declining weight and one that put equal weight to each lag. Se exhibit 5.1 for detailed MA specifications.

Out-of-sample accuracy

As mentioned previously, few candidates are able forecast more accurate than the random walk model which have an AAME of 0,7597, 0,8188, 0,7525 and 0,7777 for NOK/EUR (aug), NOK/EUR (4.Q), I-44 and KKI, respectively. For the two NOK/EUR series, the random walk model has to admit a defeat to Mean Model and several variations of the MA model. In contrast, none of the other statistical models performs better than the random walk for the two index rates, I-44 and KKI. Amongst the MA variations, the model with four lags both with equal and different weights perform best. Overall[9], the random walk is the most accurate time series model.

Summary of exhibit 5.2: Out-of-sample statistics, Time series models

	ME	MAE	MSE	AMAE
Random Walk				
NOK/EUR (aug)	0,8474	4,8079	38,2631	0,7597
NOK/EUR (4.Q)	1,0532	5,8687	49,2693	0,8188
I-44	0,1905	3,2317	17,3932	0,7525
KKI	0,4773	3,3983	18,2012	0,7777
Mean Forecast				
NOK/EUR (aug)	0,2051	4,2108	32,9031	0,6654
NOK/EUR (4.Q)	1,3824	4,9538	41,525	0,6912
I-44	-3,7604	5,2876	37,2784	1,2313
KKI	-2,096	4,5114	29,1343	1,0324

[9] Refers to the average AMAE of the four exchange rate series

VI. Fundamental Models

Many fundamental models could, perhaps should, have been included in this section. Include all would possibly be too enthusiastic, hence exclusions needed to be made and my choice fell on the most established and interesting models in my opinion. I have chosen to investigate the forecasting accuracy of the Purchasing Power Parity, Interest Rate Parity and the Taylor Rule exchange rate models.

Purchasing Power Parity[10]

The study of the relationship between exchange rates and national price levels can been tracked back to the sixteenth century and Spain's growing wealth due to the large inflow of gold and silver from America. In 1594, a Spanish Dominican theologian wrote:

"In places where money is scarce, goods will be cheaper than in those where the whole mass of money is bigger, and therefore it is lawful to exchange a smaller sum in one country for a larger sum in another…"[11]

This study led to what we now know as the quantity theory of money. In the decades and centuries to follow, the relation between national price levels and exchange rates were extensively studies (Officer 1982). Nonetheless, the theory as we know it today was not developed before the Swedish economist Gustav Cassel introduced the term "Purchasing Power Parity" in 1918 after finding evidence for the close relationship between exchange rates and a nation's purchasing power during World War 1. In a comprehensive 1982 survey of the PPP literature by the previous Governor of the Bank of Israel Jacob Frenkel, the author refer to the "collapse" of the PPP hypothesis. This was supported by other studies during the 70s and 80s, who concluded that there were no evidence for the parity, even in the long-run (Copeland 2008). Theses researchers used univariate regressions in their studies, a simple statistical method with the key attribute that only one variable is involved in the analysis. Because of the gloomy conclusion about the PPP, one would reasonable think that the interest for the PPP theory would decline, but the quite

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[10] When dealing with PPP many think of the real exchange rate, which is the nominal exchange rate adjusted for relative prices: $Q = \frac{S_t P_t^*}{P_t}$. As this dissertation focus on nominal exchange rate forecasting, the real exchange rate will not be emphasized and assumed to be equal to 1, i.e. the absolute PPP hold.

[11] Cited in Officer (1982) p.32

opposite occurred. Primarily as a result of new method for testing PPP such as cointergration and non-stationarity.

Rogoff (1966) find that not only do the real exchange rate deviate from the PPP in the short term, it also take some time before it to converge towards the PPP in the long run. He call this the Purchasing Power Parity Puzzle; if the exchange rates are so volatile why does it take such a long time for them to converge to the exchange rate predicted by the PPP? A common answer relates to sticky prices; as the exchange rate respond quickly to monetary shocks, salaries and prices on the other hand, adjust slowly to the same monetary shocks.

The PPP condition is widely used in estimating equilibrium values of currencies and is often the one economists first turn to when asked if a currency is over- or undervalued or not. In addition, the PPP relationship underpins other exchange rate models, such as the monetary model (MacDonald 2007).

Under PPP, there exist two parity conditions: *absolute* and *relative* PPP. Before I turn to the two, let me introduce the so-called law on one price (LOOP), understanding the LOOP is beneficial to fully grasp the PPP hypothesis. LOOP states that homogenous goods between two countries should, in the absent of inefficiencies such as tariffs and transportation costs, have no price inequalities when expressed in a common currency:

$$P_t^i = S_t P_t^{i*} \tag{6.1}$$

Where P_t^i and P_t^{i*} denotes the price of a homogenous good i in the home and foreign country, S_t is the nominal exchange rate expressed as the home currency price of one unit of foreign currency. Arbitrages motivates the LOOP: If we assume that the price of good i, when denoted in the same currency, is lower domestically than abroad, then risk free profits can be earned by purchasing the good domestically and ship it to the foreign country and sell for to a higher price. Repeat this process often enough the LOOP will eventually be restored, as the price of the good will increase (decrease) in the home (foreign) country due to increased demand (supply). Further, it assumes that this also holds for bundles of goods, such that P_t and P_t^* represent the overall price level in each country:

$$P_t = \sum_{i=1}^{n} \alpha^i P_t^i \tag{6.2}$$

$$P_t^* = \sum_{i=1}^{n} \alpha^i P_t^{i*} \tag{6.2'}$$

The equations above express the price level in each country as the weighted aggregate of individual prices of goods, where the weights denoted by α sums to one and are identical across the two countries. Taking equation (6.1) and substituting the individual price of good i and i^* with the price level and rearrange, we derive the *absolute* PPP, which states that the nominal exchange rate is determined by the ratio between the price level in the home and foreign country:

$$S_t = \frac{P_t}{P_t^*} \tag{6.3}$$

Therefore, according to absolute PPP, a country with relatively low price level will experience an appreciation exchange rate and vice versa. The same arbitrage situation under equation (6.1) also apply to equation (6.3) and the absolute PPP. The parity is considered as a long run relationship as it takes time for the arbitrage process to finish. Taking the natural logarithm of equation (6.3) makes this relationship considerably clearer:

$$s_t = p_t - p_t^* \tag{6.3'}$$

Alternatively, expressing the equation above in terms of changes we get the *relative* PPP, which states that the change in the nominal exchange rate is equal to the inflation difference[12] between the two countries:

$$\Delta s_t = \Delta p_t - \Delta p_t^* \tag{6.4}$$

In order to generate genuine out-of-sample forecasts, Δp_t and Δp_t^* need to be lagged. Hence, the forecast equation is as follow:

[12] Δp_t is the local approximation to $P_t - P_{t-1}/P_{t-1}$ i.e. the inflation rate for the respective country.

$$\Delta f_t = \Delta p_t - \Delta p_t^* \qquad (6.5)*$$

Even though the PPP is widely accounted for, it is not without flaws. The parity relies heavily on three main assumptions that may not hold in reality. First, it assumes that good i produced in the home country is a perfect substitute for good i produced in the foreign country. Even for very similar countries such as Norway and Sweden, it is easy to think of substitutable goods that due to minor differences make them imperfectly substitutable. The second assumption is that the weights used in calculating the price level has to be equal across countries. Because of difference in consumption-preferences in each country, the weight are likely to differ. In addition, it is not certain that the basket of goods are similar across countries. The third assumption underlying the PPP is that inefficiencies such as transportation cost, trade restrictions and taxes are non-existing, which clearly is not the case.

Another counterargument is that economic fluctuations will cause prolonged fluctuations in the real exchange rate, causing the failure of PPP in the short run. The American economist Kenneth Rogoff (1966) amongst other empirical findings supports this argument.

Interest Rate Parity

Under Interest Rate Parity, there exist two alternative parity conditions, namely *Covered Interest Rate Parity* (CIP) and *Uncovered Interest Rate Parity* (UIP). The first parity relates interest rates differential to the percentage difference between forward and spot exchange rates, whilst the latter express the relationship between the expected future spot exchange rate and interest rates. Although only the latter parity generate forecasts in this paper, both conditions are explored to fully grasp the intuition behind the parities.

By the end of the nineteenth century, it converged a growing acceptance amongst policymakers that one could manipulate exchange rates by adjusting interest rate: An increased interest rate cause the domestic currency to appreciate, and depreciate if the interest rate were adjusted downwards. Most researchers during the nineteenth century dealt with spot rates, with the exception of the German economist Walther Lotz (1889) who studies the relationship between interest rates and forward rates. Nevertheless, it was not before the first half of the twentieth century before an explanation of the relationship between the two variables were introduced. In the work "A Tract on Monetary Reform" from 1923, the author John Maynard Keynes reasoned that interest rates differential were the most important determinant of investors preferences for holding funds in one country opposed to another. This led to what we now know as the Interest Rate Parity Hypothesis.

For intuition purposes and to assist the derivation of the parity conditions, let us consider a risk averse investor who wants to make a one year investment of one unit of domestic currency, he faces two alternative investment options. First alternative, he invest domestically, and receive $(1 + i_t)$ domestic unit at the end of the year. Alternatively, he invest abroad, the investor then need to convert his unit of domestic currency into foreign currency using the spot market, he receives $\frac{1}{S_t}$ units of foreign currency, which he invest and receive a return of $(1 + i_t^*)$. Disliking risk, he agrees on a forward contract at time t so that he can convert his investment back to domestic currency at the end of the year to a forward rate F_t. The return of the two investment opportunities are expressed flowingly:

$$(1 + i_t) \tag{6.6}$$

$$\left(\frac{1}{S_t}\right)(1 + i_t^*)F_t \tag{6.7}$$

Because both alternatives provide a risk-free return and are known at time t, the alternatives must provide equal return:

$$(1 + i_t) = \left(\frac{1}{S_t}\right)(1 + i_t^*)F_t \tag{6.8}$$

If this is not the case, risk-free profits can be made by investing in the most profitable alternative. Let us assume that investing abroad provide a higher return than investing domestically. Investors would then exchange domestic currency for foreign currency, causing the current spot rate to depreciate. Higher demand for the foreign investment alternative cases the foreign interest rate to reduce. In addition, investors engage in the forward market resulting in an appreciated forward rate. These three effects will eventually result in lower return from the foreign investment option and the two alternatives will eventually provide equal return.

Using algebra on equation (6.8), it express the relationship between the interest rate differential and the forward premium or discount[13]. First, we divide by $(1 + i_t^*)$ on both sides of the equation and get:

$$\frac{(1 + i_t)}{(1 + i_t^*)} = \frac{F_t}{S_t} \tag{6.9}$$

Then, subtract with 1 on both sides of the equation, i.e. subtract with $\frac{(1+i_t^*)}{(1+i_t^*)}$ on the left-hand-side and $\frac{S_t}{S_t}$ on the right-hand-side. An expression with the foreign premium or discount on the right side of the equation and on the left side we get the interest rate differential between the two countries are expressed:

$$\frac{(i_t - i_t^*)}{(1 + i_t^*)} = \frac{F_t - S_t}{S_t} \tag{6.10}$$

In equation (6.10), which refers to CIP, a higher foreign interest rate than the domestic, cause foreign currency to be at a discount in the forward market. Meaning that the spot rate is higher than the forward rate. Analogously, if i_t is higher than i_t^* we get a forward premium. The intuition behind this is the same as for equation (6.8).

CIP is, as the name implies, covered i.e. risk free, by engaging in the forward market, UIP on the other hand, involves risk. Mathematically the parity can be formulated as the CIP only exchanging F_t with $E(S_{t+1})$.

$$(1 + i_t) = \left(\frac{1}{S_t}\right)(1 + i_t^*)E(S_{t+1}) \tag{6.11}$$

Think of the two investment opportunities as before. The only difference is that the foreign investment is not risk-free, hence investors need to rely on the future spot rate instead of a forward contract. The mechanism explained under equation (6.8) applies to equation (6.11). Rearranging equation (6.11), the relationship between the future exchange rate and the interest rate differential becomes clear and an

[13] The ppproportionate difference between the levels of the forward rate and the spot rate.

expression for the future level and percentage change of the exchange rate can be derived:

$$E(S_{t+1}) = \frac{(1+i_t)}{(1+i_t^*)} S_t \tag{6.12}$$

$$\frac{(i_t - i_t^*)}{(1+i_t^*)} = \frac{E(S_{t+1}) - S_t}{S_t} \qquad (6.13)*$$

A positive interest rate differential, i.e. home interest rate is greater than foreign interest rate, the first term of the right-hand-side of the equation will be larger than one and thus, we experience a depreciation of domestic currency. Flowingly, the exchange rate depreciate from a negative interest rate differential.

If both parity conditions hold, then the forward rate equals the expected future spot rate. To see this comparing equation (6.10) with (6.13). This is called the *unbiasedness hypothesis*, implying that the forward rate is an unbiased predictor of the future spot rate.

Taylor Rule

The Taylor Rule is primarily know as a monetary policy rule used as guidance for interest setting. It states that the interest should be set in an attempt to close the inflation- and output-gap. In the recent decade, the use of variations of the Taylor Rule in exchange rate determination has received considerable attention.

The inspiration and framework used in this and the following section is drawn from Molodtsova and Papell (2008). A general setup of the models takes the form:

$$\Delta f_{t+1} = \alpha + \beta_i \mathrm{X}_{i,t} + \varepsilon_t \qquad (6.13)*$$

where Δf_{t+1} is the model forecasts of the change in the log exchange rate, α is a constant, $\mathrm{X}_{i,t}$ is a matrix containing different variables, and β_i is the coefficient to the respective variable. Two variations of the Taylor Rule model are explored. As all variables are denoted in time t I skip the notation.

Taylor Rule (1): $\mathrm{X}_{1,t} = [(pn - peu) \quad (Y^n - Y^{eu})]$

Taylor Rule (2): $\mathrm{X}_{2,t} = [(pn - peu) \quad (Y^n - Y^{eu}) \quad (i - i^*)]$

The two variations are studied in Molodtsova and Papell (2008) and Wu and Wang (2009). Taylor Rule (1) relates the exchange rate to the inflation differential and output gap differential between Norway and the Euro-zone. Taylor Rule (2) is an extension on Taylor Rule (1), extending the model to include interest rate differential. Molodtsova and Papell (2008) and Wu and Wang (2009) use short-term interest rates and lag it by one to account for potential interest rate smoothing rules of the central bank. This model do not lag the interest variable because it uses long-term interest rates.

Out-of-sample accuracy

Between the R.PPP and the UIP, the first parity is the preferred model when forecasting the two NOK/EUR series. Whilst for I-44 and KKI, the latter parity is more accurate. Even though the accurate forecasts of the UIP, it is not able to pin out the direction of the change, the model usually forecast a percentage change of 1,4 percent each year. R.PPP on the other hand, is able to forecast the direction of the exchange rate but not necessarily by how much in each direction. R.PPP generate a AMAE of 0,7479 for the NOK/EUR (aug), which is an slightly improvement on the random walk, and UIP improves on the random walk for I-44 and KKI. On the other hand, on average neither R.PPP nor UIP outperform the random walk.

The first variation of the Taylor Rule generates more accurate forecast than the latter. Overall, Taylor Rule (1) produce a AMAE of 0,7794, slightly beaten by the random walk. On the other hand, Taylor Rule (1) outperforms the random walk benchmark by far for the NOK/EUR (4.Q) series, and by some for I-44 and KKI.

