SVERIGES RIKSBANK
Sveriges Riksbank Working Paper Series

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December 2001
No. 133

Henrik Degrér, Jan Hansen, Peter Sellin

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Henrik Degrér, Jan Hansen and Peter Sellin♣

Monetary Policy Department
Sveriges Riksbank

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Abstract

In this paper we evaluate the out of sample forecasting performance of a large number of models belonging to a popular class of exchange rate models. Forecasts of the Swedish nominal effective exchange rate for the period 1980-2000 are performed using both single equation estimation and VAR approaches. The forecast horizons used were from 1 to 12 quarters. None of the models evaluated could convincingly outperform a random walk alternative.

KEYWORDS: Exchange rates, monetary approach, forecasting.

JEL CLASSIFICATION NUMBERS: F31, F41, F47.

* We wish to thank Anders Vredin and the participants in seminars at Sveriges Riksbank for valuable comments. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Executive Board of Sveriges Riksbank.
♣ Correspondence to Peter Sellin; Monetary Policy Department; Sveriges Riksbank; SE-10337 Stockholm; Sweden. E-mail: peter.sellin@riksbank.se .

1 Introduction

In this paper we evaluate the out of sample forecasting performance of a number of structural models for the krona's nominal effective exchange rate. It is well known that forecasting nominal exchange rates is a difficult task. The most well known study in the field of out of sample forecast evaluation is Meese and Rogoff (1983). They showed that none of the models they tested could beat a random walk forecast. This result has been repeated in many other studies.[1] However, more recent research has in some cases been able to outperform a random walk, especially at long horizons.[2]

Goldberg and Frydman (1996) suggest that the poor forecasting performance of exchange rate models in general can be explained by the fact that their period of evaluation stretches over different exchange rate regimes. They stress that regime shifts significantly affect the formation of exchange rates, both concerning the effects of economic policy and expectation formation. They show that structural models fit the data properly during periods of unchanged exchange rate regimes.

The purpose of this paper is to evaluate the forecasting ability of different exchange rate models for the Swedish krona. Unfortunately, the flexible exchange rate period, since November 19, 1992, is too short for both estimating the models and evaluating their forecasting performance. Hence, we are not able to escape the Goldberg-Frydman critique. Our forecast evaluations show that it is extremely hard to beat a random walk. However, a couple of models are able to forecast the direction of the exchange rate better than a random walk.

2 Exchange Rate Models Being Evaluated

Some of the models we will be evaluating belong to the monetary class of exchange rate models. These models are comprised in the following equation:

$$s = a_0 + a_1\left(m - m^*\right) + a_2\left(y - y^*\right) + a_3\left(i - i^*\right) + a_4\left(\pi - \pi^*\right) + a_5\left(b - b^*\right) + a_6\left(q - q^*\right) + u$$

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[1] See Frankel and Rose (1995) for a summary of the exchange rate literature that developed in the twelve years after Meese and Rogoff.

[2] See Mac Donald and Marsh (1999) for a survey of the literature.

where s is the log nominal exchange rate (expressed as the price of foreign currency), m and y are the log money supply and real national income respectively, i is the short-term interest rate, π is the expected inflation rate, q is the relative price of tradable to non-tradable goods, b is the country's cumulated current account deficits relative to GDP (an asterisk denotes a foreign variable).

Under the assumption of rational expectations, the reduced form can be derived from a two-country model with uncovered interest parity (UIP) and an LM curve in the domestic and foreign country respectively. Money demand is a function of real income and the short interest rate (and possibly wealth). In a model with sticky prices an equation which describes the price dynamics has to be added for each country. Price stickiness leads to the appearance of an expected inflation differential in the reduced form. In a model with flexible prices, on the other hand, purchasing power parity (PPP) always holds and domestic and foreign inflation are the same. If the UIP relationship includes a risk premium it will also appear in the exchange rate equation.

Under the assumption of flexible prices we arrive at Model 1 in Table 1 (Frenkel (1976), Bilson (1978)), which only has money, income, and the short rate as explanatory variables. On the other hand, if we assume that prices are sticky in the short run we get Model 2 (Dornbusch (1976a), Frankel (1979)), that also includes the expected inflation differential. Model 3 includes net foreign assets (NFA) (Hooper och Morton (1982), MacDonald (2000)) while Model 4 instead includes the relative price of tradable to non-tradable goods, which is a result of the assumption that the law of one price only holds for tradable goods (Dornbusch (1976b), Chinn och Meese (1995)). [3]

We also evaluate models where we do not substitute in money, as in the monetary approach, but instead keep the relative consumer prices as explanatory variables. Moving the price differential to the left hand side would make it obvious that the rest of the explanatory variables constitute a real exchange rate model. An overview of the estimated models is given in Table 1.

The models presented above will be estimated and their forecasting performance evaluated. We estimate single equation models where the explanatory variables are assumed to be exogenous. This approach requires the input of forecasts of the explanatory variables. We follow Meese and Rogoff (1983) and use the ex post values of the explanatory variables. These are therefore not actual forecasts. Because of this we also estimate and evaluate VAR models where all variables are treated as endogenous. This will constitute a more realistic test of the models' forecasting ability, while the former evaluation will tell us something about the models' ability to describe how the exchange rate is determined. Even if we can describe exchange rate movements ex post, it does not mean that we can forecast these movements, since we do not have perfect forecasts for the explanatory variables.

A crucial issue for the model specification and estimation process are the time series properties of the variables used. However, because of problems in establishing the order of integration of the variables, we estimate all models in both level and difference form. The only exceptions are the interest rate spreads, which are in level form throughout. We also include error correction terms consisting of the different models in level form in the models in first differences.

3 Choosing a Benchmark Model

Before we begin our evaluation we need to establish some benchmark against which to test the models. Usually a random walk (with or without drift) is used as a benchmark for exchange rate forecasts. Another simple time-series model that we consider is the AR(1) process. In a first step we evaluate the following four models as potential benchmarks explaining the level of the exchange rate:

$$s_t = a + bs_{t-1} + u_t \,,$$

where μ_t is an error term, with the restrictions b=1 (Model A), a=0, b=1 (Model B), no restrictions (Model C), a=0, (Model D). For models in first differences we have the following possible benchmarks:

[3] See the Appendix for the theoretical derivation of the models considered in this paper.

$$\Delta s_t = a + b\Delta s_{t-1} + u_t ,$$

with restrictions b=0 (Model E), a=0, b=0 (Model F), no restrictions (Model G), a=0 (Model H).

The models are estimated initially for the period 1970:I-1979:IV, after which forecasts are made for 1, 2, 3, 4, 8 and 12 quarters beginning in 1980:I. We then move forward one quarter and re-estimate the model for the period 1970:I-1980:I and make a new set of forecasts. The last estimate is for the period 1970:I-2000:I and a forecast is made for 2000:II, which is the last quarter for which we have data. This of course implies that we have more forecasts for the shorter horizons than for the longer horizons. We also consider the alternative evaluation period 1993:2-2000:2, which is characterized by a floating exchange rate.

After estimating the models we compute forecast errors and perform an evaluation in terms of the Mean Error (ME), the Root Mean Squared Error (RMSE), and the Mean Absolute Error (MAE). ME can give an indication as to whether the forecast is biased. RMSE is the most frequently used measure, while MAE is less sensitive to outliers.

We find that the best forecasts are made by the random walk with drift (Models A and E) for the longer sample period, while the random walk without drift (Models B and F) perform best during the later sample period. Hence, these will be the benchmarks used in our study.

4 Evaluation of Single Equation Models

In this section we evaluate a total of 30 different single equation models of the exchange rate. Table 1 provides an overview of the tested models. Models 1 to 5 are the generic models, which we augment in three different ways in order to cover a broad spectrum of possible specifications of the exchange rate mechanism. In models 6 to 10 in table 1 we take the first differences of the variables. Models 11 to 20 are equivalent to model 1 to 10 with the exception that we augment the equations with a lagged value of the dependent variable. Models 21 to 30 are versions of models 1 to 10 where we have dropped the relative money supply and GDP and instead included the relative CPI.

We perform an out of sample evaluation of the models where we first use the period 1970:1 to 1980:1 to estimate parameter values for the different models. We then estimate forecasts of the exchange rate *h* periods ahead, where the forecast horizon (FH) is $h=1,2,3,4,8,12$ quarters. The forecast for period *h* uses the information available up to period 1980:1+*h*. This means that we have perfect information of the future values of the explanatory variables when forecasting the exchange rate. In the next section this assumption is relaxed. We then extend the estimation window one period ahead and make new forecasts *h* periods ahead. The forecasts are then compared to the benchmark forecasts.

The result from the evaluation is presented in table 2. In addition to the evaluation criteria discussed above (ME, MAE, RMSE) we also present two ratios: 1. RMSE for the model relative to RMSE for the benchmark; and 2. MAE for the model relative to MAE for the benchmark. If the model outperforms the benchmark the ratio should be smaller than one. An additional evaluation criterion we report is the fraction of times the model predicts the right direction of change.

By the ratio criteria it appears that it is difficult to outperform the benchmark forecast, which is in line with the findings of Meese and Rogoff (1983) and others. It is clear that models in level form generally perform much worse than the models in first differences. However, a notable exception to the above is found when evaluating the models where net foreign assets are included in level form. These models (model 3 and 5) beat the benchmark for forecast horizons between 2 and 3 years. Generally the forecasting ability of the models in level form increases with the forecast horizon. In a few cases the level form models are able to outperform both the benchmark model and the equivalent model in first difference form. This indicates that the explanatory variables contain some long-term information regarding the evolution of the exchange rate. Thus, the residuals from the level form models can be used as an error correction term in the models in differences form.

In the level form models the accuracy of the short term forecast is improved when a lag of the dependent variable is included (models 11-15). In contrast, the accuracy decreases in the first difference models (models 16-20) when a lagged dependent variable is included. When inflation expectations, measured by differences in long-term interest rates, are included (model 7) the forecasting ability is also improved. This indicates that there might be price rigidities present in the economy that influence the exchange rate. The forecasting ability is further improved as we add net foreign assets as an explanatory variable (model 8). For the models that use the relative price of non-tradable goods to tradable goods instead of net foreign assets (model 9), the accuracy of the forecasts is somewhere between the models with net foreign assets and the models without net foreign assets. This leads us to conclude that net foreign assets might be an important factor in explaining the behaviour of the exchange rate from 1980 and onward. Finally, we also evaluate models (model 10) which use all the available variables. These models are sometimes marginally better than the models with only net foreign assets included, but most of the time they are outperformed by other models. Of all the models presented, the model with the first difference of money supply, gross domestic product, short-term interest rate, inflation expectations and net foreign assets (model 8) provides us with the most accurate forecasts over all time horizons. It should, however, be added that the model appears to be only marginally better than a benchmark model. For the time horizon of 2-3 years, model 3 and 5 outperform the other models.

It would be possible to use a time varying risk premium in the uncovered interest rate parity condition. This risk premium would then also be included in the reduced form exchange rate equation. We have tried to include a variable that measures the risk premium over time in the evaluated models. This variable consists of a volatility measure of the historic stock market movement, i.e. we use a GARCH type volatility measure of the MSCI world index. The hypothesis is that higher uncertainty in times of financial instability would cause small currencies, such as the Swedish krona, to depreciate as investors move their capital to larger currencies, such as the US dollar. Unfortunately, this risk variable was unable to increase the forecast accuracy of the models. Hence, the results obtained when including this variable are not reported.