Overall, none of the fundamental models outperforms the random walk benchmark, but the margin is not large. With an average AMAE of 0,7772, 0,7794, 0,7820 and 0,7864 for random walk, Taylor Rule (1), UIP and PPP, respectively, there is not much separating their forecasting performance. On the other hand, the fundamental models, except of Taylor Rule (2), generates more stable forecasts expressed by MSE. The average size of the error are however quite similar.

Exhibit 6: Out-of-sample statistics, Fundamental models

	ME	MAE	MSE	AMAE
Purchasing Power Parity				
NOK/EUR (aug)	0,9060	4,7329	34,8389	0,7479
NOK/EUR (4.Q)	1,1118	5,8777	50,1201	0,8201
I-44	0,3371	3,3742	16,1896	0,7857
KKI	0,5111	3,4613	17,1301	0,7921
Uncovered Interest Rate Parity				
NOK/EUR (aug)	0,1090	4,8473	34,6051	0,7660
NOK/EUR (4.Q)	0,4655	6,4115	48,8123	0,8945
I-44	-0,1517	3,0678	15,1104	0,7144
KKI	-0,1492	3,2905	16,8608	0,7530
Taylor Rule (1)				
NOK/EUR (aug)	-2,8625	6,2143	56,0933	0,9969
NOK/EUR (4.Q)	1,5912	4,5167	28,2174	0,6478
I-44	0,2639	3,0498	11,4119	0,7305
KKI	0,6545	3,1619	11,9602	0,7425
Taylor Rule (2)				
NOK/EUR (aug)	-4,3881	6,5983	68,0201	1,0585
NOK/EUR (4.Q)	0,1174	7,4412	97,1812	1,0673
I-44	-0,6349	3,7129	20,3045	0,8893
KKI	0,0520	3,8561	19,7463	0,9055

VII. General models

In this section, I use variables that in the literature has proven to have predictive power on exchange rates to generate different forecasting models. For references to empirical work on the variables included, I refer to the introduction of this paper. I use the same framework as in the previous section. The different models are as followed:

General model 1: $\mathrm{X}_{3,t} = [(i - i^{*}) \quad X^{f}]$

General Model 2: $\mathrm{X}_{4,t} = [(i - i^{*}) \quad X^{s}]$

General model 3: $\mathrm{X}_{5,t} = [(i - i^{*}) \quad \Delta op]$

General model 4: $\mathrm{X}_{6,t} = [(i - i^{*}) \quad op]$

General model 5: $\mathrm{X}_{7,t} = [X^{f} \quad \Delta op]$

General model 6: $\mathrm{X}_{8,t} = [(i - i^{*}) \quad (Y^{n} - Y^{eu})]$

Model 1 and 2 combine the interest rate differential with the two order flow variables. Model 3 and 4 is a model with interest rate differential and the oil price. The following model relates the exchange rate to order flow and the oil price.

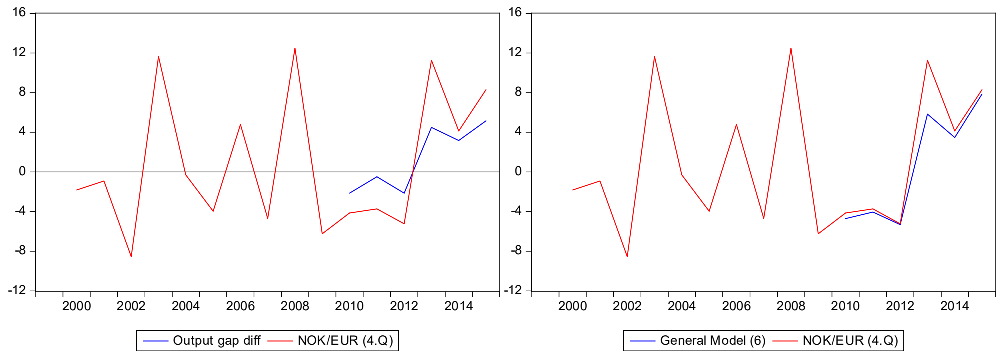
Finally, the last model combines interest rate differential with the output gap differential between Norway and the Euro-zone.

Out-of-Sample accuracy

Before I regressed the different models, I run an individual regression for all variables, naming these single variable models (SVM). The result was that the SVM using interest rate differential does not improve in the somewhat similar model, UIP. In the same way, the SVM using inflation differential does not improve on R.PPP.

An interesting result is that the SVM using output gap differential generated precise and robust forecasts, especially for the NOK/EUR (4.Q) series. In fact, this simple SVM is the only model evaluated in this paper that, overall, outperforms the random walk.

Exhibit 7.1: NOK/EUR (4.Q) forecast from the respective models



The predictive power of the output gap differential was unexpected and surprising. Its forecasting abilities is further strengthen when generating general model (6). For the NOK/EUR (4.Q) series, general model (6) produced a forecast that were astonishingly close to the actual exchange rate. With a AMAE of 0,1802 it is by far the most accurate forecaster for a single series in this survey.

Further, I find that using op provides slightly better accuracy than Δop. Using X^F is slightly better than X^S. Overall, no model with the oil price nor order flow outperform the random walk.

Exhibit 7.2: Out-of-sample statistics, Fundamental models

	ME	MAE	MSE	AMAE
General Model (1)				
NOK/EUR (aug)	-5,9468	6,0345	51,9665	0,9681
NOK/EUR (4.Q)	8,0690	23,5341	631,3447	3,3756
I-44	-0,7672	3,6812	18,4158	0,8817
KKI	-0,2378	3,4680	16,9832	0,8144
General Model (2)				
NOK/EUR (aug)	-9,3257	9,3257	105,4928	1,4960
NOK/EUR (4.Q)	20,0481	24,7288	1062,5479	3,5469
I-44	-1,8702	3,5578	15,8979	0,8521
KKI	-1,5280	3,1977	13,9934	0,7509
General Model (3)				
NOK/EUR (aug)	-0,5281	7,0197	69,0430	1,1261
NOK/EUR (4.Q)	-8,3688	8,9188	183,3871	1,2793
I-44	1,7094	4,9497	35,0066	1,1856
KKI	2,2876	5,2555	38,6463	1,2341
General Model (4)				
NOK/EUR (aug)	-5,1495	6,7007	64,6377	1,0749
NOK/EUR (4.Q)	1,1756	6,2843	45,2340	0,9014
I-44	-0,8653	4,0420	20,8001	0,9681
KKI	-0,3395	3,9229	20,4411	0,9212
General Model (5)				
NOK/EUR (aug)	8,7959	23,9843	681,8758	3,4402
NOK/EUR (4.Q)	-5,6487	6,1541	55,8564	0,9872
I-44	-0,3650	4,1240	22,1209	0,9878
KKI	0,1298	3,9527	21,0468	0,9282
General Model (6)				
NOK/EUR (aug)	-4,9037	7,9584	84,4231	1,2767
NOK/EUR (4.Q)	1,2564	1,2564	5,1224	0,1802
I-44	-0,7773	4,3570	25,5538	1,0436
KKI	-0,1801	4,5819	26,8589	1,0759

VIII. Conclusion

Do policymakers and private banks outperform the random walk? Of the sixteen candidates evaluated, seven of them are able to outperform the random walk model. The seven forecasters in ascending order are, DNB, NCB, SN, SEB, Nordea, NDF and Morgan Stanley.

Amongst the different groups, there are great differences in forecasting performance. The most stable and accurate group is Policymakers, followed by Nordic Banks. In the third best group, American banks, only Morgan Stanley is more accurate than the benchmark model. Surprisingly, no European Bank is able to create better forecasts than the random walk benchmark.

Do other time series models work as an improvement on the random walk? Overall, neither the mean model nor the different variations of the moving average model work as an improvement on the random walk. The random walk benchmark produce stable and precise forecasts and have no tendency of a forecasting bias.

Do fundamental models forecast better than time series models? Individually, for the different exchange rate series, I find that fundamental models are able to outperform the random walk model. On the other hand, overall, this paper find evidence of the failure of fundamental models ability to outperform the random walk. However, they are only beaten at the margin, but still beaten. This result support the findings of Meese and Rogoff (1983) and Bacchetta and Wincoop (2006).

Trying to reason for this result, one might look to Rime (2006) who states that in the short run it may seem that exchange rate move freely without correlation to its macro-fundamentals. Hence, a one-year forecasting horizon might be just to short horizon for the fundamental models. Further, I find that the Taylor Rule (1) is more stable and precise than UIP and R.PPP,

Do general models forecasts better than time series model? Overall, only two variables proved itself to have good predictive power on the exchange rate, namely interest rate differential and output gap differential. Individually, the first variable have poor forecasting accuracy, but combined with the latter it creates the model with the best AMAE in this study. On the other hand, the model is only a good forecaster for the NOK/EUR (4.Q) series. The latter variable, demonstrate superb predictive power both independently and combined with the interest rate differential. In fact, the single variable regression, only including the output gap differential, is the only model in this study that on average of all series outperforms the random walk.

The objective of this thesis has been to assess the forecasting performance of policymakers, private banks and exchange rate models. Overall, I find that policymakers and Nordic banks are reliable forecasters producing stable and precise forecasts. Nordic banks have the tendency to forecasts a stronger Norwegian Krone than what is actually the case, i.e. a forecast bias. Further, this paper find evidence for the failure of fundamental models to outperform the simple and naïve random walk model. Finally, I find evidence for the stable and accurate forecasting power of the Taylor Rule and the output gap differential between Norway and the Euro-zone.

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Appendix I: Exhibits

Exhibit 3: Volatility in the respective exchange rate series. Logarithmic difference

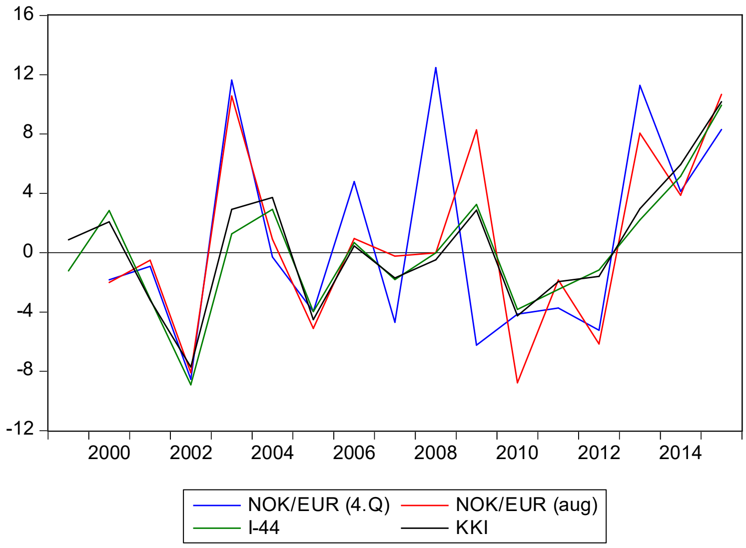


Exhibit 4: Out-of-sample statistics, Candidates

	ME	MAE	MSE	AMAE
Policymakers				
Norwegian Central Bank	0,0806	3,0382	14,0173	0,7075
Norwegian Department of Finance	0,7458	3,3108	16,0218	0,7576
Statistics Norway	0,4082	3,0395	14,2617	0,7078
Nordic Banks				
Danske Bank	5,8276	6,2156	74,2710	0,8672
DNB	1,8021	4,4200	30,7098	0,6984
Nordea	3,1913	5,2581	49,5722	0,7336
SEB	4,5724	5,2467	55,5956	0,7320
European banks				
BNP Paribas	6,4792	7,7626	98,5968	1,0831
Commerzbank	5,0499	6,0904	64,3282	0,8497
Credit Suisse	3,0919	6,6221	89,2006	0,9239
HSBC Holdings	7,8750	7,9766	105,5725	1,1129
Royal Bank Of Scotland	7,0545	7,9395	109,3289	1,1077
UBS	7,6028	7,6028	90,4458	1,0608
American banks				
Bank of America	6,2906	7,6809	94,7991	1,0716
Ctigroup	6,4169	7,6640	95,5892	1,0693
Morgan Stanley	3,7393	5,7801	61,4472	0,8064

Exhibit 5.1: Key to simple moving average specifications

$MA(1)$	$E(S_{t+1}) = \frac{(S_t + S_{t-1})}{2}$
$MA(2)$	$E(S_{t+1}) = \frac{(S_t + S_{t-1} + S_{t-2})}{3}$
$MA(3)$	$E(S_{t+1}) = \frac{(S_t + S_{t-1} + S_{t-2} + S_{t-3})}{4}$
$MA(4)$	$E(S_{t+1}) = \frac{(S_t + S_{t-1} + S_{t-2} + S_{t-3} + S_{t-4})}{5}$
$MA(5)$	$E(S_{t+1}) = \frac{(S_t + S_{t-1} + S_{t-2} + S_{t-3} + S_{t-4} + S_{t-5})}{6}$
$MA(1dw)$	$E(S_{t+1}) = \frac{3S_t + S_{t-1}}{4}$
$MA(2dw)$	$E(S_{t+1}) = \frac{3S_t + 2S_{t-1} + S_{t-2}}{6}$
$MA(3dw)$	$E(S_{t+1}) = \frac{4S_t + 3S_{t-1} + 2S_{t-2} + S_{t-3}}{10}$
$MA(4dw)$	$E(S_{t+1}) = \frac{5S_t + 4S_{t-1} + 3S_{t-2} + 2S_{t-3} + S_{t-4}}{15}$
$MA(5dw)$	$E(S_{t+1}) = \frac{6S_t + 5S_{t-1} + 4S_{t-2} + 3S_{t-3} + 2S_{t-4} + S_{t-5}}{21}$

Exhibit 5.2: Out-Of-Sample statistics, Times series models

	ME	MAE	MSE	AMAE		ME	MAE	MSE	AMAE
Random Walk					**Mean Forecast**				
NOK/EUR (aug)	0,8474	4,8079	38,2631	0,7597	NOK/EUR (aug)	0,2051	4,2108	32,9031	0,6654
NOK/EUR (4.Q)	1,0532	5,8687	49,2693	0,8188	NOK/EUR (4.Q)	1,3824	4,9538	41,5250	0,6912
I-44	0,1905	3,2317	17,3932	0,7525	I-44	-3,7604	5,2876	37,2784	1,2313
KKI	0,4773	3,3983	18,2012	0,7777	KKI	-2,0960	4,5114	29,1343	1,0324
Moving Average (1d)					**Moving Average (1)**				
NOK/EUR (aug)	0,9954	5,1362	38,8925	0,8116	NOK/EUR (aug)	0,9543	5,4345	41,1559	0,8588
NOK/EUR (4.Q)	1,2685	6,1620	48,2534	0,8597	NOK/EUR (4.Q)	1,2931	6,2235	49,4731	0,8683
I-44	-0,0268	3,5025	21,7751	0,8156	I-44	-0,1587	3,8769	26,1363	0,9028
KKI	0,0144	3,5345	22,3731	0,8088	KKI	0,1611	4,0097	27,6051	0,9176
Moving Average (2d)					**Moving Average (2)**				
NOK/EUR (aug)	1,0734	5,5330	44,0660	0,8743	NOK/EUR (aug)	1,0107	5,5658	48,7403	0,8795
NOK/EUR (4.Q)	1,5112	6,4733	53,7251	0,9032	NOK/EUR (4.Q)	1,5454	6,4827	59,5081	0,9045
I-44	-0,2062	3,8893	27,0103	0,9057	I-44	-0,4884	4,0439	31,1484	0,9417
KKI	-0,0701	3,9650	28,4784	0,9073	KKI	-0,0320	4,2344	32,6084	0,9690
Moving Average (3d)					**Moving Average (3)**				
NOK/EUR (aug)	1,6808	5,0601	41,2897	0,7996	NOK/EUR (aug)	1,5018	4,7021	42,3834	0,7430
NOK/EUR (4.Q)	2,2812	6,1934	52,6945	0,8641	NOK/EUR (4.Q)	2,2288	6,2651	57,2882	0,8741
I-44	0,1863	3,4743	23,9177	0,8090	I-44	-0,3104	3,8906	28,3204	0,9060
KKI	0,4066	3,5545	25,3276	0,8134	KKI	0,1965	3,8193	30,1148	0,8740
Moving Average (4d)					**Moving average (4)**				
NOK/EUR (aug)	1,2660	4,7418	40,5704	0,7493	NOK/EUR (aug)	1,1046	4,2101	39,0306	0,6653
NOK/EUR (4.Q)	1,9209	5,9798	52,1366	0,8343	NOK/EUR (4.Q)	1,9033	5,6034	51,8373	0,7818
I-44	0,3073	3,3949	24,4732	0,7905	I-44	-0,3196	3,8242	27,1269	0,8905
KKI	0,6193	3,7440	28,5063	0,8568	KKI	0,1088	3,7468	30,3823	0,8574
Moving average (5d)					**Moving average (5)**				
NOK/EUR (aug)	0,9103	4,5504	40,3411	0,7190	NOK/EUR (aug)	0,7174	3,9862	35,5632	0,6299
NOK/EUR (4.Q)	1,7689	6,0627	54,7417	0,8459	NOK/EUR (4.Q)	1,7626	5,7213	53,9217	0,7982
I-44	0,0754	3,8470	27,2085	0,8958	I-44	-0,6518	4,2834	29,6574	0,9974
KKI	0,2434	3,9555	31,0828	0,9052	KKI	-0,3658	4,2856	32,7403	0,9807

Exhibit 6: Out-of-sample statistics, Fundamental models

	ME	MAE	MSE	AMAE
Purchasing Power Parity				
NOK/EUR (aug)	0,9060	4,7329	34,8389	0,7479
NOK/EUR (4.Q)	1,1118	5,8777	50,1201	0,8201
I-44	0,3371	3,3742	16,1896	0,7857
KKI	0,5111	3,4613	17,1301	0,7921
Uncovered Interest Rate Parity				
NOK/EUR (aug)	0,1090	4,8473	34,6051	0,7660
NOK/EUR (4.Q)	0,4655	6,4115	48,8123	0,8945
I-44	-0,1517	3,0678	15,1104	0,7144
KKI	-0,1492	3,2905	16,8608	0,7530
Taylor Rule (1)				
NOK/EUR (aug)	-2,8625	6,2143	56,0933	0,9969
NOK/EUR (4.Q)	1,5912	4,5167	28,2174	0,6478
I-44	0,2639	3,0498	11,4119	0,7305
KKI	0,6545	3,1619	11,9602	0,7425
Taylor Rule (2)				
NOK/EUR (aug)	-4,3881	6,5983	68,0201	1,0585
NOK/EUR (4.Q)	0,1174	7,4412	97,1812	1,0673
I-44	-0,6349	3,7129	20,3045	0,8893
KKI	0,0520	3,8561	19,7463	0,9055

Exhibit 7.1: NOK/EUR (4.Q) forecast from the respective models

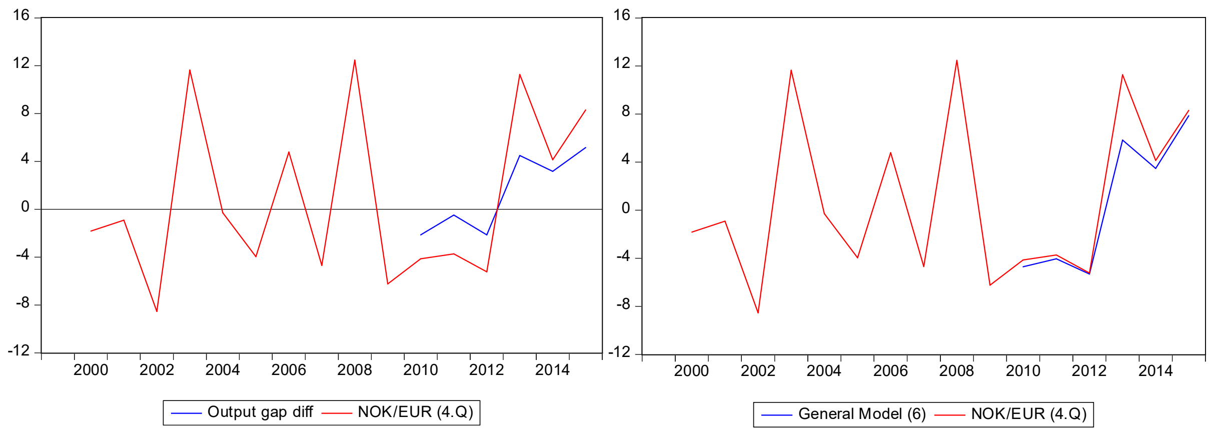


Exhibit 7.2: Out-of-sample statistics, Single Variable Models

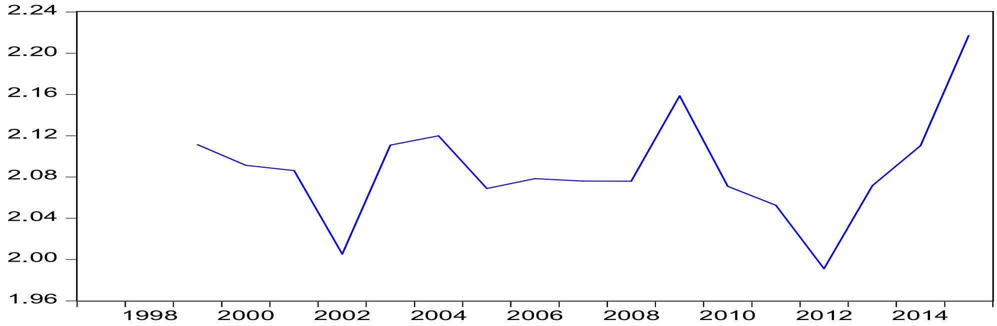
	ME	MAE	MSE	AMAE
RN-REU				
NOK/EUR (aug)	-4,8780	7,1470	69,5198	1,1465
NOK/EUR (4.Q)	1,1217	6,1271	43,2708	0,8788
I-44	-0,7704	4,1781	23,1729	1,0007
KKI	-0,1737	4,3368	24,5247	1,0184
GAPN-GAPEU				
NOK/EUR (aug)	0,0072	6,0604	44,0097	0,9722
NOK/EUR (4.Q)	0,4295	3,2055	13,4860	0,4598
I-44	1,1388	3,1639	16,6699	0,7578
KKI	1,4294	3,3375	17,8218	0,7837
LOGOP				
NOK/EUR (aug)	-2,3426	6,1375	51,1402	0,9846
NOK/EUR (4.Q)	0,8617	6,0374	41,7612	0,8660
I-44	1,1731	3,9662	22,7417	0,9500
KKI	2,0034	4,4413	28,7983	1,0429
DLOGOP				
NOK/EUR (aug)	1,4528	6,1214	44,0669	0,8780
NOK/EUR (4.Q)	1,7028	6,8038	55,4570	1,0915
I-44	4,2997	5,5861	48,5484	1,3380
KKI	3,7648	4,9397	42,7028	1,1599
NFEP-S				
NOK/EUR (aug)	-0,3483	8,6140	80,3970	1,3819
NOK/EUR (4.Q)	2,2350	10,6965	121,0496	1,5342
I-44	1,7426	5,5258	41,7662	1,3235
KKI	2,0852	5,5827	42,2794	1,3109
NFEP-F				
NOK/EUR (aug)	-1,3578	7,9117	71,4186	1,2692
NOK/EUR (4.Q)	-0,3113	13,8469	192,7444	1,9861
I-44	1,0255	5,5008	38,3462	1,3175
KKI	1,5243	5,5050	38,5955	1,2927
pn-peu				
NOK/EUR (aug)	-0,3987	5,4215	49,4314	0,8697
NOK/EUR (4.Q)	2,0601	6,8113	58,3050	0,9770
I-44	1,9726	4,3099	23,1611	1,0323
KKI	2,1532	4,4032	26,4439	1,0340

Exhibit 7.2: Out-of-sample statistics, General Models

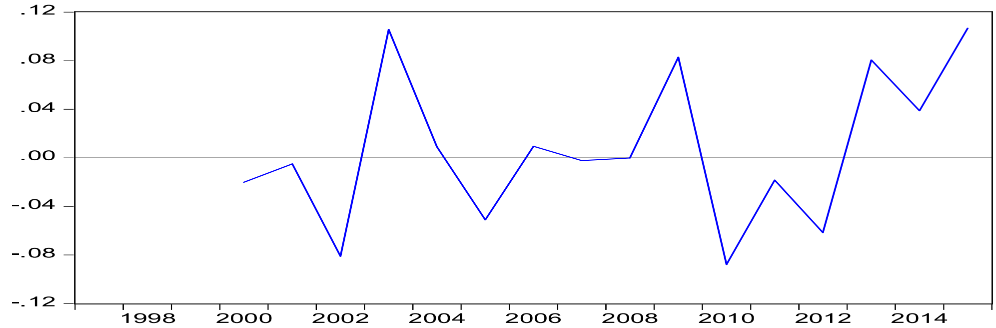
	ME	MAE	MSE	AMAE
General Model (1)				
NOK/EUR (aug)	-5,9468	6,0345	51,9665	0,9681
NOK/EUR (4.Q)	8,0690	23,5341	631,3447	3,3756
I-44	-0,7672	3,6812	18,4158	0,8817
KKI	-0,2378	3,4680	16,9832	0,8144
General Model (2)				
NOK/EUR (aug)	-9,3257	9,3257	105,4928	1,4960
NOK/EUR (4.Q)	20,0481	24,7288	1062,5479	3,5469
I-44	-1,8702	3,5578	15,8979	0,8521
KKI	-1,5280	3,1977	13,9934	0,7509
General Model (3)				
NOK/EUR (aug)	-0,5281	7,0197	69,0430	1,1261
NOK/EUR (4.Q)	-8,3688	8,9188	183,3871	1,2793
I-44	1,7094	4,9497	35,0066	1,1856
KKI	2,2876	5,2555	38,6463	1,2341
General Model (4)				
NOK/EUR (aug)	-5,1495	6,7007	64,6377	1,0749
NOK/EUR (4.Q)	1,1756	6,2843	45,2340	0,9014
I-44	-0,8653	4,0420	20,8001	0,9681
KKI	-0,3395	3,9229	20,4411	0,9212
General Model (5)				
NOK/EUR (aug)	8,7959	23,9843	681,8758	3,4402
NOK/EUR (4.Q)	-5,6487	6,1541	55,8564	0,9872
I-44	-0,3650	4,1240	22,1209	0,9878
KKI	0,1298	3,9527	21,0468	0,9282
General Model (6)				
NOK/EUR (aug)	-4,9037	7,9584	84,4231	1,2767
NOK/EUR (4.Q)	1,2564	1,2564	5,1224	0,1802
I-44	-0,7773	4,3570	25,5538	1,0436
KKI	-0,1801	4,5819	26,8589	1,0759