Our next step was to include an error correction (EC) term in the models in first differences. The EC-term we used was the level of the real exchange rate lagged one period. This term represents a gradual adjustment to purchasing power parity. The models with this term included generally provided worse forecasts than the other models. We also used the residuals from model 1-5 as EC-terms in models 6-10 without any success.

In the models above we have implicitly assumed that the effects of, say, a higher domestic short-term interest rate has exactly the same effect as a lower foreign short-term interest rate. In other words, we have assumed a symmetry constraint on the equations. It is possible that this restriction of the coefficients leads to poorer forecasts. Some of the symmetry restrictions arise by assuming the same money demand function in the two countries while other restrictions arise naturally from the rational expectations model. In Goldberg and Frydman (1996) all the symmetry restriction are dropped as they use a different kind of expectation model, namely so-called 'theory consistent expectations'. Based on their line of reasoning we also drop all of the symmetry constraints and thereby let the coefficients for domestic and foreign variables differ. The results from these types of models are equivalent to the results obtained with the symmetry constraint and are therefore not reported. If anything, it seems that the restricted models perform somewhat better than the unrestricted models (except for models 1-5 where the unrestricted are marginally better). This is what we would expect if the symmetry restrictions, and thereby the rational expectation model, would hold.

In table 3 we present the same type of forecasts as in table 2 for the evaluation period 1993 to 2000. We find that the accuracy of the forecasts is generally poorer for the shorter evaluation period. This indicates that the estimated parameter values from the fixed exchange rate regime are not suitable for making forecasts in a floating exchange rate regime.

The models that include net foreign assets tend to out-perform the other models and often manage to beat the benchmark model. This is especially true for the longer evaluation period. For the shorter evaluation period it appears as if the explanatory value of the variable decreases.

In tables 2 and 3 we find that the RMSE generally shows a higher value than the MAE which is indicative of the presence of a few large forecast errors. The large errors are due to the devaluations and the transition from a fixed rate regime to a floating rate regime in November 1992. The RMSE is also larger than the MAE under the floating rate period, but the differences are smaller. This indicates that the model has some difficulties predicting larger changes in the exchange rate.

The purchasing power parity models with relative consumer prices as an explanatory variable (models 21-30) provide forecasts that are comparable with the other level models. However, they yield somewhat better forecasts in first difference form than the monetary models (with money supply and GDP instead of relative prices) for the long evaluation period. The level form model (model 25) with all variables included provides us with good forecasts over a 2-3 year horizon with RMSE and MAE ratios of 0.5-0.6. For the forecast period after 1993 the level form PPP models perform somewhat less well with the exception of model 24 which is a little better under this period. The model with all variables included does not provide good forecasts under either the short or long evaluation period. The forecasts from the first difference form PPP models does however provide adequate forecasts (except for model 30).

The ability of the models to forecast the directional change of the exchange rate is much more satisfactory. The best models are capable of forecasting the correct direction of the change in the exchange rate 70-80 per cent of the time for forecast horizons of 2-3 years. For shorter forecast horizons of 1 year, the forecasting ability drops to below 70 per cent and for even shorter horizons the models have no explanatory value. According to our analysis, the ability to provide accurate forecasts is not negatively affected by using models where we only use only the short interest rate difference or the difference in productivity growth. It is in other words sufficient to have a good forecast of one of these variables in order to make a good forecast of the directional change of the exchange rate in 1-3 years time.

5 Evaluation of VAR- models

It was assumed in the single equation models above that we have access to “perfect” forecasts of the explanatory variables. In this section we remove this assumption by treating all variables as endogenous, in other words we evaluate actual forecasts. The first result of this exercise is that no model can systematically beat a random walk.

The forecasting performance relative to the random walk deteriorates for the period after 1993. This can potentially be explained by the fact that the models are estimated under a different exchange rate regime with different structural relationships.

The models specified in level terms perform considerably less well than the models in differences, especially for long forecast horizons. This indicates that the models do not catch long-run relationships between the exchange rate and the explanatory variables. On the contrary, the performance of models in differences relative to the random walk does not deteriorate for increasing forecasting horizons. We do not test VAR- models with error correction terms (VEC- models), because their specification and estimation requires comprehensive econometric within – sample analysis.

Concerning the models in differences and the forecast horizon after 1980, the simplest models in general achieve the best performance. Including the relative prices and net foreign assets variables, yields significantly less accurate forecasts. Models including net foreign assets seem on average to have the highest accuracy for the period after 1993. It may be promising to follow up their forecasting performance in the future.

The PPP models with relative consumer prices among the explanatory variables (models 21-30) perform about as well as models with the money supply and real GDP (i.e. the monetary models) for the period after 1980. However, for the period after 1993 the monetary models appear to perform better (according to both MAE and RMSE).

In summary, no model can beat the random walk on any forecasting horizon. We do not know if models with a larger number of observations from the flexible exchange rate regime will be able to do that. The study by Goldberg & Frydman (1996) suggests that this could be the case. However, on average the models are doing better at predicting the direction of the exchange rate (in the sense of weaker or stronger) for periods one to two years ahead (model 8 accurately predicts the direction in 2 out of 3 cases for the period after 1993).

6 Conclusions

In this paper we evaluate the out of sample forecasting performance of a large number of models belonging to a popular class of exchange rate models. Forecasts of the Swedish nominal effective exchange rate for the period 1980-2000 are produced using both single equation estimation and VAR approaches. The forecast horizons used were from 1 to 12 months. Explanatory variables include relative money supply (Swedish relative to TCW trading partners), relative GDP, relative consumer prices, relative net foreign asset position, relative productivity (measured as relative CPI/PPI), short-term interest rate spread and long-term interest rate spread. None of the models evaluated could convincingly outperform a random walk alternative.

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Appendices

A. Theory

In this Appendix we outline the monetary approach to the exchange rate and some extensions. However, we will commence with the theory of purchasing power parity of which the monetary approach is an extension.

Purchasing power parity
Purchasing power parity (PPP) states that the price levels in two countries should be the same if expressed in a common currency. This implies the following equality:

(1) $$s = p - p^*,$$

where s is the price of foreign currency in terms of the home currency, p is the domestic price level, and p^* is the foreign price level. In (1), and in all equations in this section, variables (except interest rates) are expressed in natural logarithms and foreign variables are designated with an asterisk.

Monetary flexible price model
The monetary model of the exchange rate is an extension of purchasing power parity theory. It takes as its departure the notion that an exchange rate is the relative price of two monies. Prices are assumed to be flexible so that PPP holds at all times. The monetary approach supplements PPP with equilibrium in the money market in each country:

(2a) $$m = p + \gamma_1 y - \gamma_2 i,$$

(2b) $$m^* = p^* + \gamma_1 y^* - \gamma_2 i^*,$$

where m is the money supply and the RHS variables imply that money demand is a positive function of real income, y, and a negative function of the interest rate, r. The elasticities in the money demand functions are assumed to be the same in the home and foreign countries. The LM relationships (2) are substituted into the PPP relationship (1), determining the level of the exchange rate as

(3) $$s = m - m^* - \gamma_1 (y - y^*) + \gamma_2 (i - i^*).$$

Hence, the exchange rate is determined by the relative money supplies, the relative incomes, and the interest rate differential.

Monetary sticky price model
We consider the version of the sticky price monetary model derived in Frankel (1979), also known as the "real interest differential model". It is assumed that it takes time for prices to adjust to clear excess demand in the goods market. Thus, PPP only holds in the long run but not in the short run. The price adjustment process can be modelled in the following way,

(4a) $$\dot{p} = \phi(y^d - y) + \theta, \qquad \phi > 0,$$

(4b) $$\dot{p}^* = \phi(y^{d*} - y^*) + \theta^*,$$

where a dot indicates a time derivative, ϕ is the speed of adjustment, and θ is the steady state rate of inflation. Demand is assumed to be a function of the real exchange rate $q \equiv s - p + p^*$, (5a) $y^d = hq$, $h > 0$,

(5b) $y^{d*} = -hq$.

In the fix price model asset prices still adjust instantaneously, so that uncovered interest parity (UIP) holds:

(6) $\dot{s}^e = i - i^*$

The rational expectations solution to the differential equations (4) and (6) is

(7) $\dot{q} = \lambda(q - \overline{q})$, $\lambda < 0$,

where $\overline{q}$ is the equilibrium real exchange rate. We can rewrite (7) as

(8) $\dot{s}^e - \dot{p} + \dot{p}^* = \lambda(s - p + p^* - \overline{q})$

Substituting from (2) and (6) and solving for the exchange rate gives us

(9) $s = \overline{q} + (m - m^*) - \gamma_1(y - y^*) + (\gamma_2 + 1/\lambda)(i - i^*) - (1/\lambda)(\dot{p} - \dot{p}^*)$,

where $\overline{q}$ is the equilibrium real exchange rate. There are two things worth noting about (9). First, the interest differential can now have a positive *or* a negative effect, since $\lambda < 0$. Secondly, higher expected inflation relative to the foreign country will lead to a depreciation of the exchange rate.

Net foreign assets

Frankel (1982) includes wealth in the money demand functions, resulting in the modified LM relationships:

(10a) $m = p + \gamma_1 y - \gamma_2 i + \gamma_3 w$,

(10b) $m^* = p^* + \gamma_1 y^* - \gamma_2 i^* + \gamma_3 w^*$,

where *w* is real financial wealth. He derives the following version of the flexible-price monetary exchange rate equation,

(11) $s = m - m^* - \gamma_1(y - y^*) + \gamma_2(i - i^*) - \gamma_3(w - w^*)$.

For the sticky-price version of the model he derives the following equation of exchange rate determination,

(12) $s = \overline{q} + (m - m^*) - \gamma_1(y - y^*) + (\gamma_2 + 1/\lambda)(i - i^*) - (1/\lambda)(\dot{p} - \dot{p}^*) - \gamma_3(w - w^*)$.

Thus, net foreign assets will enter as an explanation of the exchange rate because of the incorporation of wealth in the money demand equations. In Hooper and Morton (1982) net foreign assets are instead included in the exchange rate equation as a determinant of the real exchange rate.

Purchasing power parity for tradables

Dornbusch (1976) assumes that the law of one price holds for tradable goods prices,

(13) $s = p_T - p_T^*$.

Adding and subtracting the domestic and foreign price levels to (and from) the right hand side and rearranging terms, we get

(14) $s = p - p^* - p + p_T + p^* - p_T^*$.

This can be approximated by

(15) $s = p - p^* - (n - n^*)$,

where *n-n** is the index constructed by Kakkar and Ogaki (1999) reflecting the relative price of non-tradables versus tradables:

(16) $n - n^* = \ln(CPI/WPI) - \ln(CPI^*/WPI^*)$.

In order to arrive at (16), we have used the proxies $p = \ln(CPI)$ and $p_T = \ln(WPI)$ and analogy for the foreign prices. The rationale is that the WPI contains mainly tradables prices, while the CPI contains both tradables and non-tradables prices.

Equation (15) can be rewritten so that we have the real exchange rate on the left hand side. Then, a relative increase in domestic non-tradables prices would lead to an appreciation of the real exchange rate. This will be the case if relatively high productivity in the tradables sector raises the wage level in the whole economy — the Balassa-Samuelson productiviy bias effect. Another reason could be sector-specific demand shocks.