Appendix II: Graphs of variables

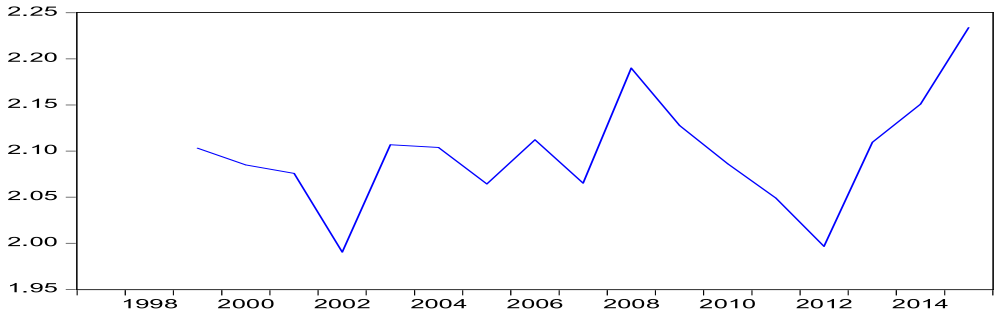
s_t^{aug}



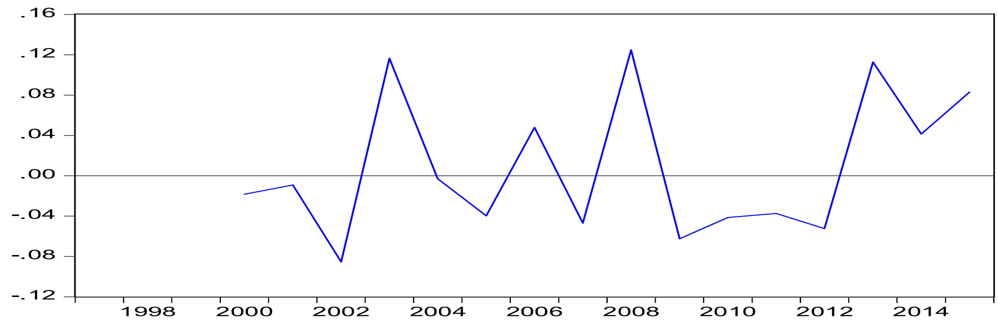
Δs_t^{aug}



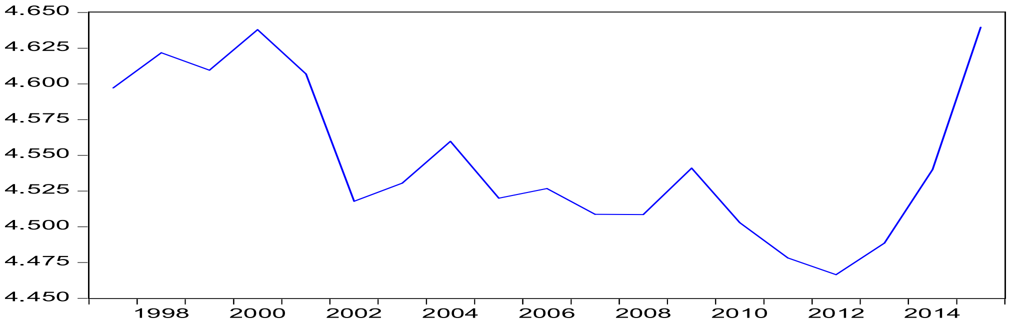
s_t^{4Q}



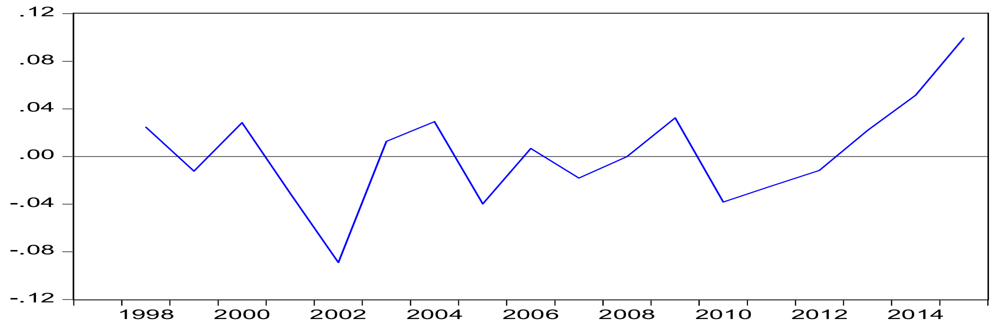
Δs_t^{4Q}



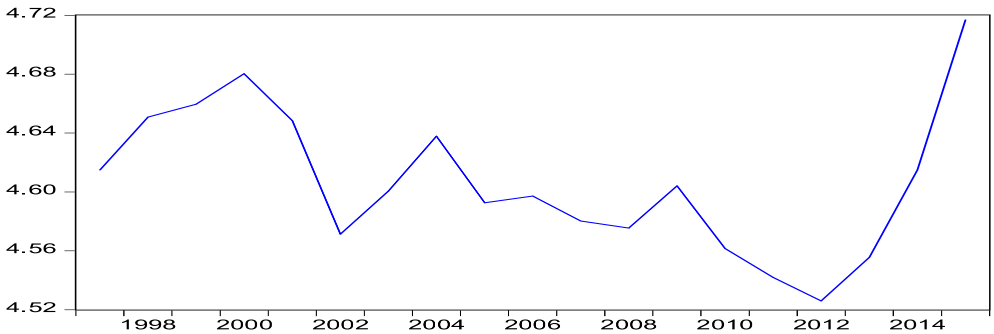
s_t^{I44}



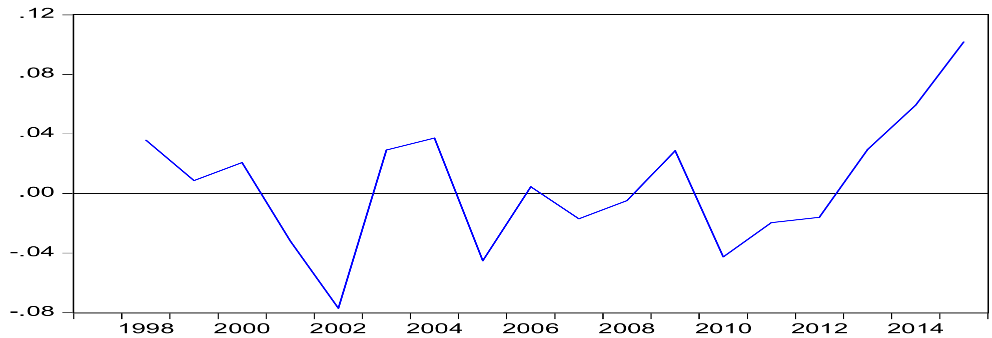
Δs_t^{I44}



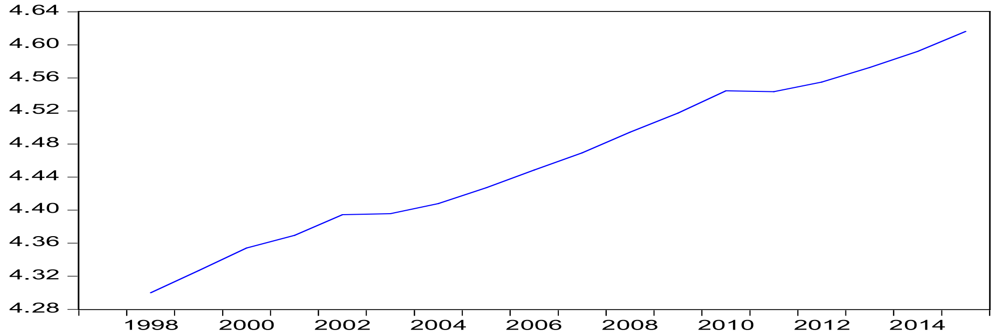
s_t^{KKI}



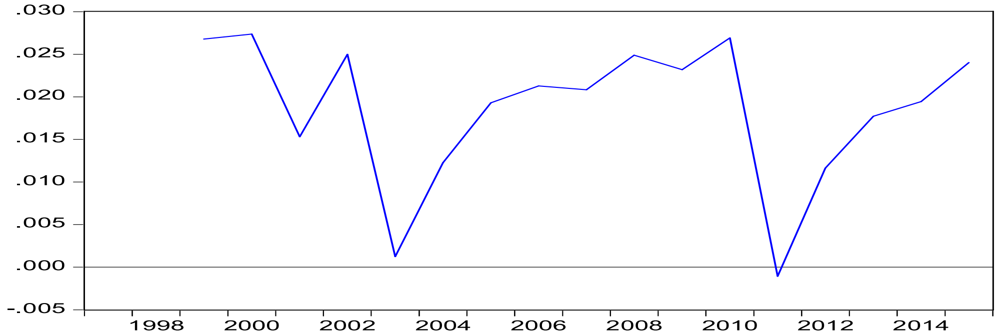
Δs_t^{KKI}



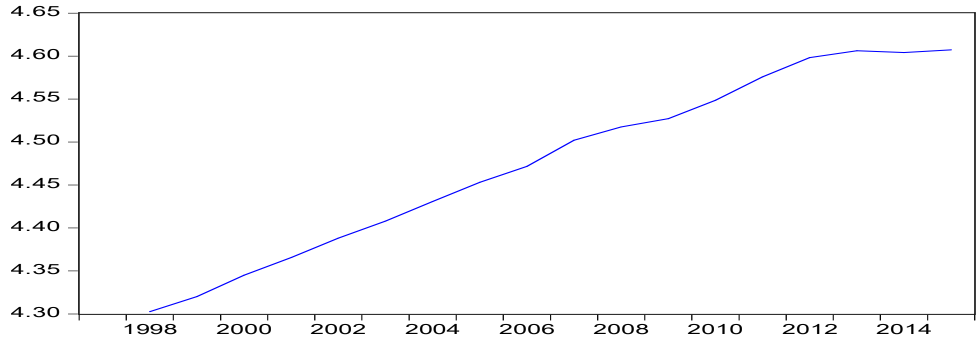
p_t^N



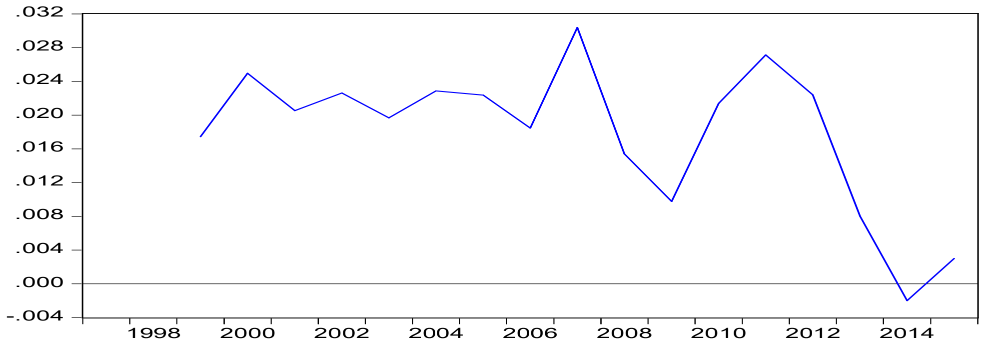
Δp_t^N



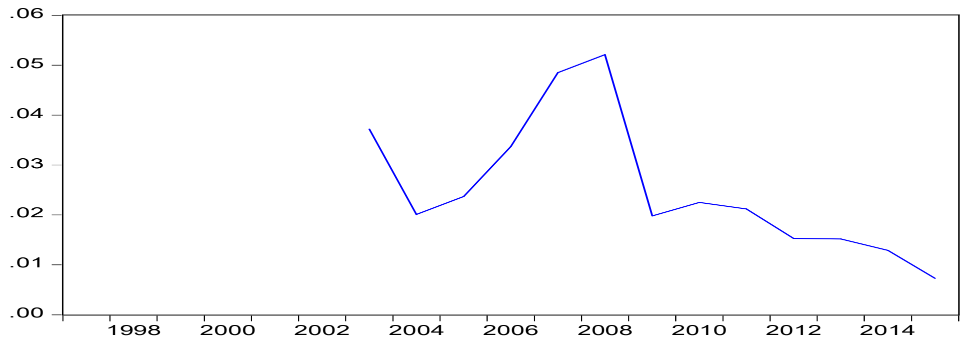
p_t^{EU}



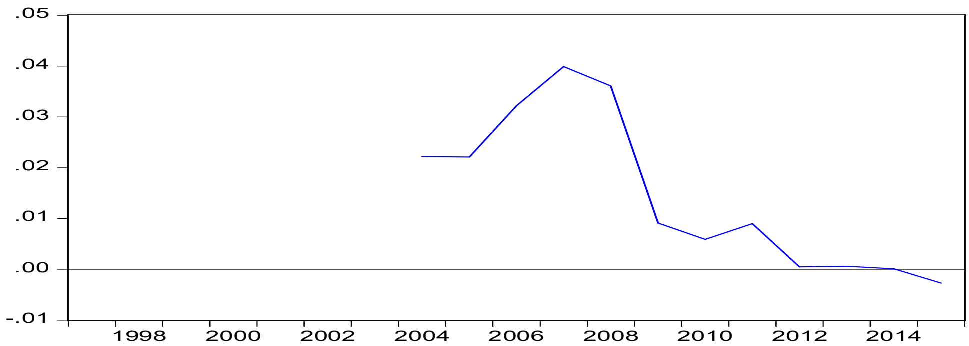
Δp_t^{EU}



i_t^N

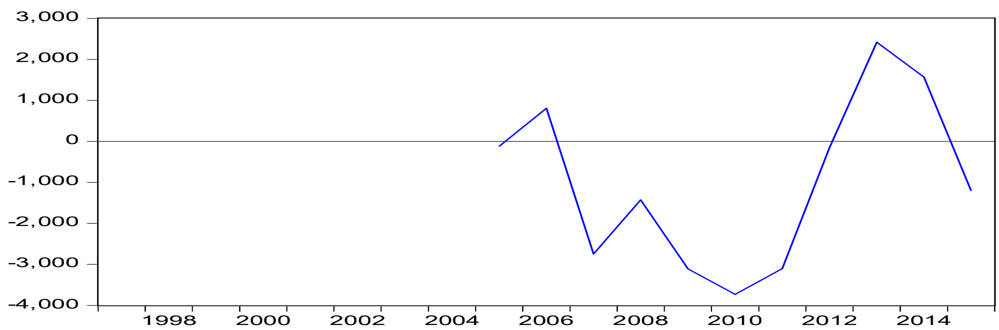


i_t^{EU}

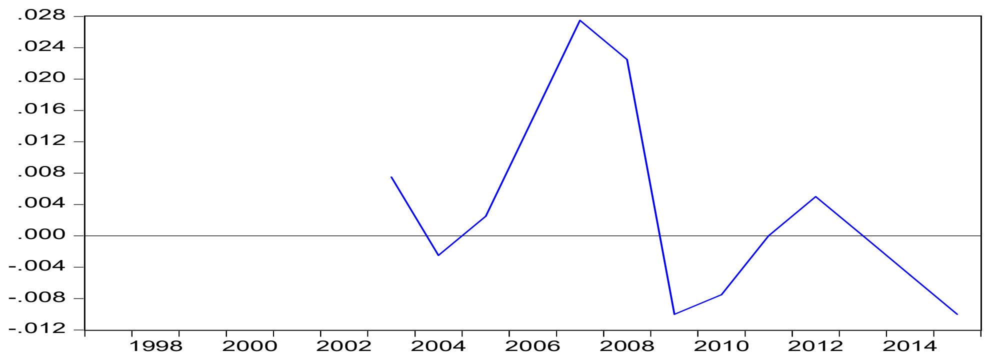


X_t^S

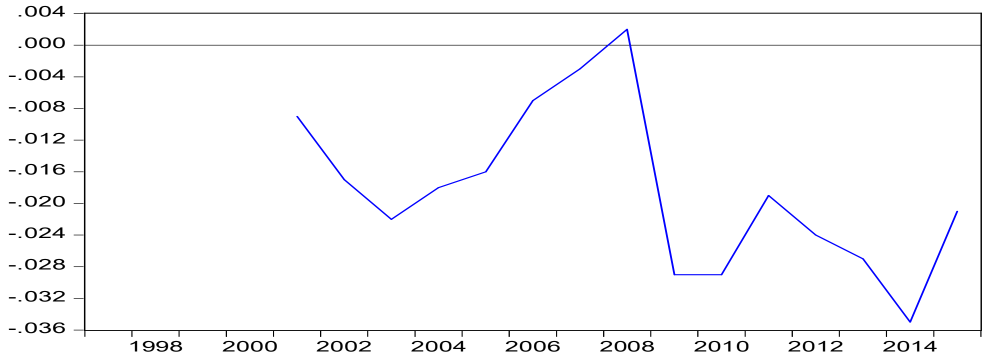
X_t^F



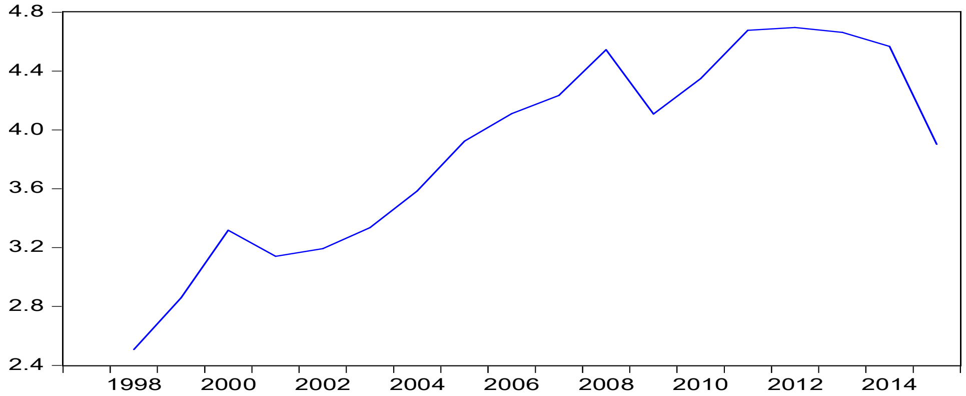
Y_t^n



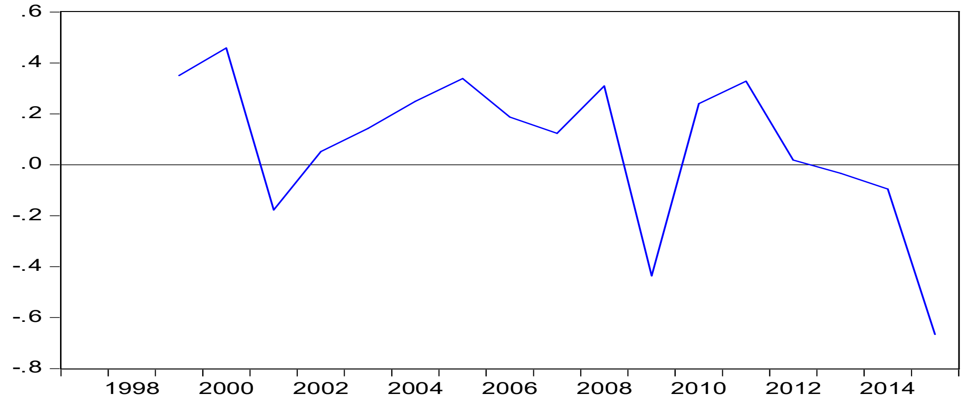
Y_t^{eu}



op_t



Δop_t



Appendix III: Estimation Output

Taylor Rule (1)

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 08/01/16 Time: 10:53
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.060324	0.062411	-0.966562	0.4051
DLOGPN(-1)-DLOGPEU(-1)	3.661581	1.682262	2.176582	0.1177
GAPN(-1)-GAPEU(-1)	3.790203	2.811317	1.348195	0.2704

R-squared	0.622055	Mean dependent var	0.007970
Adjusted R-squared	0.370091	S.D. dependent var	0.043031
S.E. of regression	0.034152	Akaike info criterion	-3.609125
Sum squared resid	0.003499	Schwarz criterion	-3.713245
Log likelihood	13.82737	Hannan-Quinn criter.	-4.025927
F-statistic	2.468829	Durbin-Watson stat	1.933228
Prob(F-statistic)	0.232350		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 08/01/16 Time: 10:54
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.060804	0.052497	-1.158223	0.3306
DLOGPN(-1)-DLOGPEU(-1)	1.116375	1.415033	0.788940	0.4877
GAPN(-1)-GAPEU(-1)	2.990167	2.364736	1.264483	0.2954

R-squared	0.357574	Mean dependent var	0.001755
Adjusted R-squared	-0.070709	S.D. dependent var	0.027762
S.E. of regression	0.028727	Akaike info criterion	-3.955098
Sum squared resid	0.002476	Schwarz criterion	-4.059219
Log likelihood	14.86529	Hannan-Quinn criter.	-4.371900
F-statistic	0.834900	Durbin-Watson stat	2.283009
Prob(F-statistic)	0.514914		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 08/01/16 Time: 10:54
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.130288	0.135771	-0.959611	0.4080
DLOGPN(-1)-DLOGPEU(-1)	-1.482338	3.659638	-0.405050	0.7126
GAPN(-1)-GAPEU(-1)	5.560231	6.115815	0.909156	0.4303

R-squared	0.349950	Mean dependent var	0.003467
Adjusted R-squared	-0.083417	S.D. dependent var	0.071378
S.E. of regression	0.074296	Akaike info criterion	-2.054675
Sum squared resid	0.016560	Schwarz criterion	-2.158795
Log likelihood	9.164025	Hannan-Quinn criter.	-2.471477
F-statistic	0.807514	Durbin-Watson stat	2.572946
Prob(F-statistic)	0.524107		

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 08/01/16 Time: 10:55
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.069791	0.057415	-1.215559	0.3111
DLOGPN(-1)-DLOGPEU(-1)	0.988707	1.547574	0.638875	0.5683
GAPN(-1)-GAPEU(-1)	3.306762	2.586233	1.278602	0.2910

R-squared	0.353928	Mean dependent var	0.000596
Adjusted R-squared	-0.076787	S.D. dependent var	0.030277
S.E. of regression	0.031418	Akaike info criterion	-3.776026
Sum squared resid	0.002961	Schwarz criterion	-3.880146
Log likelihood	14.32808	Hannan-Quinn criter.	-4.192828
F-statistic	0.821721	Durbin-Watson stat	2.288534
Prob(F-statistic)	0.519304		

Taylor Rule (2)

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/28/16 Time: 13:35
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001731	0.045649	0.037912	0.9759
DLOGPN(-1)-DLOGPEU(-1)	2.512381	1.856880	1.353012	0.4052
GAPN(-1)-GAPEU(-1)	-0.509626	2.491082	-0.204580	0.8715
RENTEN(-1)-RENTEEU(-1)	4.376976	2.422010	1.807167	0.3218

R-squared	0.951425	Mean dependent var	0.007739
Adjusted R-squared	0.805699	S.D. dependent var	0.048106
S.E. of regression	0.021205	Akaike info criterion	-4.878613
Sum squared resid	0.000450	Schwarz criterion	-5.191063
Log likelihood	16.19653	Hannan-Quinn criter.	-5.717197
F-statistic	6.528878	Durbin-Watson stat	3.042897
Prob(F-statistic)	0.278331		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/28/16 Time: 13:39
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.189340	0.169847	-1.114768	0.4655
DLOGPN(-1)-DLOGPEU(-1)	-5.550748	6.908982	-0.803410	0.5691
GAPN(-1)-GAPEU(-1)	8.196274	9.268687	0.884297	0.5390
RENTEN(-1)-RENTEEU(-1)	1.277745	9.011689	0.141788	0.9103

R-squared	0.755170	Mean dependent var	0.004744
Adjusted R-squared	0.020682	S.D. dependent var	0.079727
S.E. of regression	0.078898	Akaike info criterion	-2.250764
Sum squared resid	0.006225	Schwarz criterion	-2.563213
Log likelihood	9.626909	Hannan-Quinn criter.	-3.089348
F-statistic	1.028158	Durbin-Watson stat	3.042897
Prob(F-statistic)	0.603257		

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/28/16 Time: 13:44
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.021306	0.053991	-0.394626	0.7607
DLOGPN(-1)-DLOGPEU(-1)	1.130926	2.196231	0.514940	0.6973
GAPN(-1)-GAPEU(-1)	0.240574	2.946335	0.081652	0.9481
RENTEN(-1)-RENTEEU(-1)	2.323075	2.864640	0.810948	0.5662

R-squared	0.788205	Mean dependent var	-0.006738
Adjusted R-squared	0.152821	S.D. dependent var	0.027248
S.E. of regression	0.025080	Akaike info criterion	-4.542923
Sum squared resid	0.000629	Schwarz criterion	-4.855373
Log likelihood	15.35731	Hannan-Quinn criter.	-5.381507
F-statistic	1.240518	Durbin-Watson stat	3.042897
Prob(F-statistic)	0.564563		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/28/16 Time: 13:42
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014011	0.053008	-0.264311	0.8355
DLOGPN(-1)-DLOGPEU(-1)	0.693884	2.156253	0.321801	0.8018
GAPN(-1)-GAPEU(-1)	-0.126901	2.892704	-0.043869	0.9721
RENTEN(-1)-RENTEEU(-1)	2.832238	2.812496	1.007019	0.4978

R-squared	0.794237	Mean dependent var	-0.003743
Adjusted R-squared	0.176950	S.D. dependent var	0.027142
S.E. of regression	0.024624	Akaike info criterion	-4.579664
Sum squared resid	0.000606	Schwarz criterion	-4.892114
Log likelihood	15.44916	Hannan-Quinn criter.	-5.418248
F-statistic	1.286657	Durbin-Watson stat	3.042897
Prob(F-statistic)	0.557087		

SVM, Interest Rate Differential

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/30/16 Time: 14:04
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.023158	0.009494	-2.439231	0.0926
RN(-1)-REU(-1)	3.207009	1.152691	2.782194	0.0689

R-squared	0.720686	Mean dependent var	-0.006738
Adjusted R-squared	0.627581	S.D. dependent var	0.027248
S.E. of regression	0.016629	Akaike info criterion	-5.066204
Sum squared resid	0.000830	Schwarz criterion	-5.222429
Log likelihood	14.66551	Hannan-Quinn criter.	-5.485496
F-statistic	7.740602	Durbin-Watson stat	2.519076
Prob(F-statistic)	0.068865		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/30/16 Time: 13:58
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003687	0.052551	0.070166	0.9485
RN(-1)-REU(-1)	0.206467	6.380466	0.032359	0.9762

R-squared	0.000349	Mean dependent var	0.004744
Adjusted R-squared	-0.332868	S.D. dependent var	0.079727
S.E. of regression	0.092044	Akaike info criterion	-1.643920
Sum squared resid	0.025416	Schwarz criterion	-1.800145
Log likelihood	6.109799	Hannan-Quinn criter.	-2.063212
F-statistic	0.001047	Durbin-Watson stat	3.192025
Prob(F-statistic)	0.976218		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/30/16 Time: 14:01
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.020531	0.008779	-2.338812	0.1013
RN(-1)-REU(-1)	3.278934	1.065840	3.076384	0.0543

R-squared	0.759310	Mean dependent var	-0.003743
Adjusted R-squared	0.679079	S.D. dependent var	0.027142
S.E. of regression	0.015376	Akaike info criterion	-5.222875
Sum squared resid	0.000709	Schwarz criterion	-5.379100
Log likelihood	15.05719	Hannan-Quinn criter.	-5.642167
F-statistic	9.464140	Durbin-Watson stat	2.669841
Prob(F-statistic)	0.054290		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/30/16 Time: 13:53
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.022863	0.014072	-1.624722	0.2027
RN(-1)-REU(-1)	5.976878	1.708517	3.498283	0.0395

R-squared	0.803124	Mean dependent var	0.007739
Adjusted R-squared	0.737498	S.D. dependent var	0.048106
S.E. of regression	0.024647	Akaike info criterion	-4.279150
Sum squared resid	0.001822	Schwarz criterion	-4.435375
Log likelihood	12.69787	Hannan-Quinn criter.	-4.698442
F-statistic	12.23799	Durbin-Watson stat	2.592151
Prob(F-statistic)	0.039530		

SVM, DLOGOP

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 08/01/16 Time: 10:35
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.019130	0.018321	-1.044143	0.3269
DLOGOP(-1)	0.066739	0.068690	0.971599	0.3597

R-squared	0.105546	Mean dependent var	-0.005539
Adjusted R-squared	-0.006261	S.D. dependent var	0.037300
S.E. of regression	0.037417	Akaike info criterion	-3.556534
Sum squared resid	0.011200	Schwarz criterion	-3.496017
Log likelihood	19.78267	Hannan-Quinn criter.	-3.622921
F-statistic	0.944005	Durbin-Watson stat	2.022833
Prob(F-statistic)	0.359706		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 08/01/16 Time: 10:23
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003202	0.037430	0.085554	0.9339
DLOGOP(-1)	-0.003713	0.140331	-0.026456	0.9795

R-squared	0.000087	Mean dependent var	0.002446
Adjusted R-squared	-0.124902	S.D. dependent var	0.072073
S.E. of regression	0.076442	Akaike info criterion	-2.127721
Sum squared resid	0.046747	Schwarz criterion	-2.067204
Log likelihood	12.63860	Hannan-Quinn criter.	-2.194108
F-statistic	0.000700	Durbin-Watson stat	3.077119
Prob(F-statistic)	0.979542		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 08/01/16 Time: 10:23
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.026962	0.017623	-1.529935	0.1646
DLOGOP(-1)	0.098782	0.066073	1.495046	0.1733

R-squared	0.218381	Mean dependent var	-0.006846
Adjusted R-squared	0.120678	S.D. dependent var	0.038382
S.E. of regression	0.035991	Akaike info criterion	-3.634222
Sum squared resid	0.010363	Schwarz criterion	-3.573705
Log likelihood	20.17111	Hannan-Quinn criter.	-3.700609
F-statistic	2.235161	Durbin-Watson stat	1.919668
Prob(F-statistic)	0.173264		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 08/01/16 Time: 10:22
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.007516	0.028174	-0.266764	0.7964
DLOGOP(-1)	0.060130	0.105632	0.569243	0.5848

R-squared	0.038928	Mean dependent var	0.004729
Adjusted R-squared	-0.081206	S.D. dependent var	0.055337
S.E. of regression	0.057540	Akaike info criterion	-2.695819
Sum squared resid	0.026487	Schwarz criterion	-2.635302
Log likelihood	15.47910	Hannan-Quinn criter.	-2.762206
F-statistic	0.324038	Durbin-Watson stat	2.054774
Prob(F-statistic)	0.584815		

SVM, Inflation Differential

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 08/01/16 Time: 09:58
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004079	0.012669	-0.321938	0.7558
DLOGPN(-1)-DLOGPEU(-1)	0.713118	1.436380	0.496469	0.6329

R-squared	0.029889	Mean dependent var	-0.005539
Adjusted R-squared	-0.091375	S.D. dependent var	0.037300
S.E. of regression	0.038967	Akaike info criterion	-3.475337
Sum squared resid	0.012148	Schwarz criterion	-3.414820
Log likelihood	19.37669	Hannan-Quinn criter.	-3.541724
F-statistic	0.246481	Durbin-Watson stat	2.120829
Prob(F-statistic)	0.632916		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 08/01/16 Time: 09:56
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000354	0.024485	-0.014475	0.9888
DLOGPN(-1)-DLOGPEU(-1)	-1.367335	2.776085	-0.492541	0.6356

R-squared	0.029432	Mean dependent var	0.002446
Adjusted R-squared	-0.091889	S.D. dependent var	0.072073
S.E. of regression	0.075312	Akaike info criterion	-2.157507
Sum squared resid	0.045375	Schwarz criterion	-2.096990
Log likelihood	12.78753	Hannan-Quinn criter.	-2.223894
F-statistic	0.242596	Durbin-Watson stat	3.132621
Prob(F-statistic)	0.635569		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 08/01/16 Time: 09:57
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004990	0.012930	-0.385946	0.7096
DLOGPN(-1)-DLOGPEU(-1)	0.906141	1.466022	0.618095	0.5537

R-squared	0.045579	Mean dependent var	-0.006846
Adjusted R-squared	-0.073724	S.D. dependent var	0.038382
S.E. of regression	0.039771	Akaike info criterion	-3.434485
Sum squared resid	0.012654	Schwarz criterion	-3.373968
Log likelihood	19.17242	Hannan-Quinn criter.	-3.500872
F-statistic	0.382041	Durbin-Watson stat	1.980438
Prob(F-statistic)	0.553698		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 08/01/16 Time: 09:54
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009456	0.017673	0.535055	0.6072
DLOGPN(-1)-DLOGPEU(-1)	2.307899	2.003756	1.151787	0.2827

R-squared	0.142239	Mean dependent var	0.004729
Adjusted R-squared	0.035019	S.D. dependent var	0.055337
S.E. of regression	0.054359	Akaike info criterion	-2.809544
Sum squared resid	0.023640	Schwarz criterion	-2.749027
Log likelihood	16.04772	Hannan-Quinn criter.	-2.875931
F-statistic	1.326612	Durbin-Watson stat	1.961686
Prob(F-statistic)	0.282665		

SVM, Output gap differential

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 08/01/16 Time: 10:08
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.058309	0.050334	-1.158449	0.3111
GAPN(-1)-GAPEU(-1)	2.589246	2.150406	1.204073	0.2949

R-squared	0.266027	Mean dependent var	0.000596
Adjusted R-squared	0.082534	S.D. dependent var	0.030277
S.E. of regression	0.029001	Akaike info criterion	-3.981799
Sum squared resid	0.003364	Schwarz criterion	-4.051212
Log likelihood	13.94540	Hannan-Quinn criter.	-4.259667
F-statistic	1.449792	Durbin-Watson stat	2.511667
Prob(F-statistic)	0.294938		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 08/01/16 Time: 10:06
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.147501	0.114686	-1.286132	0.2678
GAPN(-1)-GAPEU(-1)	6.635982	4.899704	1.354364	0.2471

R-squared	0.314399	Mean dependent var	0.003467
Adjusted R-squared	0.142999	S.D. dependent var	0.071378
S.E. of regression	0.066078	Akaike info criterion	-2.334763
Sum squared resid	0.017465	Schwarz criterion	-2.404176
Log likelihood	9.004288	Hannan-Quinn criter.	-2.612631
F-statistic	1.834301	Durbin-Watson stat	2.838346
Prob(F-statistic)	0.247074		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 08/01/16 Time: 10:07
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.047840	0.047448	-1.008258	0.3704
GAPN(-1)-GAPEU(-1)	2.180000	2.027100	1.075428	0.3427