As before, we can substitute in the LM relationships from (2) to obtain the exchange rate equation,

(17) $$s = m - m^* - \gamma_1(y - y^*) + \gamma_2(i - i^*) - (n - n^*),$$

or alternatively from (10) to get an exchange rate equation incorporating both relative prices and net foreign assets,

(18) $$s = m - m^* - \gamma_1(y - y^*) + \gamma_2(r - r^*) - \gamma_3(w - w^*) - (n - n^*).$$

Model equations to evaluate

We will evaluate the monetary equations (3), (9), (11), (12), (17), and (18). We will also evaluate the PPP equation (1), as well as the equation resulting from resubstituting the LM relationship in the sticky price version, which results in

(9)’ $$s = \bar{q} + (p - p^*) + (1/\lambda)(i - i^*) - (1/\lambda)(\dot{p} - \dot{p}^*).$$

Following the same procedure of using the price level differences, rather than the substituted LM relationship, gives us the following equations to evaluate:

(11)’ $$s = p - p^* - \gamma_3(w - w^*),$$

where net foreign assets remain in the Hooper and Morton (1982) version of (12). The sticky-price version of the model becomes

(12)’ $$s = \bar{q} + (p - p^*) + (1/\lambda)(i - i^*) - (1/\lambda)(\dot{p} - \dot{p}^*) - \gamma_3(w - w^*).$$

The relative price equations to evaluate are (15) and

(18)’ $$s = p - p^* - \gamma_3(w - w^*) - (n - n^*),$$

where again the LM relationship in (2) has been used because we think of net foreign assets determining the real exchange rate as in Hooper and Morton (1982).

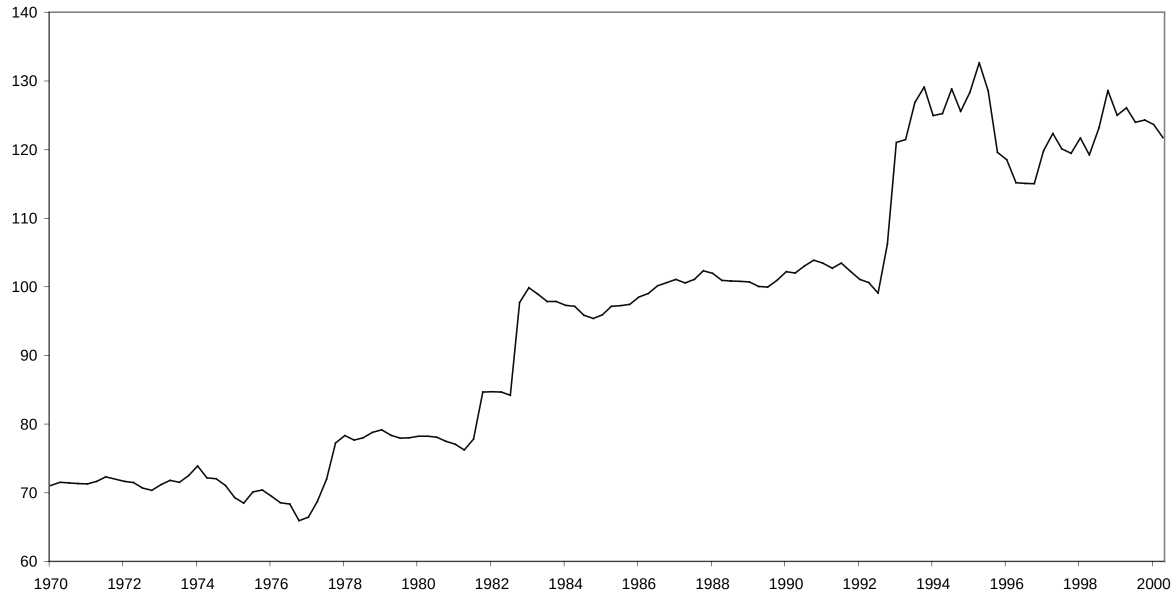
B. Data

All series are (if necessary) seasonally adjusted. All variables refer to Sweden relative the TCW area. Countries with trade weights in the TCW index exceeding 5 per cent are taken as an approximation for the TCW area. These are Germany, the USA, the UK, France, Finland, Italy, Denmark, Norway and Japan. Data for the individual countries have been weighted together by their trade weights, with all trade weights summing up to 100 per cent. Most data are calculated as the difference between the log (geometric) index for the Swedish and TCW variable.

The nominal effective exchange rate of the krona

The TCW index reflects the krona’s nominal effective exchange rate.
Sources: IMF (International Financial Statistics) and the Riksbank.

The krona's nominal TCW exchange rate



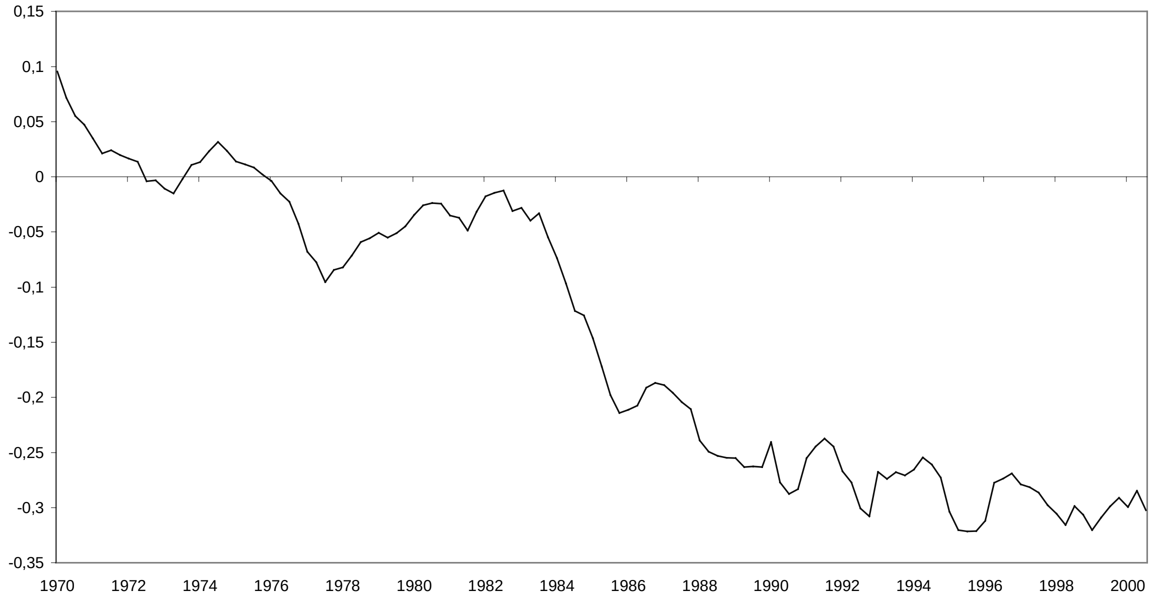
Sources: IMF and the Riksbank

Relative money supply

This variable reflects the relation between broad money supply (M3 or M4) in Sweden and the TCW trading partners. Figure x shows that broad money increased by about 40 per cent more in the TCW area than in Sweden.

Sources: IMF (International Financial Statistics), OECD (Main Economic Indicators) and the Riksbank.

Swedish money supply relative to the TCW- trading partners



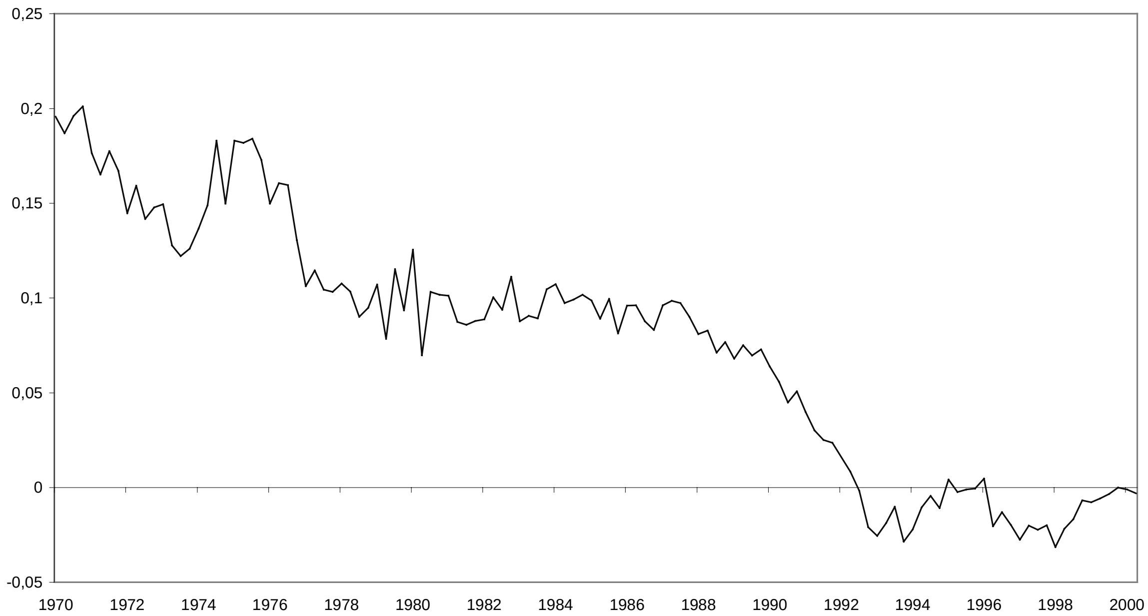
Sources: IMF, OECD and the Riksbank

Relative GDP

This variable reflects the relation between real GDP in Sweden and the TCW trading partners. Figure x shows that relative real GDP in Sweden has fallen during the 1970s and 1980s. During the 1990s, GDP in Sweden has grown in line with the TCW trading partners.

Sources: OECD (Main Economic Indicators) and the Riksbank.

Swedish GDP relative to the TCW- trading partners



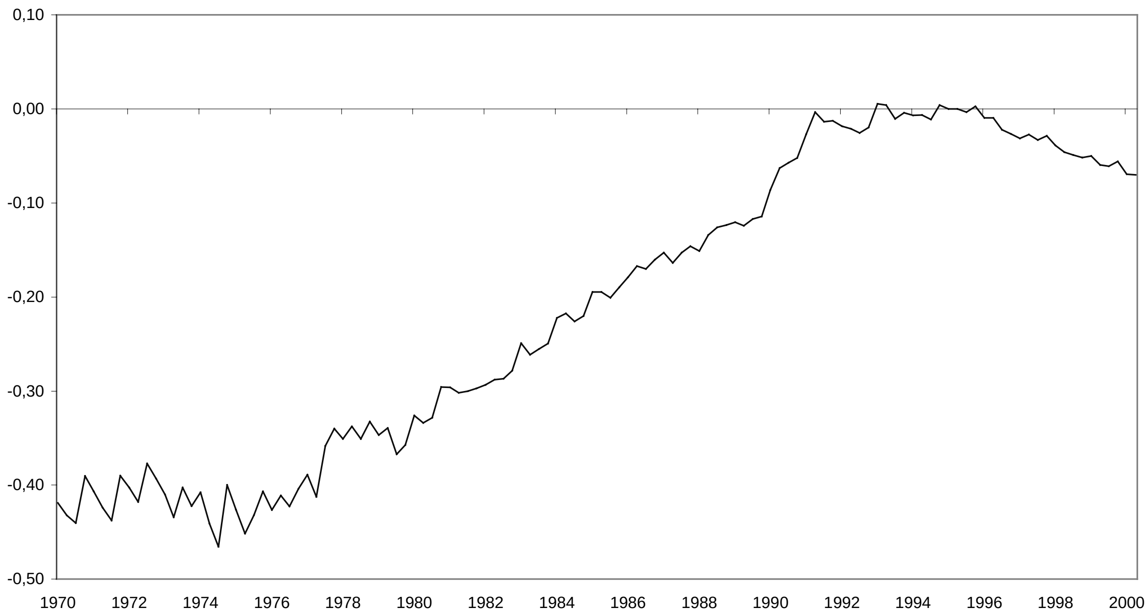
Sources: OECD and the Riksbank

Relative consumer prices

This variable reflects the relation between consumer prices in Sweden and the TCW trading partners. Figure x shows that relative Swedish consumer prices increased between the mid 1970s, and the beginning of the 1990s.