R-squared	0.224287	Mean dependent var	0.001755
Adjusted R-squared	0.030359	S.D. dependent var	0.027762
S.E. of regression	0.027338	Akaike info criterion	-4.099900
Sum squared resid	0.002989	Schwarz criterion	-4.169314
Log likelihood	14.29970	Hannan-Quinn criter.	-4.377768
F-statistic	1.156546	Durbin-Watson stat	2.380438
Prob(F-statistic)	0.342726		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 08/01/16 Time: 10:05
Sample (adjusted): 2004 2009
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.017804	0.082441	-0.215964	0.8396
GAPN(-1)-GAPEU(-1)	1.132950	3.522112	0.321668	0.7638

R-squared	0.025215	Mean dependent var	0.007970
Adjusted R-squared	-0.218481	S.D. dependent var	0.043031
S.E. of regression	0.047500	Akaike info criterion	-2.994991
Sum squared resid	0.009025	Schwarz criterion	-3.064404
Log likelihood	10.98497	Hannan-Quinn criter.	-3.272859
F-statistic	0.103470	Durbin-Watson stat	1.598353
Prob(F-statistic)	0.763812		

SVM, DLOGOP

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/30/16 Time: 13:26
Sample (adjusted): 1999 2009
Included observations: 11 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014897	0.068197	-0.218446	0.8320
LOGOP(-1)	0.003024	0.019090	0.158406	0.8776

R-squared	0.002780	Mean dependent var	-0.004244
Adjusted R-squared	-0.108022	S.D. dependent var	0.035646
S.E. of regression	0.037522	Akaike info criterion	-3.564824
Sum squared resid	0.012671	Schwarz criterion	-3.492480
Log likelihood	21.60653	Hannan-Quinn criter.	-3.610427
F-statistic	0.025093	Durbin-Watson stat	2.157245
Prob(F-statistic)	0.877634		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/30/16 Time: 13:23
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.024784	0.169139	-0.146533	0.8871
LOGOP(-1)	0.007513	0.046188	0.162661	0.8748

R-squared	0.003296	Mean dependent var	0.002446
Adjusted R-squared	-0.121292	S.D. dependent var	0.072073
S.E. of regression	0.076319	Akaike info criterion	-2.130935
Sum squared resid	0.046597	Schwarz criterion	-2.070418
Log likelihood	12.65467	Hannan-Quinn criter.	-2.197322
F-statistic	0.026458	Durbin-Watson stat	3.085735
Prob(F-statistic)	0.874819		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/30/16 Time: 13:25
Sample (adjusted): 1999 2009
Included observations: 11 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.050246	0.068307	-0.735590	0.4807
LOGOP(-1)	0.012179	0.019120	0.636989	0.5400

R-squared	0.043139	Mean dependent var	-0.007338
Adjusted R-squared	-0.063179	S.D. dependent var	0.036449
S.E. of regression	0.037582	Akaike info criterion	-3.561603
Sum squared resid	0.012712	Schwarz criterion	-3.489258
Log likelihood	21.58882	Hannan-Quinn criter.	-3.607206
F-statistic	0.405755	Durbin-Watson stat	2.198619
Prob(F-statistic)	0.539995		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/30/16 Time: 13:22
Sample (adjusted): 2000 2009
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.111682	0.123252	-0.906128	0.3913
LOGOP(-1)	0.032118	0.033658	0.954261	0.3679

R-squared	0.102194	Mean dependent var	0.004729
Adjusted R-squared	-0.010031	S.D. dependent var	0.055337
S.E. of regression	0.055614	Akaike info criterion	-2.763915
Sum squared resid	0.024743	Schwarz criterion	-2.703398
Log likelihood	15.81957	Hannan-Quinn criter.	-2.830302
F-statistic	0.910613	Durbin-Watson stat	2.510774
Prob(F-statistic)	0.367892		

SVM, NFEP-S

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/30/16 Time: 13:35
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014642	0.028777	-0.508804	0.6615
NFEP-S(-1)	4.44E-06	6.77E-06	0.656026	0.5792

R-squared	0.177080	Mean dependent var	0.002869
Adjusted R-squared	-0.234380	S.D. dependent var	0.019356
S.E. of regression	0.021505	Akaike info criterion	-4.534214
Sum squared resid	0.000925	Schwarz criterion	-4.841067
Log likelihood	11.06843	Hannan-Quinn criter.	-5.207580
F-statistic	0.430371	Durbin-Watson stat	1.975645
Prob(F-statistic)	0.579191		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/30/16 Time: 13:32
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.056648	0.132303	-0.428170	0.7102
NFEP-S(-1)	1.84E-05	3.11E-05	0.590721	0.6146

R-squared	0.148556	Mean dependent var	0.015845
Adjusted R-squared	-0.277166	S.D. dependent var	0.087485
S.E. of regression	0.098868	Akaike info criterion	-1.483210
Sum squared resid	0.019550	Schwarz criterion	-1.790063
Log likelihood	4.966420	Hannan-Quinn criter.	-2.156576
F-statistic	0.348951	Durbin-Watson stat	2.487812
Prob(F-statistic)	0.614570		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/30/16 Time: 13:34
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.016970	0.029933	-0.566949	0.6279
NFEP-S(-1)	5.64E-06	7.05E-06	0.801046	0.5071

R-squared	0.242904	Mean dependent var	0.005271
Adjusted R-squared	-0.135643	S.D. dependent var	0.020990
S.E. of regression	0.022368	Akaike info criterion	-4.455489
Sum squared resid	0.001001	Schwarz criterion	-4.762342
Log likelihood	10.91098	Hannan-Quinn criter.	-5.128855
F-statistic	0.641674	Durbin-Watson stat	1.969896
Prob(F-statistic)	0.507147		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/30/16 Time: 13:31
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.010194	0.061603	-0.165486	0.8838
NFEP-S(-1)	8.28E-06	1.45E-05	0.571243	0.6255

R-squared	0.140273	Mean dependent var	0.022447
Adjusted R-squared	-0.289591	S.D. dependent var	0.040538
S.E. of regression	0.046035	Akaike info criterion	-3.011974
Sum squared resid	0.004238	Schwarz criterion	-3.318827
Log likelihood	8.023948	Hannan-Quinn criter.	-3.685340
F-statistic	0.326319	Durbin-Watson stat	2.118352
Prob(F-statistic)	0.625470		

SVM, NFEP-F

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/30/16 Time: 13:43
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001018	0.013200	-0.077151	0.9455
NFEP-F(-1)	-4.46E-06	8.25E-06	-0.540885	0.6428

R-squared	0.127611	Mean dependent var	0.002869
Adjusted R-squared	-0.308583	S.D. dependent var	0.019356
S.E. of regression	0.022142	Akaike info criterion	-4.475838
Sum squared resid	0.000981	Schwarz criterion	-4.782690
Log likelihood	10.95168	Hannan-Quinn criter.	-5.149203
F-statistic	0.292556	Durbin-Watson stat	1.902684
Prob(F-statistic)	0.642773		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/30/16 Time: 13:41
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.013433	0.051326	-0.261714	0.8180
NFEP-F(-1) (-1)	-3.36E-05	3.21E-05	-1.047555	0.4048

R-squared	0.354291	Mean dependent var	0.015845
Adjusted R-squared	0.031437	S.D. dependent var	0.087485
S.E. of regression	0.086099	Akaike info criterion	-1.759795
Sum squared resid	0.014826	Schwarz criterion	-2.066647
Log likelihood	5.519589	Hannan-Quinn criter.	-2.433160
F-statistic	1.097371	Durbin-Watson stat	1.834611
Prob(F-statistic)	0.404776		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/30/16 Time: 13:42
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.31E-05	0.013746	0.003863	0.9973
NFEP-F(-1)	-5.99E-06	8.59E-06	-0.697030	0.5579

R-squared	0.195446	Mean dependent var	0.005271
Adjusted R-squared	-0.206830	S.D. dependent var	0.020990
S.E. of regression	0.023059	Akaike info criterion	-4.394691
Sum squared resid	0.001063	Schwarz criterion	-4.701544
Log likelihood	10.78938	Hannan-Quinn criter.	-5.068057
F-statistic	0.485851	Durbin-Watson stat	1.909572
Prob(F-statistic)	0.557907		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/30/16 Time: 13:38
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.017317	0.028838	0.600505	0.6092
NFEP-F(-1)	-5.89E-06	1.80E-05	-0.326671	0.7749

R-squared	0.050654	Mean dependent var	0.022447
Adjusted R-squared	-0.424019	S.D. dependent var	0.040538
S.E. of regression	0.048375	Akaike info criterion	-2.912816
Sum squared resid	0.004680	Schwarz criterion	-3.219669
Log likelihood	7.825632	Hannan-Quinn criter.	-3.586182
F-statistic	0.106714	Durbin-Watson stat	1.840858
Prob(F-statistic)	0.774935		

General Model (1)

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/29/16 Time: 15:36
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.013278	0.014284	-0.929588	0.5232
RN(-1)-REU(-1)	2.817816	2.075087	1.357927	0.4041
NFEP-F(-1)	3.86E-06	9.24E-06	0.417897	0.7480

R-squared	0.693249	Mean dependent var	0.002869
Adjusted R-squared	0.079748	S.D. dependent var	0.019356
S.E. of regression	0.018568	Akaike info criterion	-5.021037
Sum squared resid	0.000345	Schwarz criterion	-5.481316
Log likelihood	13.04207	Hannan-Quinn criter.	-6.031086
F-statistic	1.129988	Durbin-Watson stat	2.061082
Prob(F-statistic)	0.553851		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/29/16 Time: 15:31
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.044872	0.016272	2.757552	0.2215
RN(-1)-REU(-1)	-13.40064	2.363925	-5.668808	0.1112
NFEP-F(-1)	-7.32E-05	1.05E-05	-6.950897	0.0910

R-squared	0.980513	Mean dependent var	0.015845
Adjusted R-squared	0.941539	S.D. dependent var	0.087485
S.E. of regression	0.021153	Akaike info criterion	-4.760396
Sum squared resid	0.000447	Schwarz criterion	-5.220676
Log likelihood	12.52079	Hannan-Quinn criter.	-5.770445
F-statistic	25.15814	Durbin-Watson stat	2.061082
Prob(F-statistic)	0.139596		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/29/16 Time: 15:34
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.012419	0.015490	-0.801753	0.5698
RN(-1)-REU(-1)	2.866614	2.250278	1.273893	0.4237
NFEP-F(-1)	2.48E-06	1.00E-05	0.247487	0.8455

R-squared	0.693247	Mean dependent var	0.005271
Adjusted R-squared	0.079740	S.D. dependent var	0.020990
S.E. of regression	0.020136	Akaike info criterion	-4.858935
Sum squared resid	0.000405	Schwarz criterion	-5.319215
Log likelihood	12.71787	Hannan-Quinn criter.	-5.868984
F-statistic	1.129975	Durbin-Watson stat	2.061082
Prob(F-statistic)	0.553853		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/29/16 Time: 15:22
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014610	0.014771	-0.989119	0.5035
RN(-1)-REU(-1)	7.338166	2.145820	3.419749	0.1811
NFEP-F(-1)	1.58E-05	9.56E-06	1.652123	0.3465

R-squared	0.925217	Mean dependent var	0.022447
Adjusted R-squared	0.775651	S.D. dependent var	0.040538
S.E. of regression	0.019201	Akaike info criterion	-4.953999
Sum squared resid	0.000369	Schwarz criterion	-5.414279
Log likelihood	12.90800	Hannan-Quinn criter.	-5.964048
F-statistic	6.186018	Durbin-Watson stat	2.061082
Prob(F-statistic)	0.273465		

General Model (2)

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/29/16 Time: 15:49
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003118	0.024092	0.129405	0.9181
RN(-1)-REU(-1)	3.597876	2.228958	1.614151	0.3531
NFEP-S(-1)	-6.39E-06	8.39E-06	-0.760714	0.5860

R-squared	0.771759	Mean dependent var	0.002869
Adjusted R-squared	0.315277	S.D. dependent var	0.019356
S.E. of regression	0.016017	Akaike info criterion	-5.316670
Sum squared resid	0.000257	Schwarz criterion	-5.776949
Log likelihood	13.63334	Hannan-Quinn criter.	-6.326719
F-statistic	1.690666	Durbin-Watson stat	2.386768
Prob(F-statistic)	0.477746		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/29/16 Time: 15:43
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.144203	0.086470	-1.667677	0.3439
RN(-1)-REU(-1)	-17.73749	7.999986	-2.217190	0.2697
NFEP-S(-1)	7.18E-05	3.01E-05	2.382676	0.2530

R-squared	0.856076	Mean dependent var	0.015845
Adjusted R-squared	0.568228	S.D. dependent var	0.087485
S.E. of regression	0.057486	Akaike info criterion	-2.760859
Sum squared resid	0.003305	Schwarz criterion	-3.221138
Log likelihood	8.521718	Hannan-Quinn criter.	-3.770907
F-statistic	2.974058	Durbin-Watson stat	2.386768
Prob(F-statistic)	0.379373		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/29/16 Time: 15:46
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000788	0.027426	0.028715	0.9817
RN(-1)-REU(-1)	3.597497	2.537354	1.417814	0.3911
NFEP-S(-1)	-5.18E-06	9.56E-06	-0.542538	0.6835

R-squared	0.748490	Mean dependent var	0.005271
Adjusted R-squared	0.245469	S.D. dependent var	0.020990
S.E. of regression	0.018233	Akaike info criterion	-5.057495
Sum squared resid	0.000332	Schwarz criterion	-5.517774
Log likelihood	13.11499	Hannan-Quinn criter.	-6.067543
F-statistic	1.487990	Durbin-Watson stat	2.386768
Prob(F-statistic)	0.501508		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/29/16 Time: 15:41
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.033931	0.015939	2.128780	0.2796
RN(-1)-REU(-1)	8.939300	1.474681	6.061855	0.1041
NFEP-S(-1)	-1.86E-05	5.55E-06	-3.353386	0.1845

R-squared	0.977223	Mean dependent var	0.022447
Adjusted R-squared	0.931670	S.D. dependent var	0.040538
S.E. of regression	0.010597	Akaike info criterion	-6.142856
Sum squared resid	0.000112	Schwarz criterion	-6.603135
Log likelihood	15.28571	Hannan-Quinn criter.	-7.152904
F-statistic	21.45236	Durbin-Watson stat	2.386768
Prob(F-statistic)	0.150919		

General Model (3)

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/29/16 Time: 16:07
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.047290	0.023574	-2.006030	0.1827
RN(-1)-REU(-1)	3.143210	1.111768	2.827218	0.1056
DLOGOP(-1)	0.101188	0.091107	1.110653	0.3824

R-squared	0.827240	Mean dependent var	-0.006738
Adjusted R-squared	0.654480	S.D. dependent var	0.027248
S.E. of regression	0.016017	Akaike info criterion	-5.146638
Sum squared resid	0.000513	Schwarz criterion	-5.380975
Log likelihood	15.86659	Hannan-Quinn criter.	-5.775576
F-statistic	4.788378	Durbin-Watson stat	1.878494
Prob(F-statistic)	0.172760		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/29/16 Time: 16:03
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.096739	0.149777	0.645888	0.5846
RN(-1)-REU(-1)	0.452467	7.063597	0.064056	0.9548
DLOGOP(-1)	-0.390170	0.578845	-0.674049	0.5697