Sources: OECD (Main Economic Indicators, Hanson & Partners).

Consumer prices in Sweden relative to the TCW- trading partners



Sources: OECD, Hanson & partners and the Riksbank

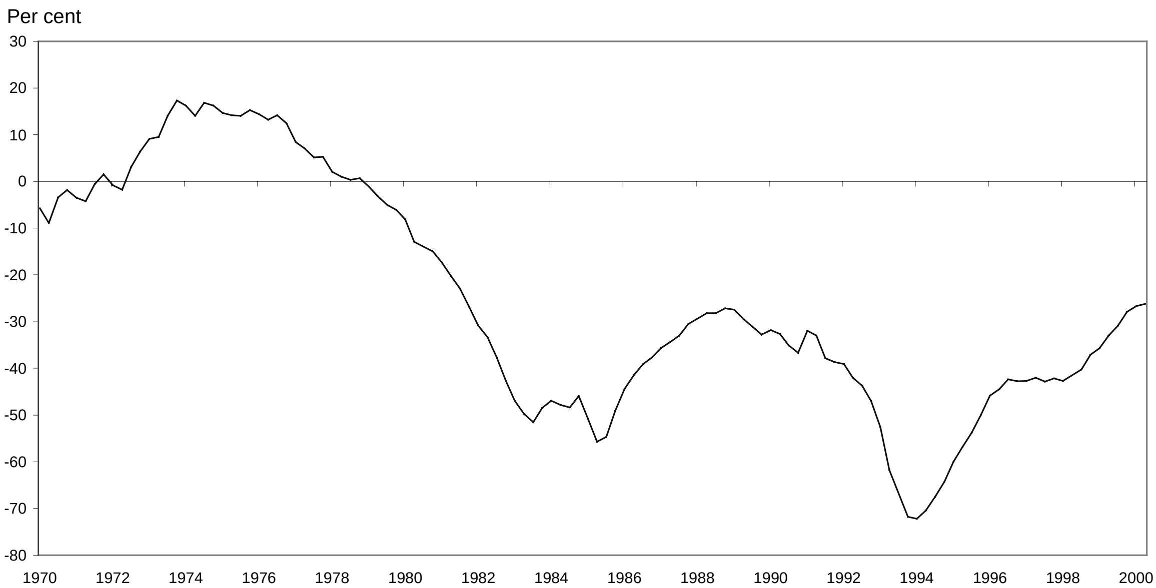
Relative GDP ratio of net foreign assets

This variable reflects the Swedish net foreign asset position relative to the TCW trading partners. Starting in 1970, current account deficits have been accumulated for all countries and calculated as a share of GDP. All variables have been converted to current dollar values.[4] Finally, the difference has been calculated between the GDP ratio of net foreign assets for Sweden and the TCW trading partners.

The Swedish relative GDP ratio of net foreign assets has fallen significantly between the mid-1970s and 1990s, mainly due to downward adjustments of the krona's nominal exchange rate. However, since the mid-1990s the relative Swedish net foreign asset position has improved rapidly.

Sources: IMF, OECD, Hansson & Partners and the Riksbank.

GDP ratio of net foreign assets of Sweden relative to the TCW- trading partners



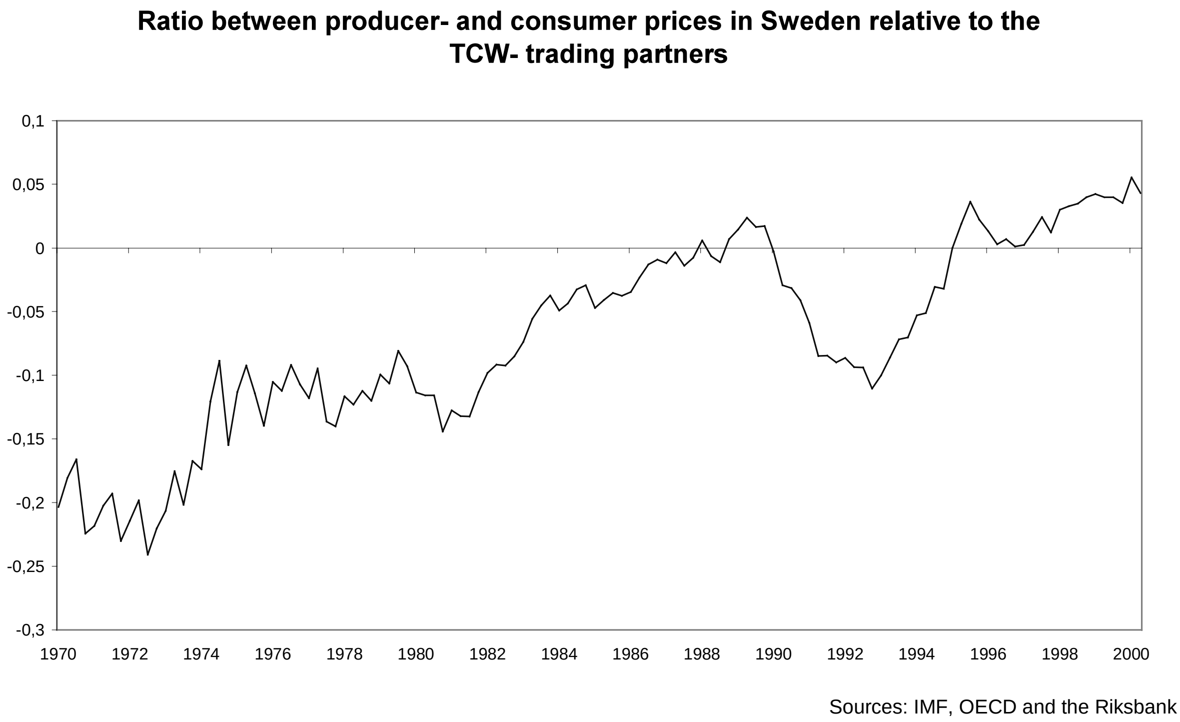
Sources: IMF, OECD, Hanson & Partners and the Riksbank

[4] The conversion of the Swedish GDP and stock of net foreign assets to current dollar values entails the risk of creating spurious correlation with the nominal effective exchange rate of the krona. After trying a couple of different ways of calculation, we decided to apply a 3-quarter moving average for the current dollar exchange rate.

Ratio of producer to consumer prices

This variable reflects the ratio of Swedish producer to consumer prices relative to the TCW area.

Sources: IMF (International Financial Statistics), OECD (Main Economic Indicators) and the Riksbank.

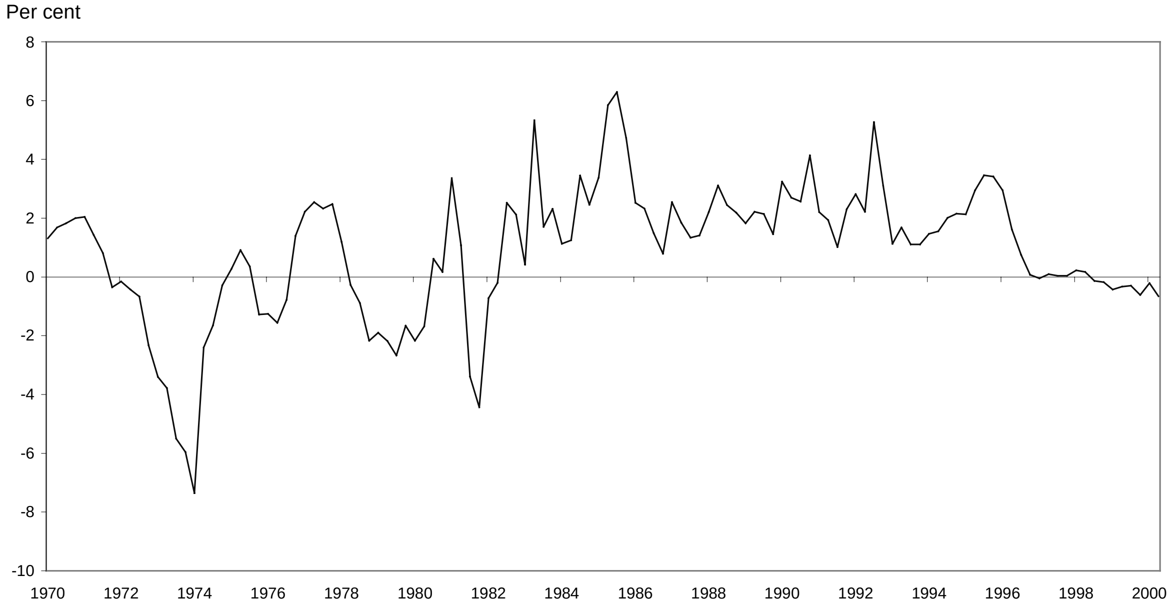


Short-term interest rate spread

This variable reflects the spread between short-term interest rates (time to maturity 3 months) in Sweden relative to the TCW area.

Sources: IMF (International Financial Statistics) and the Riksbank.

Short- term interest rate spread between Sweden and the TCW- trading partners



Sources: IMF and the Riksbank

Long- term interest rate spread

This variable reflects the spread between long- term interest rates (time to maturity 10years) in Sweden relative to the TCW area.

Sources: IMF (International Financial Statistics) and the Riksbank.

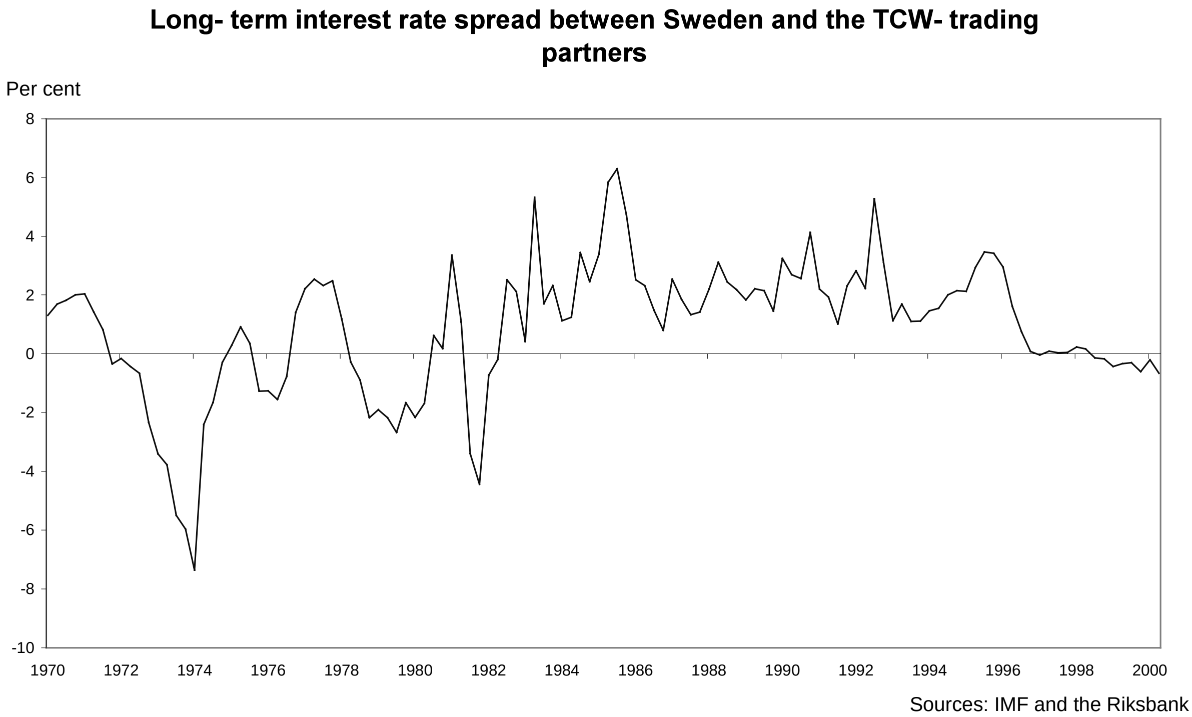


Table 1. Single-equation models

Models 1-5 in level form and models 6-10 in difference form:

1. $s_t = a_0 + a_1(m_t - m_t^*) + a_2(y_t - y_t^*) + a_3(i_t - i_t^*) + u_t$
2. $s_t = a_0 + a_1(m_t - m_t^*) + a_2(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4(\pi_t - \pi_t^*) + u_t$
3. $s_t = a_0 + a_1(m_t - m_t^*) + a_2(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4(\pi_t - \pi_t^*) + a_5(b_t - b_t^*) + u_t$
4. $s_t = a_0 + a_1(m_t - m_t^*) + a_2(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4(\pi_t - \pi_t^*) + a_5(q_t - q_t^*) + u_t$
5. $s_t = a_0 + a_1(m_t - m_t^*) + a_2(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4(\pi_t - \pi_t^*) + a_5(b_t - b_t^*) + a_6(q_t - q_t^*) + u_t$
6. $\Delta s_t = a_0 + a_1\Delta(m_t - m_t^*) + a_2\Delta(y_t - y_t^*) + a_3(i_t - i_t^*) + u_t$
7. $\Delta s_t = a_0 + a_1\Delta(m_t - m_t^*) + a_2\Delta(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4\Delta(\pi_t - \pi_t^*) + u_t$
8. $\Delta s_t = a_0 + a_1\Delta(m_t - m_t^*) + a_2\Delta(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4\Delta(\pi_t - \pi_t^*) + a_5\Delta(b_t - b_t^*) + u_t$
9. $\Delta s_t = a_0 + a_1\Delta(m_t - m_t^*) + a_2\Delta(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4\Delta(\pi_t - \pi_t^*) + a_5\Delta(q_t - q_t^*) + u_t$
10. $\Delta s_t = a_0 + a_1\Delta(m_t - m_t^*) + a_2\Delta(y_t - y_t^*) + a_3(i_t - i_t^*) + a_4\Delta(\pi_t - \pi_t^*) + a_5\Delta(b_t - b_t^*) + a_6\Delta(q_t - q_t^*) + u_t$

Models 11-15 = (Model 1-5) + $a_i s_{t-1}$

Models 16-20 = (Model 6-10) + $a_i \Delta s_{t-1}$

21. $s_t = a_0 + a_1(p_t - p_t^*) + a_2(i_t - i_t^*) + u_t$
22. $s_t = a_0 + a_1(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3(\pi_t - \pi_t^*) + u_t$
23. $s_t = a_0 + a_1(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3(\pi_t - \pi_t^*) + a_4(b_t - b_t^*) + u_t$
24. $s_t = a_0 + a_1(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3(\pi_t - \pi_t^*) + a_4(q_t - q_t^*) + u_t$
25. $s_t = a_0 + a_1(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3(\pi_t - \pi_t^*) + a_4(b_t - b_t^*) + a_5(q_t - q_t^*) + u_t$
26. $\Delta s_t = a_0 + a_1\Delta(p_t - p_t^*) + a_2(i_t - i_t^*) + u_t$
27. $\Delta s_t = a_0 + a_1\Delta(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3\Delta(\pi_t - \pi_t^*) + u_t$
28. $\Delta s_t = a_0 + a_1\Delta(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3\Delta(\pi_t - \pi_t^*) + a_4\Delta(b_t - b_t^*) + u_t$
29. $\Delta s_t = a_0 + a_1\Delta(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3\Delta(\pi_t - \pi_t^*) + a_4\Delta(q_t - q_t^*) + u_t$
30. $\Delta s_t = a_0 + a_1\Delta(p_t - p_t^*) + a_2(i_t - i_t^*) + a_3\Delta(\pi_t - \pi_t^*) + a_4\Delta(b_t - b_t^*) + a_5\Delta(q_t - q_t^*) + u_t$

Table 2. Single equation models evaluated for the period 1980 to 2000

Model 1

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	4,8	9,4	7,3	3,085	4,036	0,444
2	5,4	10,2	8,0	2,177	2,758	0,525
3	5,9	11,0	8,6	1,900	2,281	0,481
4	6,5	11,8	9,3	1,735	2,020	0,500
8	8,9	15,2	11,7	1,550	1,645	0,500
12	10,8	17,7	13,6	1,546	1,462	0,557

Model 2

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	6,6	9,2	7,2	3,045	3,991	0,605
2	7,3	10,1	7,9	2,156	2,750	0,650
3	8,1	10,9	8,6	1,875	2,282	0,608
4	8,8	11,6	9,3	1,705	2,039	0,474
8	11,9	14,7	12,2	1,498	1,712	0,459
12	14,6	17,2	15,0	1,505	1,606	0,400

Model 3

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	3,3	5,7	4,6	1,874	2,570	0,58
2	3,6	6,2	5,1	1,324	1,775	0,60
3	3,9	6,7	5,6	1,146	1,471	0,61
4	4,2	7,1	5,9	1,033	1,294	0,54
8	5,7	8,0	6,8	**0,813**	**0,959**	0,58
12	7,0	8,3	7,4	**0,723**	**0,796**	0,69

Model 4

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	6,0	8,4	6,7	2,762	3,737	0,58
2	6,8	9,4	7,6	2,002	2,626	0,59
3	7,7	10,3	8,4	1,776	2,218	0,59
4	8,6	11,2	9,1	1,643	1,993	0,56
8	12,2	14,8	12,4	1,509	1,744	0,47
12	15,6	18,0	15,6	1,571	1,677	0,37

<u>Model 5</u>

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	3,1	5,0	4,0	1,656	2,242	0,57
2	3,5	5,5	4,5	1,181	1,561	0,61
3	3,9	6,0	4,9	1,029	1,305	0,65
4	4,3	6,4	5,3	**0,933**	1,159	0,60
8	6,2	7,4	6,5	**0,761**	**0,912**	0,61
12	7,9	8,5	7,9	**0,741**	**0,843**	0,59

Model 6

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,0	3,2	1,9	1,037	1,087	0,42
2	0,0	4,9	3,1	1,046	1,090	0,46
3	0,0	6,1	4,1	1,054	1,106	0,53
4	0,1	7,1	4,9	1,044	1,074	0,64
8	0,5	10,1	7,5	1,022	1,038	0,70
12	0,4	11,9	10,0	1,014	1,041	0,76

Model 7

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,2	3,1	1,9	1,030	1,064	0,49
2	0,3	4,9	3,0	1,032	1,056	0,51
3	0,5	6,0	4,1	1,033	1,084	0,51
4	0,7	6,9	4,7	1,009	1,036	0,60
8	1,8	9,7	7,1	**0,982**	**0,974**	0,69
12	2,5	11,3	9,0	**0,965**	**0,938**	0,74

Model 8

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,3	3,0	1,9	**0,999**	1,028	0,52
2	0,7	4,6	3,0	**0,974**	1,026	0,50
3	1,1	5,5	4,1	**0,954**	1,073	0,48
4	1,5	6,3	4,8	**0,920**	1,052	0,56
8	3,6	8,7	6,5	**0,885**	**0,912**	0,68
12	5,2	10,1	8,3	**0,885**	**0,896**	0,67

Model 9

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,1	3,1	1,9	1,032	1,069	0,52
2	0,3	4,9	3,0	1,034	1,060	0,50
3	0,5	6,0	4,1	1,036	1,089	0,48
4	0,7	6,9	4,7	1,013	1,034	0,62
8	1,8	9,7	7,1	**0,986**	**0,974**	0,69
12	2,5	11,4	9,1	**0,970**	**0,948**	0,73

Model 10

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,3	3,0	1,9	1,001	1,038	0,51
2	0,7	4,6	3,0	**0,977**	1,041	0,49
3	1,1	5,6	4,1	**0,960**	1,081	0,48
4	1,6	6,3	4,8	**0,926**	1,057	0,58
8	3,8	8,7	6,6	**0,894**	**0,920**	0,65
12	5,5	10,3	8,5	**0,903**	**0,918**	0,69

Model 11

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,3	3,1	1,9	1,032	1,085	0,47
2	-0,5	5,0	3,3	1,067	1,142	0,49
3	-0,8	6,5	4,5	1,114	1,183	0,49
4	-1,2	8,0	5,8	1,167	1,268	0,56
8	-3,0	14,2	10,3	1,449	1,439	0,64
12	-6,9	22,7	14,3	1,981	1,540	0,76

Model 12

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,3	3,0	1,8	**0,998**	**0,994**	0,62
2	0,7	4,8	3,0	1,021	1,043	0,68
3	1,0	6,2	4,2	1,063	1,098	0,62
4	1,3	7,6	5,4	1,109	1,179	0,58
8	2,3	12,7	10,0	1,296	1,406	0,47
12	1,8	17,9	13,7	1,563	1,475	0,51

Model 13

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,6	2,9	1,9	**0,963**	1,058	0,63
2	1,0	4,5	3,3	**0,958**	1,142	0,63
3	1,4	5,6	4,4	**0,969**	1,165	0,61
4	1,6	6,7	5,3	**0,975**	1,158	0,60
8	2,2	10,4	7,6	1,066	1,071	0,64
12	2,0	12,9	9,5	1,127	1,016	0,66

Model 14

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,4	3,1	1,8	1,008	**0,998**	0,64
2	0,9	4,9	3,1	1,041	1,067	0,66
3	1,4	6,3	4,3	1,092	1,134	0,63
4	1,8	7,8	5,6	1,143	1,219	0,56
8	3,6	13,2	10,6	1,347	1,485	0,41
12	3,9	18,0	14,4	1,574	1,544	0,40

Model 15

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,7	3,0	1,9	**0,973**	1,065	0,64
2	1,2	4,5	3,3	**0,969**	1,152	0,61
3	1,7	5,7	4,5	**0,979**	1,182	0,62
4	2,1	6,7	5,4	**0,981**	1,181	0,60
8	3,2	10,5	8,0	1,077	1,127	0,59
12	3,5	13,1	10,3	1,142	1,110	0,64

Model 16

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,1	3,2	2,0	1,041	1,083	0,51
2	-0,1	5,1	3,3	1,086	1,138	0,43
3	-0,0	6,4	4,4	1,103	1,110	0,47
4	0,0	7,4	5,2	1,085	1,130	0,60
8	0,6	10,7	7,9	1,089	1,101	0,70
12	0,6	12,7	10,1	1,106	1,085	0,74