R-squared	0.185402	Mean dependent var	0.004744
Adjusted R-squared	-0.629196	S.D. dependent var	0.079727
S.E. of regression	0.101763	Akaike info criterion	-1.448631
Sum squared resid	0.020711	Schwarz criterion	-1.682968
Log likelihood	6.621578	Hannan-Quinn criter.	-2.077569
F-statistic	0.227599	Durbin-Watson stat	3.521917
Prob(F-statistic)	0.814598		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/29/16 Time: 16:05
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.044845	0.020500	-2.187513	0.1602
RN(-1)-REU(-1)	3.214657	0.966818	3.324986	0.0798
DLOGOP(-1)	0.101948	0.079228	1.286761	0.3270

R-squared	0.868322	Mean dependent var	-0.003743
Adjusted R-squared	0.736645	S.D. dependent var	0.027142
S.E. of regression	0.013929	Akaike info criterion	-5.426030
Sum squared resid	0.000388	Schwarz criterion	-5.660367
Log likelihood	16.56508	Hannan-Quinn criter.	-6.054968
F-statistic	6.594305	Durbin-Watson stat	2.172284
Prob(F-statistic)	0.131678		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/29/16 Time: 15:55
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.065512	0.030055	-2.179712	0.1611
RN(-1)-REU(-1)	5.864126	1.417440	4.137124	0.0538
DLOGOP(-1)	0.178831	0.116156	1.539579	0.2635

R-squared	0.909903	Mean dependent var	0.007739
Adjusted R-squared	0.819805	S.D. dependent var	0.048106
S.E. of regression	0.020421	Akaike info criterion	-4.660835
Sum squared resid	0.000834	Schwarz criterion	-4.895172
Log likelihood	14.65209	Hannan-Quinn criter.	-5.289773
F-statistic	10.09910	Durbin-Watson stat	1.926630
Prob(F-statistic)	0.090097		

General Model (4)

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/29/16 Time: 16:24
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.190358	0.278820	-0.682730	0.5652
RN(-1)-REU(-1)	1.199536	3.588717	0.334252	0.7700
LOGOP(-1)	0.043503	0.072491	0.600116	0.6094

R-squared	0.763307	Mean dependent var	-0.006738
Adjusted R-squared	0.526614	S.D. dependent var	0.027248
S.E. of regression	0.018748	Akaike info criterion	-4.831778
Sum squared resid	0.000703	Schwarz criterion	-5.066115
Log likelihood	15.07944	Hannan-Quinn criter.	-5.460716
F-statistic	3.224886	Durbin-Watson stat	2.751992
Prob(F-statistic)	0.236693		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/29/16 Time: 16:20
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.058120	1.676108	0.034676	0.9755
RN(-1)-REU(-1)	0.860010	21.57337	0.039864	0.9718
LOGOP(-1)	-0.014163	0.435773	-0.032500	0.9770

R-squared	0.000877	Mean dependent var	0.004744
Adjusted R-squared	-0.998247	S.D. dependent var	0.079727
S.E. of regression	0.112701	Akaike info criterion	-1.244448
Sum squared resid	0.025403	Schwarz criterion	-1.478785
Log likelihood	6.111119	Hannan-Quinn criter.	-1.873386
F-statistic	0.000877	Durbin-Watson stat	3.158559
Prob(F-statistic)	0.999123		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/29/16 Time: 16:22
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.116271	0.271746	-0.427865	0.7104
RN(-1)-REU(-1)	2.129455	3.497669	0.608821	0.6046
LOGOP(-1)	0.024910	0.070652	0.352571	0.7581

R-squared	0.773394	Mean dependent var	-0.003743
Adjusted R-squared	0.546788	S.D. dependent var	0.027142
S.E. of regression	0.018272	Akaike info criterion	-4.883173
Sum squared resid	0.000668	Schwarz criterion	-5.117511
Log likelihood	15.20793	Hannan-Quinn criter.	-5.512111
F-statistic	3.412943	Durbin-Watson stat	2.795313
Prob(F-statistic)	0.226606		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/29/16 Time: 16:19
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.296626	0.404987	-0.732434	0.5401
RN(-1)-REU(-1)	2.689975	5.212630	0.516049	0.6572
LOGOP(-1)	0.071229	0.105293	0.676480	0.5685

R-squared	0.839783	Mean dependent var	0.007739
Adjusted R-squared	0.679566	S.D. dependent var	0.048106
S.E. of regression	0.027231	Akaike info criterion	-4.085198
Sum squared resid	0.001483	Schwarz criterion	-4.319535
Log likelihood	13.21300	Hannan-Quinn criter.	-4.714136
F-statistic	5.241542	Durbin-Watson stat	2.468347
Prob(F-statistic)	0.160217		

General Model (5)

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 07/30/16 Time: 12:51
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.196964	0.268293	-0.734138	0.5968
NFEP-F(-1)	-4.22E-07	1.09E-05	-0.038674	0.9754
LOGOP(-1)	0.047453	0.064871	0.731496	0.5979

R-squared	0.431701	Mean dependent var	0.002869
Adjusted R-squared	-0.704898	S.D. dependent var	0.019356
S.E. of regression	0.025273	Akaike info criterion	-4.404425
Sum squared resid	0.000639	Schwarz criterion	-4.864704
Log likelihood	11.80885	Hannan-Quinn criter.	-5.414473
F-statistic	0.379818	Durbin-Watson stat	2.036527
Prob(F-statistic)	0.753856		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 07/30/16 Time: 12:47
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.266237	0.167415	7.563476	0.0837
NFEP-F(-1)	-6.00E-05	6.81E-06	-8.806359	0.0720
LOGOP(-1)	-0.309904	0.040480	-7.655793	0.0827

R-squared	0.989168	Mean dependent var	0.015845
Adjusted R-squared	0.967504	S.D. dependent var	0.087485
S.E. of regression	0.015771	Akaike info criterion	-5.347638
Sum squared resid	0.000249	Schwarz criterion	-5.807917
Log likelihood	13.69528	Hannan-Quinn criter.	-6.357686
F-statistic	45.65947	Durbin-Watson stat	2.036527
Prob(F-statistic)	0.104077		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 07/30/16 Time: 12:50
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.195327	0.285559	-0.684015	0.6181
NFEP-F(-1)	-1.96E-06	1.16E-05	-0.168698	0.8936
LOGOP(-1)	0.047316	0.069046	0.685282	0.6175

R-squared	0.452540	Mean dependent var	0.005271
Adjusted R-squared	-0.642380	S.D. dependent var	0.020990
S.E. of regression	0.026900	Akaike info criterion	-4.279689
Sum squared resid	0.000724	Schwarz criterion	-4.739969
Log likelihood	11.55938	Hannan-Quinn criter.	-5.289738
F-statistic	0.413309	Durbin-Watson stat	2.036527
Prob(F-statistic)	0.739905		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 07/29/16 Time: 16:28
Sample (adjusted): 2006 2009
Included observations: 4 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.585607	0.403438	-1.451543	0.3840
NFEP-F(-1)	6.54E-06	1.64E-05	0.398594	0.7585
LOGOP(-1)	0.146013	0.097548	1.496829	0.3750

R-squared	0.707037	Mean dependent var	0.022447
Adjusted R-squared	0.121111	S.D. dependent var	0.040538
S.E. of regression	0.038004	Akaike info criterion	-3.588543
Sum squared resid	0.001444	Schwarz criterion	-4.048822
Log likelihood	10.17709	Hannan-Quinn criter.	-4.598592
F-statistic	1.206700	Durbin-Watson stat	2.036527
Prob(F-statistic)	0.541261		

General Model (6)

Dependent Variable: DLOGKKI
Method: Least Squares
Date: 08/06/16 Time: 11:18
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.011873	0.040394	-0.293926	0.7965
RN(-1)-REU(-1)	3.407451	1.544626	2.206004	0.1581
GAPN(-1)-GAPEU(-1)	-0.575281	1.975714	-0.291176	0.7983

R-squared	0.732045	Mean dependent var	-0.006738
Adjusted R-squared	0.464090	S.D. dependent var	0.027248
S.E. of regression	0.019947	Akaike info criterion	-4.707722
Sum squared resid	0.000796	Schwarz criterion	-4.942059
Log likelihood	14.76931	Hannan-Quinn criter.	-5.336660
F-statistic	2.731972	Durbin-Watson stat	2.429564
Prob(F-statistic)	0.267955		

Dependent Variable: DLOG4Q
Method: Least Squares
Date: 08/06/16 Time: 11:16
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.235641	0.144920	-1.626002	0.2455
RN(-1)-REU(-1)	-4.044528	5.541545	-0.729856	0.5414
GAPN(-1)-GAPEU(-1)	12.20061	7.088130	1.721273	0.2273

R-squared	0.597141	Mean dependent var	0.004744
Adjusted R-squared	0.194281	S.D. dependent var	0.079727
S.E. of regression	0.071564	Akaike info criterion	-2.152739
Sum squared resid	0.010243	Schwarz criterion	-2.387076
Log likelihood	8.381847	Hannan-Quinn criter.	-2.781677
F-statistic	1.482256	Durbin-Watson stat	3.317361
Prob(F-statistic)	0.402859		

Dependent Variable: DLOGI44
Method: Least Squares
Date: 08/06/16 Time: 11:17
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.008223	0.037040	-0.222001	0.8449
RN(-1)-REU(-1)	3.497561	1.416345	2.469428	0.1322
GAPN(-1)-GAPEU(-1)	-0.627471	1.811631	-0.346357	0.7621

R-squared	0.772930	Mean dependent var	-0.003743
Adjusted R-squared	0.545859	S.D. dependent var	0.027142
S.E. of regression	0.018291	Akaike info criterion	-4.881127
Sum squared resid	0.000669	Schwarz criterion	-5.115464
Log likelihood	15.20282	Hannan-Quinn criter.	-5.510065
F-statistic	3.403920	Durbin-Watson stat	2.643839
Prob(F-statistic)	0.227070		

Dependent Variable: DLOGAUG
Method: Least Squares
Date: 08/06/16 Time: 11:14
Sample (adjusted): 2005 2009
Included observations: 5 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.022687	0.051085	0.444102	0.7004
RN(-1)-REU(-1)	6.785944	1.953432	3.473857	0.0738
GAPN(-1)-GAPEU(-1)	-2.322069	2.498614	-0.929343	0.4508

R-squared	0.862501	Mean dependent var	0.007739
Adjusted R-squared	0.725002	S.D. dependent var	0.048106
S.E. of regression	0.025227	Akaike info criterion	-4.238110
Sum squared resid	0.001273	Schwarz criterion	-4.472447
Log likelihood	13.59527	Hannan-Quinn criter.	-4.867048
F-statistic	6.272781	Durbin-Watson stat	2.035538
Prob(F-statistic)	0.137499		

Appendix IV: Data and Sources

Exchange Rates					
Year	NOK/EUR (aug)	NOK/EUR (4.Q)	I-44	KKI	Source
1999	8,2602	8,1920	100,44	105,59	NCBwebpage
2000	8,0959	8,0439	103,33	107,81	NCBwebpage
2001	8,0552	7,9705	100,17	104,42	NCBwebpage
2002	7,4284	7,3183	91,64	96,67	NCBwebpage
2003	8,2558	8,2220	92,81	99,54	NCBwebpage
2004	8,3315	8,1981	95,57	103,32	NCBwebpage
2005	7,9165	7,8793	91,84	98,76	NCBwebpage
2006	7,9920	8,2660	92,47	99,21	NCBwebpage
2007	7,9735	7,8871	90,80	97,53	NCBwebpage
2008	7,9723	8,9354	90,79	97,07	NCBwebpage
2009	8,6602	8,3949	93,79	99,90	NCBwebpage
2010	7,9325	8,0544	90,28	95,74	NCBwebpage
2011	7,7882	7,7598	88,07	93,88	NCBwebpage
2012	7,3239	7,3645	87,06	92,39	NCBwebpage
2013	7,9386	8,2437	88,99	95,17	NCBwebpage
2014	8,2522	8,5921	93,70	100,99	NCBwebpage
2015	9,1815	9,3363	103,50	111,81	NCBwebpage

Forecasts								
Year	SN	Source	NCB	Source	NDF	Source	DNB	Source
1999	-2,4	OekonomiskeAnalyser1998nr9side15	2,2	OekonomiskeAnalyser1998nr9side15	-1,5	OekonomiskeAnalyser1998nr9side15	NA	NA
2000	-0,5	OekonomiskeAnalyser1999nr9side15	NA	NA	NA	NA	NA	NA
2001	0,1	OekonomiskeAnalyser2000nr9side15	0,2	Inflasjonsrapport2000nr4side14	0	OekonomiskeAnalyser2000nr9side15	NA	NA
2002	0,7	OekonomiskeAnalyser2001nr6side58stjerne	-1,25	Inflasjonsrapport2001nr3side35	NA	NA	NA	NA
2003	-2,1	OekonomiskeAnalyser2002nr6side58stjerne	-3,5	Inflasjonsrapport2002nr3side43	NA	NA	NA	NA
2004	2,8	OekonomiskeAnalyser2003nr6side56stjerne	95,8	Inflasjonsrapport2003nr3side74	NA	NA	NA	NA
2005	-2,9	OekonomiskeAnalyser2004nr6side58stjerne	93,1	Inflasjonsrapport2004nr3side70	NA	NA	8,10	OekonomiskeUtsikter2004.8side74
2006	-0,6	OekonomiskeAnalyser2005nr6side58stjerne	91	Inflasjonsrapport2005nr3side71	NA	NA	8,20	OekonomiskeUtsikter2005.8side81
2007	-0,3	OekonomiskeAnalyser2006nr6side66stjerne	94,75	Inflasjonsrapport2006nr3side63	NA	NA	7,80	OekonomiskeUtsikter2006.8side69
2008	-2,0	OekonomiskeAnalyser2007nr6side58stjerne	88,25	PengePolitiskRapport2007nr3side63	NA	NA	8,00	OekonomiskeUtsikter2007.8side73
2009	7,3	OekonomiskeAnalyser2008nr6side54stjerne	94,2	PengePolitiskRapport2008nr3side79	101,2	RevidertNasjonalbudsjett2009side24	7,80	OekonomiskeUtsikter2008.8side77
2010	-6,6	OekonomiskeAnalyser2009nr6side52stjerne	91	PengePolitiskRapport2009nr3side47	0	Nasjonalbudsjettet2010sidene31og32	8,30	OekonomiskeUtsikter2009.8side73
2011	0,5	OekonomiskeAnalyser2010nr6side52stjerne	90,75	PengePolitiskRapport2010nr3side51	NA	Nasjonalbudsjettet2011sidene30og31	7,80	OekonomiskeUtsikter2010.8side63
2012	-0,6	OekonomiskeAnalyser2011nr6side50stjerne	88,5	PengePolitiskRapport2011nr3side47	93,9	Nasjonalbudsjettet2012side26	7,70	OekonomiskeUtsikter2011.8side81
2013	-3,2	OekonomiskeAnalyser2012nr6side46stjerne	85,75	PengePolitiskRapport2012nr3side39	93,3	Nasjonalbudsjettet2013side26	7,40	OekonomiskeUtsikter2012.8side84
2014	2,1	OekonomiskeAnalyser2013nr5side46stjerne	91,25	PengePolitiskRapport2013nr4side55	3,1	Nasjonalbudsjettet2014side29	7,90	OekonomiskeUtsikter2013.8side97
2015	4,0	OekonomiskeAnalyser2014nr6side46stjerne	96,25	PengePolitiskRapport2014nr4side55	1,9	Nasjonalbudsjettet2015side26	8,40	OekonomiskeUtsikter2014.8side111