Model 17

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,1	3,1	2,0	1,026	1,090	0,49
2	0,4	4,9	3,1	1,056	1,086	0,56
3	0,6	6,2	4,3	1,063	1,127	0,56
4	0,9	7,1	5,0	1,038	1,093	0,58
8	2,6	10,4	8,0	1,061	1,114	0,58
12	4,0	12,5	10,4	1,092	1,119	0,49

Model 18

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,3	3,1	2,0	1,016	1,087	0,56
2	0,7	4,8	3,2	1,027	1,095	0,51
3	1,1	5,9	4,4	1,021	1,165	0,48
4	1,7	6,7	5,1	**0,978**	1,115	0,58
8	4,3	9,8	7,5	1,006	1,050	0,68
12	6,5	11,9	9,8	1,043	1,049	0,57

Model 19

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,2	3,1	2,0	1,026	1,093	0,49
2	0,4	5,0	3,1	1,057	1,088	0,54
3	0,7	6,2	4,3	1,065	1,123	0,54
4	1,0	7,1	5,0	1,042	1,082	0,62
8	2,8	10,4	7,9	1,061	1,106	0,59
12	4,3	12,5	10,4	1,094	1,114	0,49

Model 20

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,3	3,1	2,0	1,016	1,095	0,54
2	0,7	4,8	3,2	1,026	1,106	0,58
3	1,3	5,9	4,4	1,024	1,162	0,49
4	1,8	6,7	5,1	**0,984**	1,122	0,54
8	4,7	9,9	7,4	1,014	1,035	0,68
12	7,1	12,2	9,8	1,067	1,055	0,59

Modell 21

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	1.694	9.112	7.813	3.001	4.340	0.59
2	1.666	9.764	8.362	2.084	2.898	0.60
3	1.635	10.416	8.902	1.793	2.355	0.58
4	1.634	11.058	9.463	1.620	2.065	0.56
8	1.586	13.325	11.469	1.362	1.607	0.58
12	1.023	14.908	12.900	1.301	1.385	0.77

Model 22

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	3.277	8.944	7.700	2.946	4.277	0.57
2	3.303	9.640	8.358	2.057	2.896	0.59
3	3.313	10.322	9.011	1.777	2.384	0.57
4	3.352	10.978	9.692	1.608	2.115	0.56
8	3.403	13.239	12.104	1.353	1.696	0.57
12	3.016	14.544	13.527	1.269	1.452	0.80

Model 23

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	4.260	6.894	5.409	2.271	3.004	0.58
2	4.627	7.385	5.917	1.576	2.050	0.64
3	4.988	7.871	6.400	1.355	1.693	0.62
4	5.378	8.345	6.872	1.223	1.500	0.59
8	7.041	9.955	8.595	1.017	1.205	0.62
12	8.541	11.027	9.834	0.962	1.056	0.64

Model 24

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.507	6.738	5.658	2.220	3.142	0.48
2	-0.690	7.429	6.309	1.585	2.186	0.55
3	-0.883	8.098	6.930	1.394	1.833	0.61
4	-1.047	8.715	7.494	1.277	1.636	0.62
8	-1.854	10.826	9.263	1.106	1.298	0.70
12	-3.339	12.532	10.454	1.093	1.122	0.90

Model 25

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	1.186	4.320	3.347	1.423	1.859	0.51
2	1.267	4.729	3.744	1.009	1.298	0.59
3	1.338	5.108	4.116	**0.879**	1.089	0.59
4	1.427	5.401	4.403	**0.791**	**0.961**	0.60
8	1.696	5.830	4.976	**0.596**	**0.697**	0.69
12	1.445	5.854	4.822	**0.511**	**0.518**	0.86

Model 26

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.085	3.052	1.819	**0.998**	1.060	0.43
2	0.203	4.706	2.924	**0.993**	1.076	0.48
3	0.349	5.869	3.855	**0.992**	1.051	0.53
4	0.521	6.906	4.683	**0.987**	1.030	0.64
8	1.331	9.830	7.239	**0.953**	1.002	0.72
12	1.499	11.359	9.442	**0.913**	1.037	0.77

Model 27

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.275	3.026	1.761	**0.990**	1.026	0.54
2	0.562	4.638	2.816	**0.978**	1.037	0.63
3	0.864	5.767	3.782	**0.975**	1.031	0.58
4	1.177	6.730	4.585	**0.962**	1.008	0.60
8	2.769	9.604	6.930	**0.931**	**0.959**	0.70
12	3.850	11.027	8.745	**0.887**	**0.960**	0.74

Model 28

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.455	2.942	1.779	**0.962**	1.037	0.57
2	0.957	4.364	2.756	**0.921**	**1.015**	0.55
3	1.492	5.329	3.691	**0.901**	1.007	0.47
4	2.058	6.123	4.471	**0.876**	**0.983**	0.47
8	4.682	8.886	6.502	**0.862**	**0.900**	0.64
12	6.651	10.425	8.239	**0.838**	**0.905**	0.71

Model 29

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.177	2.967	1.831	**0.970**	1.067	0.59
2	0.373	4.353	2.922	**0.918**	1.076	0.61
3	0.578	5.409	3.982	**0.915**	1.086	0.59
4	0.795	6.357	4.816	**0.909**	1.059	0.62
8	2.014	9.590	7.211	**0.930**	**0.998**	0.66
12	2.813	11.086	8.610	**0.891**	**0.946**	0.64

Model 30

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.360	2.888	1.850	**0.944**	1.078	0.58
2	0.762	4.069	2.720	**0.858**	1.001	0.59
3	1.189	4.924	3.570	**0.833**	**0.974**	0.58
4	1.637	5.655	4.396	**0.809**	**0.967**	0.55
8	3.753	8.561	6.788	**0.830**	**0.940**	0.57
12	5.249	9.885	7.985	**0.795**	**0.877**	0.66

Table 3. Single-equation models evaluated for the period 1993-2000

Model 1

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	5,5	7,3	6,0	2,724	2,744	0,48
2	5,6	7,7	6,1	1,929	2,114	0,57
3	5,6	7,6	6,1	1,673	1,722	0,59
4	5,5	7,5	5,9	1,445	1,439	0,58
8	5,0	6,8	5,2	1,066	**0,937**	0,59
12	5,0	5,8	5,1	**0,861**	**0,842**	0,72

Model 2

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	7,8	9,0	7,9	3,348	3,630	0,55
2	8,1	9,5	8,2	2,386	2,828	0,57
3	8,1	9,4	8,2	2,083	2,344	0,56
4	8,2	9,4	8,3	1,817	2,002	0,42
8	8,6	9,7	8,6	1,535	1,557	0,41
12	9,5	10,2	9,5	1,515	1,582	0,67

Model 3

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	6,3	7,0	6,3	2,600	2,910	0,52
2	6,7	7,4	6,7	1,869	2,323	0,57
3	7,1	7,8	7,1	1,715	2,023	0,59
4	7,5	8,2	7,5	1,572	1,815	0,46
8	9,1	9,6	9,1	1,519	1,643	0,41
12	10,1	10,6	10,1	1,583	1,679	0,67

Model 4

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	5,1	7,7	5,9	2,864	2,717	0,48
2	5,1	7,9	6,0	1,999	2,061	0,50
3	4,9	7,6	5,8	1,678	1,652	0,59
4	4,7	7,3	5,6	1,398	1,358	0,62
8	4,1	6,3	4,9	**0,990**	**0,880**	0,59
12	4,1	5,1	4,1	**0,761**	**0,690**	0,78

Model 5

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	4,9	5,7	5,0	2,106	2,305	0,52
2	5,3	6,0	5,3	1,513	1,832	0,54
3	5,5	6,3	5,6	1,381	1,588	0,63
4	5,8	6,5	5,9	1,260	1,417	0,54
8	7,0	7,6	7,0	1,206	1,272	0,55
12	7,8	8,3	7,8	1,238	1,299	0,67

Model 6

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,7	3,0	2,5	1,098	1,143	0,45
2	-1,5	4,6	3,5	1,150	1,192	0,46
3	-2,3	5,7	4,3	1,241	1,209	0,44
4	-3,1	6,9	5,0	1,319	1,197	0,58
8	-6,1	9,7	7,5	1,503	1,319	0,59
12	-10,4	13,4	11,0	1,936	1,740	0,33

Model 7

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,6	2,8	2,3	1,014	1,055	0,55
2	-1,3	4,3	3,4	1,073	1,146	0,46
3	-2,1	5,4	4,3	1,170	1,197	0,48
4	-2,8	6,4	4,8	1,223	1,166	0,62
8	-5,1	8,7	6,9	1,347	1,222	0,59
12	-8,6	11,9	9,8	1,719	1,552	0,33

Model 8

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,2	2,6	2,1	**0,967**	**0,966**	0,66
2	-0,3	3,8	3,0	**0,969**	1,022	0,50
3	-0,5	4,6	3,9	1,020	1,100	0,44
4	-0,7	5,4	4,4	1,031	1,058	0,69
8	-0,6	5,1	4,2	**0,813**	**0,769**	0,82
12	-2,3	7,1	6,1	1,053	1,022	0,56

Model 9

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,5	2,8	2,3	1,017	1,059	0,55
2	-1,3	4,3	3,4	1,077	1,148	0,46
3	-2,0	5,4	4,3	1,172	1,205	0,44
4	-2,7	6,4	4,8	1,223	1,162	0,65
8	-5,0	8,6	6,9	1,335	1,214	0,59
12	-8,5	11,7	9,7	1,702	1,537	0,33

Model 10

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,2	2,6	2,1	**0,987**	**0,978**	0,62
2	-0,2	3,9	3,0	**0,984**	1,042	0,50
3	-0,4	4,7	3,9	1,040	1,113	0,48
4	-0,6	5,4	4,4	1,047	1,068	0,65
8	-0,2	5,0	4,1	**0,789**	**0,742**	0,77
12	-1,8	6,6	5,8	**0,989**	**0,963**	0,67

Model 11

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,9	2,8	2,3	1,046	1,065	0,48
2	-1,7	4,2	3,2	1,058	1,101	0,46
3	-2,6	5,1	3,7	1,119	1,046	0,48
4	-3,7	6,2	4,6	1,194	1,117	0,58
8	-7,1	9,5	7,5	1,506	1,352	0,59
12	-11,7	14,2	11,7	2,123	1,954	0,33

Model 12

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,1	2,7	2,1	**0,996**	**0,979**	0,59
2	-0,1	4,0	3,0	**0,996**	1,041	0,64
3	-0,2	4,7	3,5	1,032	**0,995**	0,63
4	-0,4	5,6	4,2	1,074	1,020	0,65
8	-0,8	8,2	7,4	1,304	1,336	0,27
12	-2,5	10,1	9,5	1,508	1,578	0,17

Model 13

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	1,0	2,7	2,1	**0,986**	**0,964**	0,66
2	1,8	3,8	3,2	**0,958**	1,096	0,61
3	2,4	4,4	3,7	**0,969**	1,066	0,56
4	2,9	5,0	4,2	**0,967**	1,019	0,58
8	4,9	6,7	5,5	1,061	1,005	0,50
12	5,8	7,9	6,7	1,181	1,107	0,67

Model 14

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0,1	2,7	2,1	1,006	**0,969**	0,66
2	0,2	4,0	3,1	1,018	1,070	0,61
3	0,2	4,9	3,8	1,076	1,072	0,67
4	0,2	5,9	4,6	1,142	1,117	0,58
8	0,6	9,2	8,4	1,463	1,517	0,32
12	-0,4	11,6	10,6	1,725	1,767	0,22