	Forecasts												
Year	SEB	Danske Bank	Nordea	BNP Paribas	HSBC	RBC	Citigroup	BOA	Morgan Stanley	Credit Suisse	UBS	Commerzbank	Source
1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2007	7,6000	7,8000	NA	7,6000	7,5000	7,7000	7,7000	7,7000	7,9000	8,1500	7,8000	7,9700	BloombergProfessional
2008	8,0000	7,7500	NA	7,5000	7,5000	7,4000	7,2500	7,8100	7,9000	7,3200	7,8000	7,9000	BloombergProfessional
2009	8,0000	8,2000	8,5000	8,6000	8,2000	8,0000	7,8300	8,2000	8,7000	8,2800	8,2000	8,2000	BloombergProfessional
2010	8,0000	8,0000	8,2000	8,2000	7,8000	8,1000	7,7500	7,8500	7,7000	8,2000	7,8000	8,0000	BloombergProfessional
2011	7,7500	7,7000	7,7000	7,5000	7,5000	8,0000	7,7000	7,7000	7,6500	7,8100	7,5000	7,7500	BloombergProfessional
2012	7,6000	7,5000	7,7000	7,5000	7,4000	7,4000	7,8000	7,8500	7,8000	8,1600	7,1000	7,6500	BloombergProfessional
2013	7,0000	7,1000	7,4000	7,4000	6,9000	7,1500	7,2100	7,2500	7,0500	7,1900	7,3000	7,3800	BloombergProfessional
2014	8,5000	8,0000	8,2500	7,3000	7,6000	7,5000	7,8600	7,8000	8,5500	8,6000	7,3000	7,6500	BloombergProfessional
2015	8,8500	8,3200	8,2000	8,3000	8,5000	8,2000	8,8100	7,8000	8,7000	8,6800	8,2500	8,4000	BloombergProfessional

Variables													
NFEP-S	NFEP-F	RN	Source	HCPI-EU	REU	Source	GAPEU	Source	GAPN	Source	Oilprice	Source
NA	NA	NA	NCBwp.	75,2000	NA	ECPwp.	NA	NA	NA	PengepolitsikRapport1999.4.p44	17,4400	OECDwp.
NA	NA	NA	NCBwp.	77,1000	NA	ECPwp.	NA	NA	NA	PengepolitsikRapport2000.4.p39	27,6000	OECDwp.
NA	NA	NA	NCBwp.	78,7000	NA	ECPwp.	-0,009	WorldEconomicOutlook.Dec2001.p44	NA	PengepolitsikRapport2001.3.p35	23,1200	OECDwp.
NA	NA	NA	NCBwp.	80,5000	NA	ECPwp.	-0,017	WorldEconomicOutlook.Sep2002.p16	NA	PengepolitsikRapport2002.3.p43	24,3600	OECDwp.
NA	NA	0,0372	NCBwp.	82,1000	NA	ECPwp.	-0,022	WorldEconomicOutlook.Sep2003.p13	0,0075	PengepolitsikRapport2003.3.p75	28,1000	OECDwp.
NA	NA	0,0201	NCBwp.	84,0000	0,0222	ECPwp.	-0,018	WorldEconomicOutlook.Sep2004.p14	-0,0025	PengepolitsikRapport2004.3.p71	36,0500	OECDwp.
2 492	-120	0,0237	NCBwp.	85,9000	0,0221	ECPwp.	-0,016	WorldEconomicOutlook.Sep2005.p14	0,0025	PengepolitsikRapport2005.3.p71	50,5900	OECDwp.
2 276	807	0,0337	NCBwp.	87,5000	0,0322	ECPwp.	-0,007	WorldEconomicOutlook.Sep2006.p21	0,0150	PengepolitsikRapport2006.3.p63	61,0000	OECDwp.
5 922	-2 747	0,0485	NCBwp.	90,2000	0,0399	ECPwp.	-0,003	WorldEconomicOutlook.Oct2007.p247	0,0275	PengepolitsikRapport2007.3.p63	69,0400	OECDwp.
5 072	-1 427	0,0521	NCBwp.	91,6000	0,0361	ECPwp.	0,002	WorldEconomicOutlook.Oct2008.p293	0,0225	PengepolitsikRapport2008.3.p79	94,1000	OECDwp.
4 465	-3 111	0,0198	NCBwp.	92,5000	0,0091	ECPwp.	-0,029	WorldEconomicOutlook.Oct2009.p201	-0,0100	PengepolitsikRapport2009.3.p47	60,8600	OECDwp.
6 278	-3 732	0,0225	NCBwp.	94,5000	0,0059	ECPwp.	-0,029	WorldEconomicOutlook.Oct2010.p210	-0,0075	PengepolitsikRapport2010.3.p51	77,3800	OECDwp.
5 175	-3103	0,0212	NCBwp.	97,1000	0,0090	ECPwp.	-0,019	WorldEconomicOutlook.Sep2011.p211	0,0000	PengepolitsikRapport2011.3.p47	107,4600	OECDwp.
2 862	-160	0,0153	NCBwp.	99,3000	0,0005	ECPwp.	-0,024	WorldEconomicOutlook.Oct2012.p222	0,0050	PengepolitsikRapport2012.4.p39	109,4500	OECDwp.
-1 418	2417	0,0152	NCBwp.	100,1000	0,0006	ECPwp.	-0,027	WorldEconomicOutlook.Oct2013.p182	0,0000	PengepolitsikRapport2013.4.p55	105,8700	OECDwp.
-398	1569	0,0129	NCBwp.	99,9000	0,0001	ECPwp.	-0,035	WorldEconomicOutlook.Oct2014.p214	-0,0050	PengepolitsikRapport2014.4.p55	96,2900	OECDwp.
-529	-1198	0,0073	NCBwp.	100,2000	-0,0027	ECPwp.	-0,021	WorldEconomicOutlook.Oct2015.p200	-0,0100	PengepolitsikRapport2015.4.p61	49,4900	OECDwp.

Preliminary Thesis Report

GRA 19003

ID-number: **0912112**

Date: **15.01.2016**

I have structured this preliminary thesis report into three parts. First, I present my motivation and research question. Then, I go on explaining my model and data before I end with a plan for how to proceed my work on the master thesis.

Motivation and research question

In the well cited paper from 1983, "*Empirical Exchange Rate Models of The Seventies – Do they fit out of sample?"* the authors Richard A. Meese and Kenneth Rogoff find that a wide range of exchange rate models were unable to outperform a simple random walk model. This motivated the study of the correlation between exchange rates and macroeconomic variables. Empirical results have found that macroeconomic foundations can account and be a good forecaster for exchange rate movements, at least in the long run (Bjørnstad and Hungnes, 2006). From the theory of Purchasing Power Parity and Interest Parities we find the two variables that are the most established indicators for predicting the exchange rate in the long run, namely relative prices and interest rate differential.

In the short run, on the contrary, it may seem that exchange rates move freely without correlation to its macro-fundamentals (Rime, 2006), a phenomenon referred to as the exchange rate determination puzzle. This inspired me to take a closer look at what factors that drive the exchange rate in the short run. In my master thesis, I will examine the short run relationship between the Norwegian Krone and the EURO and try to develop a model that can account for short run movements and create forecasts.

Data and model

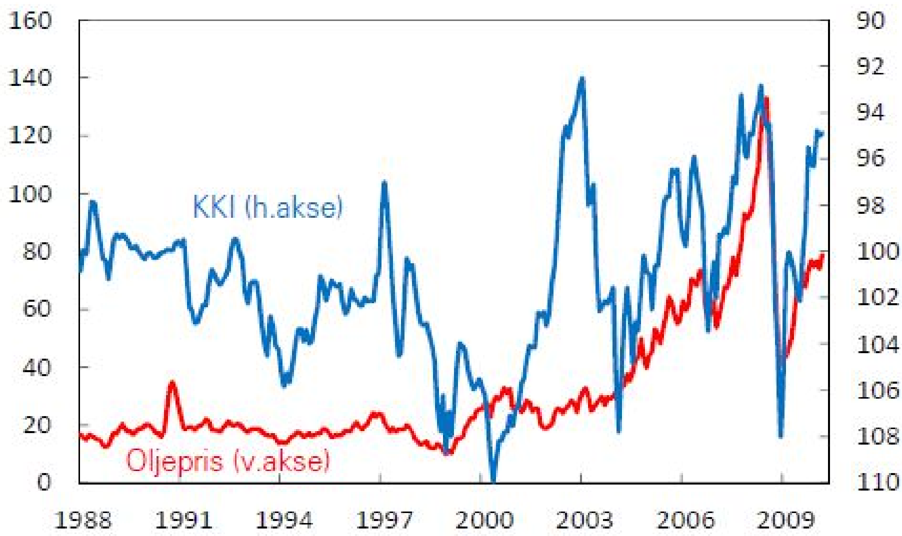
In this section, I present the different variables I would like to include in my model, as well as some theory and reasoning for why I include my chosen variables. My chosen variables; Oil price, interest rate differential between Norwegian and Euro rates, a measure of international financial uncertainty and order flow. There might be more variables that can be interesting to include in the model, but at this time, these are the ones that I find the most interesting.

Oil price

Akram (2004) find a non-linear relationship between the oil price and the Norwegian Krona. In addition, in the media it seems that there exist a general belief in the market that the oil price affects the exchange rate, and increased oil price would in theory increase the demand for oil investment and oil related stocks. Therefore, movements in the oil price could affect the exchange rate trough a pure psychological effect and increased demand for Norwegian currency. Because of this, I include oil price in my model.

Figure 1 plots the Norwegian exchange rate and the oil price; it appears that after 2004 there exist a close correlation between the oil price and the value of the krona. Up to 2004 the oil price stayed around 10-30 USD per barrel and the relationship between the two variables seem to be non-existing, a graphical result that fits with Akram's (2004) findings. Another factor that could contribute to explain this could be Norway's several fixed exchange rate regimes before 2001.

Figure 1: Norwegian Exchange rate (KKI) and oil price in USD. Monthly data. January 1988 – March 2010



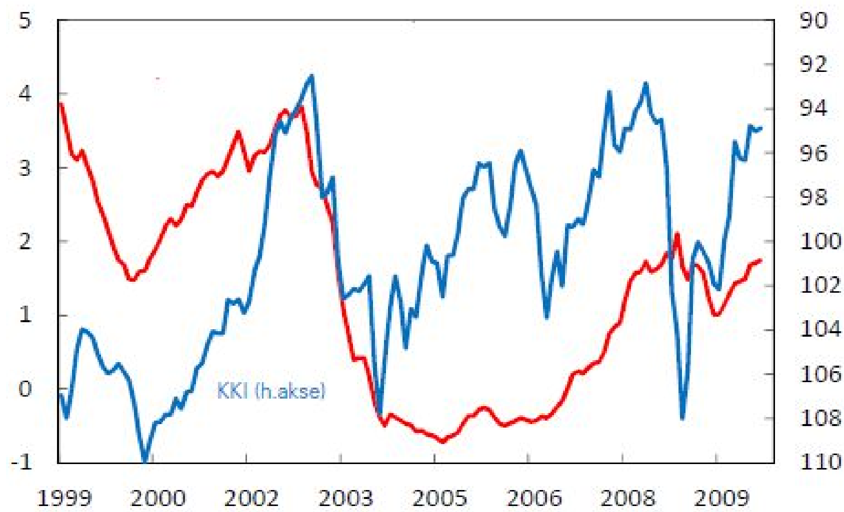
Source: Thomson Reuters and Norges Bank

The short theoretical explanation of the link between oil price and the Norwegian exchange rate is that increased oil price results in increased oil revenues and these revenues can be used to increase imports and therefore allow sheltered industry to grow at the expense of competitive industry. The wealth transfer from competitive to sheltered sector demand a real appreciation of the exchange rate. The Norwegian fiscal rule that allows for 4 percent of revenues from the Government pension fund to be injected into the economy limit the need for a real appreciation. In addition, the demand for Norwegian currency are reduced by Norges Bank foreign investment to build up the pension fund (Fidjestøl, 2007). The two mechanisms above cause the Norwegian krona to be less correlated to movements in the oil price.

Interest rate differential

Interest rate differential are often mention to as the variable that best can account for exchange rate movements, both in the short and long run (Flatner, Tornes and Østnor, 2010). Uncovered interest parity states that a positive interest rate differential will cause a depreciation of the krona over time, on the other hand, we expect an increased interest will increase demand for a country's currency, hence increasing the value of the currency. The phenomenon of a sudden appreciation followed by a deprecation over time are in literature referred to as overshooting. In figure 2, we see that a tendency that increased differential in interest rates strengthen the Norwegian currency, and vice versa.

Figure 2: Norwegian Exchange rate (KKI) and three-month interest rate differential against trade partners. Monthly data January 1999- March 2010



Source: Thomson Reuters and Norges Bank

International financial uncertainty

Empirical results suggest that international financial uncertainty will reduce the value of the Norwegian krone (Alendal, 2010). In periods with high volatility and uncertainty, investors seek to safe haven currencies such as dollars, euros and

Japanese yen. Which implies that investor who hold their investment in Norwegian currency will draw their investment out of Norwegian krona, thus reducing the demand for NOK and it will depreciate.

At this point, I have not read enough literature or search for available data to decide on what type of measure of international financial uncertainty to use in my model. Two measures that are used in research and by players in the market are the VIX-index and GRI-index;

VIX-index. A measure for expected volatility in the S&P 500 index. An increase in the VIX-index implies increases uncertainty and reduced risk-taking by investors. Many players in the market use the index as a measure for uncertainty.

GRI-index. A global risk index based on implicit volatility derived from the price of three-month currency options between euro, dollar and yen.

Order flow

As mentioned earlier, international research found it hard to link macroeconomic foundations to the exchange rate in the short run. Including order flow into exchange rate models have shown to increase its forecasting abilities (Flatner, Tornes and Østnor, 2010). Because order flow reflects the markets belief about macroeconomic fundamentals, Rime, Sarno and Sojli (2008) argue that order flow can link exchange rate to macro-variables.

Dataset

As my focus is on short term relations and forecast, the choice of data frequency stood between daily and weekly data. I chose weekly data as this will be easier to obtain for some of my variables and I think this will provide the best results for my model.

It is reasonable to assume that different monetary policy regimes would cause the relationship between the exchange rate and some macro-variables to change. For instance, under a fixed exchange rate regime the interest rate would be changed because of changes in the exchange rate, whiles under an inflation targeting regime the interest will be adjusted to stabilize inflation and output. Therefore, I will only use data from after March 2001 when Norway adopted a flexible inflation target. Furthermore, I need to limit my dataset to 2005 since I have not found data for order flow older than this. I believe I have enough data to find good and interesting result.

How to solve my thesis

First, I need to do more research so that I get a broader overview of relevant theories and empirical work on the subject. Then, after deciding on which variables to include and developing my model, I start collecting data and preparing it for analysis. Thereafter, analyse and evaluate my results. I believe my biggest challenge are related to econometric method and analysis as I have little experience with practicing this. However, I am enthusiastic and motivated to succeed and looking forward to working on my thesis.

I will structure my thesis accordingly:

I. Introduction: Motivation, research question, presentation of the master thesis.

II. Theory and empirical work: Present relevant theories and empirical work on the subject. Explanation and reasoning for my chosen variables.

III. Data and Model: Explaining the data and the model.

IV. Analysis: Perform an out-of-sample forecast, use measures as Mean Absolute Error and Mean Squared Error to say something about the precision of my model/forecast.

V. Conclusion: Summing up and point to my main findings.

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