Model 15

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	1,0	2,7	2,1	**0,986**	**0,969**	0,66
2	1,8	3,8	3,2	**0,960**	1,094	0,61
3	2,5	4,4	3,8	**0,973**	1,071	0,56
4	3,0	5,1	4,3	**0,977**	1,035	0,54
8	5,1	7,0	5,7	1,099	1,039	0,50
12	6,3	8,4	7,1	1,259	1,184	0,67

Model 16

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,7	3,0	2,4	1,106	1,111	0,55
2	-1,3	4,5	3,5	1,144	1,198	0,43
3	-2,1	5,5	4,1	1,213	1,177	0,44
4	-3,1	6,8	5,1	1,312	1,242	0,58
8	-6,0	9,4	7,3	1,488	1,327	0,59
12	-10,7	13,7	11,5	2,042	1,912	0,33

Model 17

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,5	2,7	2,2	1,011	1,021	0,59
2	-1,1	4,2	3,3	1,050	1,121	0,54
3	-1,8	5,1	4,1	1,130	1,167	0,48
4	-2,6	6,2	4,8	1,197	1,157	0,58
8	-4,5	8,2	6,6	1,291	1,189	0,55
12	-8,0	11,8	10,2	1,758	1,694	0,33

Model 18

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,3	2,7	2,2	1,010	1,028	0,69
2	-0,4	3,9	3,1	**0,987**	1,062	0,54
3	-0,7	4,7	4,0	1,025	1,135	0,48
4	-0,9	5,5	4,5	1,064	1,099	0,69
8	-0,7	5,2	4,4	**0,827**	**0,805**	0,91
12	-2,4	7,6	6,4	1,126	1,064	0,50

Model 19

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,5	2,7	2,2	1,018	1,033	0,62
2	-1,0	4,2	3,3	1,060	1,129	0,54
3	-1,7	5,1	4,2	1,141	1,194	0,44
4	-2,4	6,2	4,7	1,198	1,147	0,62
8	-4,2	7,9	6,4	1,251	1,166	0,55
12	-7,7	11,3	9,8	1,691	1,634	0,33

Model 20

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0,3	2,8	2,3	1,023	1,041	0,62
2	-0,3	4,0	3,2	1,006	1,090	0,57
3	-0,5	4,8	4,1	1,051	1,156	0,48
4	-0,7	5,6	4,7	1,083	1,130	0,65
8	-0,2	5,0	4,2	**0,786**	**0,754**	0,91
12	-1,6	6,9	5,9	1,036	**0,979**	0,44

Modell 21

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	7.602	8.734	7.794	3.242	3.592	0.52
2	7.946	9.120	8.123	2.298	2.802	0.54
3	8.056	9.251	8.209	2.040	2.335	0.52
4	8.126	9.326	8.252	1.797	1.997	0.42
8	8.738	9.981	8.749	1.575	1.584	0.41
12	9.515	10.431	9.515	1.556	1.584	0.67

Model 22

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	9.663	10.638	9.663	3.949	4.454	0.52
2	10.057	11.114	10.057	2.800	3.469	0.54
3	10.188	11.239	10.188	2.478	2.898	0.52
4	10.275	11.282	10.275	2.174	2.486	0.42
8	11.240	12.238	11.240	1.931	2.036	0.41
12	12.777	13.492	12.777	2.012	2.127	0.67

Model 23

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	8.562	9.726	8.562	3.611	3.946	0.52
2	9.091	10.226	9.091	2.576	3.136	0.54
3	9.491	10.638	9.491	2.345	2.699	0.52
4	9.916	11.064	9.916	2.132	2.399	0.42
8	11.986	12.968	11.986	2.046	2.171	0.41
12	13.442	14.437	13.442	2.153	2.238	0.67

Model 24

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	4.521	6.973	5.585	2.588	2.574	0.41
2	4.533	7.136	5.678	1.798	1.959	0.50
3	4.344	6.853	5.537	1.511	1.575	0.63
4	4.086	6.365	5.289	1.226	1.280	0.54
8	3.551	5.392	4.394	**0.851**	**0.796**	0.59
12	3.760	4.595	3.760	**0.685**	**0.626**	0.83

Model 25

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	4.468	5.390	4.644	2.001	2.140	0.48
2	4.732	5.706	4.913	1.438	1.695	0.57
3	4.899	5.873	5.081	1.295	1.445	0.63
4	5.066	6.047	5.215	1.165	1.262	0.54
8	6.020	7.102	6.020	1.121	1.090	0.50
12	6.622	7.611	6.622	1.135	1.102	0.67

Model 26

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.434	2.768	2.242	1.028	1.033	0.48
2	-0.824	4.070	3.134	1.025	1.081	0.46
3	-1.372	4.743	3.674	1.046	1.045	0.48
4	-1.991	5.569	4.076	1.073	**0.986**	0.58
8	-3.908	7.506	5.672	1.184	1.027	0.59
12	-7.104	9.824	8.331	1.465	1.387	0.33

Model 27

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.287	2.528	2.027	**0.939**	**0.935**	0.66
2	-0.556	3.740	2.897	**0.942**	**0.999**	0.64
3	-1.001	4.376	3.575	**0.965**	1.017	0.59
4	-1.511	5.007	3.979	**0.965**	**0.963**	0.65
8	-2.746	6.510	5.136	1.027	**0.930**	0.59
12	-5.061	8.300	7.340	1.238	1.222	0.33

Model 28

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.074	2.472	2.055	**0.918**	**0.947**	0.69
2	0.281	3.342	2.581	**0.842**	**0.890**	0.61
3	0.389	3.760	3.072	**0.829**	**0.874**	0.44
4	0.501	4.275	3.452	**0.824**	**0.835**	0.50
8	1.844	4.270	3.618	**0.674**	**0.655**	0.64
12	1.780	5.526	4.430	**0.824**	**0.737**	0.67

Model 29

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.180	2.548	2.005	**0.946**	**0.924**	0.66
2	-0.337	3.620	2.845	**0.912**	**0.981**	0.68
3	-0.668	4.178	3.542	**0.921**	1.007	0.59
4	-1.058	4.994	4.221	**0.962**	1.021	0.65
8	-1.732	7.571	6.040	1.195	1.094	0.68
12	-2.394	9.114	7.764	1.359	1.292	0.33

Model 30

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.166	2.524	2.106	**0.937**	**0.971**	0.69
2	0.467	3.240	2.449	**0.816**	**0.845**	0.71
3	0.665	3.566	2.777	**0.786**	**0.790**	0.63
4	0.868	4.272	3.555	**0.823**	**0.860**	0.62
8	2.576	6.115	5.394	**0.965**	**0.977**	0.50
12	3.900	8.413	6.925	1.255	1.153	0.56

Table 4. VAR(4) evaluated for the period 1980-2000

Model 1

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.026	3.587	2.524	1.182	1.402	0.46
2	0.022	5.749	4.013	1.227	1.391	0.50
3	0.052	7.442	5.173	1.281	1.369	0.48
4	0.006	9.621	6.482	1.410	1.415	0.54
8	-1.167	23.214	2.421	2.372	1.741	0.54
12	-5.947	55.534	21.290	4.846	2.286	0.49

Model 2

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.061	3.824	2.741	1.260	1.522	0.52
2	0.088	5.902	4.117	1.260	1.427	0.48
3	0.195	7.723	5.338	1.329	1.412	0.43
4	0.491	10.191	6.712	1.493	1.465	0.49
8	-0.264	23.433	13.716	2.395	1.922	0.53
12	-5.774	52.263	21.756	4.560	2.336	0.49

Model 3

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.217	3.767	2.703	1.241	1.501	0.56
2	0.468	5.684	4.121	1.213	1.428	0.55
3	0.664	6.860	5.223	1.181	1.382	0.57
4	1.418	8.132	6.306	1.191	1.376	0.59
8	1.397	13.720	11.045	1.402	1.548	0.61
12	0.699	22.814	17.984	1.991	1.931	0.49

Model 4

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.110	4.021	2.890	1.325	1.605	0.47
2	-0.030	6.237	4.397	1.331	1.523	0.48
3	0.061	8.355	5.646	1.438	1.494	0.43
4	0.617	11.085	7.205	1.624	1.572	0.49
8	0.838	25.935	15.165	2.650	2.125	0.45
12	-4.109	58.303	24.779	5.087	2.660	0.46

Model 5

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.240	3.992	2.839	1.315	1.577	0.54
2	0.369	5.841	4.214	1.247	1.460	0.51
3	0.414	6.935	5.148	1.194	1.362	0.59
4	1.193	7.873	5.926	1.153	1.293	0.59
8	2.049	12.323	9.167	1.259	1.285	0.69
12	2.979	22.122	16.402	1.930	1.761	0.47

Model 6

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.026	3.731	2.584	1.229	1.435	0.47
2	0.032	5.715	3.776	1.220	1.308	0.49
3	0.062	7.013	4.795	1.207	1.269	0.54
4	0.386	8.241	5.652	1.207	1.234	0.60
8	1.253	11.611	8.398	1.187	1.177	0.59
12	1.340	13.104	10.227	1.143	1.098	0.67

Model 7

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.054	3.835	2.806	1.263	1.558	0.49
2	0.210	5.767	3.872	1.231	1.342	0.45
3	0.351	6.932	4.843	1.193	1.281	0.48
4	0.840	8.064	5.668	1.182	1.237	0.55
8	1.999	11.046	8.265	1.129	1.158	0.58
12	2.191	12.613	10.031	1.101	1.077	0.66

Model 8

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.124	3.910	2.895	1.288	1.608	0.46
2	0.339	5.922	4.025	1.264	1.395	0.49
3	0.507	7.187	4.980	1.237	1.318	0.52
4	1.017	8.064	5.792	1.181	1.264	0.55
8	1.631	11.096	8.238	1.134	1.154	0.70
12	0.728	13.829	10.091	1.207	1.083	0.69

Model 9

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.041	3.975	2.939	1.309	1.632	0.52
2	0.245	5.999	4.069	1.280	1.410	0.48
3	0.454	7.478	5.300	1.287	1.402	0.51
4	0.975	8.825	6.220	1.293	1.357	0.59
8	1.542	13.437	9.748	1.373	1.366	0.54
12	1.335	16.766	12.445	1.463	1.336	0.63

Model 10

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.119	4.030	3.035	1.328	1.686	0.48
2	0.308	6.061	4.185	1.293	1.450	0.48
3	0.390	7.527	5.240	1.296	1.386	0.53
4	0.882	8.576	6.170	1.257	1.347	0.55
8	0.965	13.625	9.741	1.392	1.365	0.62
12	0.737	19.985	13.416	1.744	1.440	0.59

Model 11

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.087	3.485	2.422	1.148	1.345	0.56
2	-0.152	5.465	3.821	1.166	1.324	0.51
3	-0.268	7.032	5.131	1.210	1.358	0.52
4	-0.357	8.789	6.500	1.288	1.419	0.55
8	-1.397	16.258	11.562	1.661	1.620	0.59
12	-4.301	26.170	16.311	2.284	1.751	0.63

Model 12

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.168	3.693	2.596	1.217	1.442	0.59
2	0.346	5.969	4.143	1.274	1.436	0.55
3	0.437	7.644	5.505	1.316	1.456	0.54
4	0.521	9.393	6.944	1.376	1.515	0.51
8	0.675	16.193	12.643	1.655	1.772	0.39
12	-0.168	22.136	17.290	1.932	1.856	0.47

Model 13

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.851	3.635	2.629	1.198	1.460	0.58
2	1.858	5.697	4.348	1.216	1.507	0.59
3	2.896	7.117	5.521	1.225	1.461	0.57
4	3.977	8.482	6.728	1.243	1.468	0.53
8	7.013	14.967	13.025	1.530	1.825	0.36
12	8.413	23.288	19.477	2.032	2.091	0.36

Model 14

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.349	3.884	2.795	1.279	1.552	0.54
2	-0.868	6.113	4.502	1.304	1.560	0.56
3	-1.411	7.691	5.955	1.324	1.576	0.52
4	-1.904	9.416	7.301	1.380	1.593	0.64
8	-3.450	17.778	14.716	1.817	2.062	0.54
12	-6.939	23.544	20.139	2.054	2.162	0.61

Model 15

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.507	3.962	2.782	1.305	1.545	0.64
2	0.823	6.020	4.414	1.285	1.530	0.59
3	1.089	7.203	5.521	1.240	1.461	0.62
4	1.530	7.414	5.644	1.086	1.232	0.68
8	1.831	12.997	10.473	1.328	1.468	0.62
12	-0.139	20.997	16.421	1.832	1.763	0.60

Model 16

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.221	3.602	2.337	1.186	1.298	0.48
2	-0.374	5.559	3.614	1.186	1.252	0.53
3	-0.437	6.874	4.653	1.183	1.231	0.51
4	-0.272	8.239	5.701	1.207	1.244	0.62
8	0.586	11.953	8.668	1.222	1.215	0.65
12	0.791	14.033	10.821	1.225	1.162	0.73

Model 17

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.110	3.739	2.609	1.232	1.449	0.49
2	-0.177	5.818	3.941	1.242	1.366	0.54
3	-0.239	7.128	4.862	1.227	1.286	0.51
4	0.026	8.306	5.767	1.217	1.259	0.58
8	0.834	11.872	8.830	1.213	1.237	0.62
12	1.236	14.062	11.043	1.227	1.186	0.74

Model 18

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.113	3.702	2.687	1.219	1.492	0.44
2	-0.216	5.787	3.846	1.235	1.333	0.55
3	-0.328	7.134	4.832	1.228	1.278	0.56
4	-0.134	8.192	5.743	1.200	1.253	0.59
8	-0.075	12.263	8.827	1.253	1.237	0.61
12	-0.244	15.329	11.217	1.338	1.204	0.67

Model 19

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.154	3.929	2.863	1.294	1.590	0.51
2	-0.243	6.003	4.255	1.281	1.474	0.50
3	-0.349	7.259	5.125	1.249	1.356	0.54
4	-0.165	8.589	6.011	1.258	1.312	0.60
8	0.662	13.327	9.618	1.362	1.348	0.57
12	0.909	16.338	11.961	1.426	1.284	0.63

Model 20

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.105	3.968	2.896	1.307	1.608	0.46
2	-0.158	6.067	4.206	1.295	1.457	0.48
3	-0.242	7.343	5.188	1.264	1.373	0.53
4	-0.115	8.429	6.033	1.235	1.317	0.62
8	0.224	13.767	9.807	1.407	1.374	0.59
12	0.106	17.821	12.896	1.555	1.384	0.63

Table 5. VAR(4) evaluated for the period 1993-2000

Model 1

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.490	3.149	2.538	1.169	1.170	0.52
2	-0.902	4.315	3.237	1.087	1.117	0.57
3	-1.533	4.912	3.529	1.083	1.004	0.59
4	-2.542	6.094	4.259	1.174	1.030	0.65
8	-6.988	9.832	7.365	1.552	1.334	0.59
12	-11.501	14.140	11.595	2.109	1.930	0.33

Model 2

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.320	3.296	2.669	1.224	1.230	0.55
2	-0.665	4.542	3.339	1.144	1.152	0.54
3	-1.420	5.047	3.779	1.113	1.075	0.56
4	-2.708	6.353	4.422	1.224	1.070	0.69
8	-8.535	11.562	8.846	1.824	1.602	0.59
12	-14.577	17.573	14.577	2.621	2.427	0.33

Model 3

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.644	3.174	2.586	1.178	1.192	0.55
2	1.307	4.359	3.562	1.098	1.229	0.54
3	1.645	4.688	4.053	1.034	1.153	0.63
4	1.621	5.256	4.440	1.013	1.074	0.54
8	-1.411	10.240	7.878	1.616	1.427	0.55
12	-7.072	17.461	13.475	2.604	2.243	0.33

Model 4

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.385	3.435	2.743	1.275	1.265	0.52
2	-0.822	4.766	3.553	1.201	1.226	0.54
3	-1.718	5.314	3.883	1.172	1.104	0.52
4	-3.187	6.566	4.703	1.265	1.138	0.69
8	-9.636	11.628	9.693	1.835	1.755	0.59
12	-15.703	17.862	15.703	2.664	2.614	0.33

Model 5

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.422	3.261	2.654	1.211	1.224	0.59
2	0.786	4.328	3.468	1.090	1.196	0.57
3	0.805	4.476	3.587	0.987	1.020	0.70
4	0.476	4.804	3.895	0.926	0.942	0.65
8	-3.239	8.842	5.951	1.395	1.078	0.73
12	-9.951	15.885	10.316	2.369	1.717	0.50

Model 6

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.198	3.279	2.778	1.217	1.280	0.45
2	-0.368	4.512	3.237	1.137	1.117	0.54
3	-0.740	4.834	3.601	1.066	1.024	0.56
4	-1.364	5.865	4.251	1.130	1.029	0.62
8	-3.776	7.746	5.773	1.222	1.045	0.59
12	-7.394	9.919	8.209	1.479	1.367	0.33

Model 7

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.111	3.410	2.864	1.266	1.320	0.45
2	-0.210	4.650	3.407	1.172	1.175	0.36
3	-0.513	4.824	3.671	1.064	1.044	0.48
4	-1.127	5.883	4.340	1.134	1.050	0.65
8	-3.598	7.891	5.879	1.245	1.065	0.59
12	-7.301	10.393	8.717	1.550	1.451	0.33

Model 8

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.163	3.362	2.839	1.248	1.309	0.38
2	0.305	4.501	3.375	1.134	1.164	0.46
3	0.267	4.511	3.340	**0.994**	**0.950**	0.59
4	-0.072	5.039	3.492	**0.971**	**0.845**	0.65
8	-2.511	6.782	4.881	1.070	**0.884**	0.73
12	-6.046	9.805	7.650	1.462	1.274	0.44

Model 9

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.235	3.469	2.864	1.288	1.320	0.48
2	-0.474	4.827	3.506	1.216	1.209	0.43
3	-0.872	5.228	3.854	1.153	1.096	0.44
4	-1.609	6.425	4.604	1.238	1.114	0.58
8	-4.761	9.270	6.863	1.463	1.243	0.59
12	-8.952	12.609	10.397	1.881	1.731	0.33

Model 10

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.025	3.422	2.866	1.270	1.321	0.45
2	-0.049	4.735	3.574	1.193	1.233	0.43
3	-0.304	5.150	3.761	1.135	1.070	0.59
4	-0.886	5.994	4.224	1.155	1.022	0.65
8	-4.330	8.629	6.484	1.362	1.174	0.68
12	-8.391	12.518	9.914	1.867	1.650	0.39

Model 11

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.074	3.181	2.562	1.181	1.181	0.55
2	0.339	4.600	3.416	1.159	1.178	0.46
3	0.365	5.195	3.927	1.145	1.117	0.41
4	-0.180	6.226	4.982	1.200	1.205	0.38
8	-3.560	8.946	7.369	1.412	1.334	0.50
12	-8.870	13.020	10.712	1.942	1.783	0.33

Model 12

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	0.173	3.335	2.710	1.238	1.249	0.52
2	0.484	4.888	3.601	1.231	1.242	0.39
3	0.403	5.368	4.101	1.183	1.166	0.41
4	-0.273	6.402	5.186	1.234	1.255	0.35
8	-3.653	9.681	7.736	1.528	1.401	0.41
12	-8.784	13.590	11.192	2.027	1.863	0.33

Model 13

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	1.341	3.460	2.820	1.284	1.300	0.52
2	2.893	5.386	4.676	1.357	1.613	0.46
3	3.881	6.339	5.676	1.398	1.614	0.56
4	4.244	7.385	6.362	1.423	1.539	0.46
8	3.525	11.768	10.567	1.857	1.914	0.36
12	-0.738	18.073	15.617	2.695	2.600	0.28

Model 14

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.219	3.505	2.904	1.301	1.339	0.38
2	-0.329	5.065	3.876	1.276	1.337	0.43
3	-0.750	5.417	4.349	1.194	1.237	0.33
4	-1.729	6.409	5.162	1.235	1.249	0.46
8	-5.460	8.883	6.733	1.402	1.219	0.64
12	-10.183	12.845	10.334	1.916	1.720	0.33

Model 15

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	1.136	3.373	2.831	1.252	1.305	0.59
2	2.514	4.926	4.188	1.241	1.445	0.46
3	3.462	5.530	4.892	1.219	1.391	0.52
4	3.868	5.901	5.028	1.137	1.217	0.50
8	2.876	6.275	5.760	0.990	1.043	0.45
12	-1.589	10.322	7.885	1.539	1.313	0.44

Model 16

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.835	3.318	2.634	1.232	1.214	0.41
2	-1.629	5.002	3.785	1.260	1.306	0.50
3	-2.324	5.745	4.355	1.267	1.239	0.41
4	-3.191	6.880	5.218	1.326	1.262	0.58
8	-5.587	9.602	7.520	1.515	1.362	0.59
12	-9.502	12.971	10.930	1.934	1.820	0.33

Model 17

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.726	3.466	2.799	1.287	1.290	0.41
2	-1.445	5.222	4.083	1.316	1.408	0.43
3	-2.185	5.886	4.598	1.298	1.308	0.37
4	-3.077	7.016	5.337	1.352	1.291	0.50
8	-5.684	9.832	7.635	1.552	1.383	0.59
12	-9.560	13.584	11.453	2.026	1.907	0.33

Model 18

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.411	3.212	2.720	1.192	1.254	0.38
2	-1.007	4.602	3.217	1.159	1.110	0.54
3	-1.798	5.113	3.694	1.127	1.051	0.63
4	-2.740	6.162	4.570	1.187	1.106	0.69
8	-6.071	9.342	6.865	1.474	1.243	0.64
12	-10.285	14.441	11.181	2.154	1.861	0.33

Model 19

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.915	3.562	2.941	1.322	1.356	0.41
2	-1.822	5.078	4.186	1.279	1.444	0.36
3	-2.696	5.382	4.322	1.187	1.229	0.52
4	-3.538	6.335	4.948	1.221	1.197	0.65
8	-6.039	8.793	6.844	1.388	1.239	0.59
12	-9.624	12.291	10.175	1.833	1.694	0.33

Model 20

FH	ME	RMSE	MAE	Ratio 1	Ratio 2	Direction
1	-0.591	3.371	2.903	1.251	1.338	0.34
2	-1.371	4.628	3.480	1.166	1.201	0.36
3	-2.304	4.817	3.664	1.062	1.042	0.59
4	-3.226	5.693	4.508	1.097	1.091	0.69
8	-6.626	8.693	6.626	1.372	1.200	0.68
12	-10.703	13.560	11.257	2.022	1.874	0.39