Imperfect Common Knowledge and Learning in the Swedish Kronor Market

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November 2006

Abstract

We use both macroeconomic and microeconomic information to test for heterogeneous information and the presence of learning on Swedish Kronor currency market. We further test whether our findings improve in-sample fit and out-of-sample prediction of the Swedish Kronor exchange rates at daily and monthly frequencies. We consider both public and private information in our analysis and find that public information explains more of the exchange rate movement in and out of sample than does private information. Moreover, we find positive autocorrelation in exchange rate changes at monthly frequency. We take this as evidence of homogeneous learning rather than heterogeneous information. We also find that macroeconomic information is only weakly correlated with future exchange rate changes. Including macroeconomic variables worsens the out-of-sample predictions, while including microeconomic information slightly improves the forecast, especially at monthly frequencies.

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1 Introduction

Traditionally, exchange rates could be predicted using macroeconomic fundamentals only at long run (3 years or more) frequencies and even then not terribly well. At shorter horizons, however, they have exhibited a complete "disconnect" from fundamentals. In particular, Meese and Rogoff (1983) initiated a large literature showing that across currency pairs and time periods, the random walk model of the exchange rate can better predict exchange rate movements out of sample. The Swedish kronor is no different in this respect from most currencies.

In the case of the Swedish Kronor, in recent years, exchange rate movements were the opposite of what theory would predict. For example, there has been a large depreciation against the US dollar while at the same time, Sweden has been running large current account surpluses and the US large current account deficits.

Recently, studies using micro-based data has been able to predict exchange rate movements at very short horizons. Evans and Lyons (2005) have been able to improve upon the random walk prediction by almost 20% at 20-day frequencies for the Euro/Dollar exchange rate. Following Engel and West (2004), they interpret their findings as suggesting that with fundamentals which are integrated of order one and discount factors close to one, publicly announced macroeconomic information gets incorporated into exchange rates immediately and permanently. In other words, exchange rates follow martingales and future exchange rate changes are not predictable from current macroeconomic variables. However, this does not exclude the possibility that private information gets incorporated into exchange rates slowly and therefore current non-publicly available information has predictive power for future exchange rate movements.

In this paper, we look at a range of micro-based predictors of exchange rates: prior prices, large versus small price movements, and measures using order flow. We analyze both in sample fit and out of sample predictions at daily and monthly frequencies. At a daily level, we also analyze the effects of the repo rate announcements by the Riksbank. At the monthly level, we also integrate macroeconomic information such as money supply growth, inflation, fiscal deficits, and the trade balance. Different from prior results (Evans and Lyons (2002) and Evans and Lyons (2005)), our results are relatively weak. While in sample and at the daily level, customer initiated and domestic

order flow are strongly correlated with future exchange rate movements, they are not at all useful in terms of out of sample prediction. Additionally, announcements of interest rate changes seem to only weakly be correlated with future exchange rate movements. These results are consistent with work by Faust et. al. (2003) as well as Dominguez (2003a, b) and Andersen (2003) who find that exchange rate movements from announcements happen very rapidly.

At the monthly level, we look at order flow, interest rates, and macroeconomic determinants of exchange rate movements. We conduct our analysis using OLS as well as vector autoregressions, following Eichenbaum and Evans (1995). Different from the daily level, transactions data here are not useful for either in-sample or out-of-sample prediction. Moreover, the only macroeconomic variables which are correlated with future exchange rate movements are the interest rate and the inflation rate (and only in the Kronor/Dollar market for the inflation rate). We do, however, find that lagged changes in the exchange rate do predict future exchange rate movements quite strongly both in and out of sample. In our best OLS specification, we reduce forecasting error by up to 7.5% relative to a detrended martingale. However, once we recognize that the exchange rate is integrated of order one and autoregressive in first differences, nothing else seems to improve out of sample forecasting ability. Unfortunately, this out-of-sample predictability (though not the in-sample correlation) seems to only work in the Euro market not in the market for the US dollar.

Our results for VARs are somewhat more optimistic, which is surprising for two reasons. First, our VAR specifications include more variables which should weaken our out-of-sample predictability. Moreover, VARs trade off fit in exchange rate prediction with fit in prediction of the other variables in the VAR. Nevertheless, in our best VAR specification, we can improve by up to 5% one, three or six months in advance by using for different impacts of small and prior changes in the exchange rate. Once again, our results only work in the Euro market, not in the Dollar market.

Thus, our forecasting results are stronger at the monthly level. This is not surprising given that, since we are regressing first differences in the exchange rate on lagged first differences, noise trades will cause a decrease in the coefficient and will also cause problems for out of sample prediction. It is therefore not surprising that we get negative serial correlation at the daily level but strong and positive serial correlation at the monthly level. Moreover, it is equally not surprising that our

out-of-sample predictability is greater at the monthly level where noise trading plays less of a role.

We interpret these results as consistent with the presence of learning in exchange rate dynamics. However, it appears that learning is homogeneous across traders and that there is very little effect of heterogeneity of information. Domestic and customer trades in one day have persistent impacts the following day in exchange rate movements. However, this information does not seem to be useful at the daily level for prediction in advance and only seems to be useful in or out of sample at the monthly level in a VAR. There seems to be less role for order flow in the Kronor than in previously explored currency markets.

The paper is organized as follows: In part two we describe our data, in part three we present our empirical methodology, part four discusses our findings, and part five concludes.

2 Data description

The data on Kronor/Euro and Kronor/Dollar trading day spot exchange rates come from Datastream (daily average) and Bloomberg (end of the day for Kronor/Dollar). The Kronor/Euro series was augmented from before January 1, 1999 by the German Deutchmark, using the Euro/Deutchmark exchange rate on January 1, 1999 to make the Kronor/Euro rate smooth. We take a simple average of the daily average exchange rates over a month for our monthly regressions. Figure 1 presents the dynamics of daily average exchange rates for our sample period: January 4, 1993 — February 3, 2006.

In all of the analysis, we use natural logarithm of the spot exchange rate. Because spot exchange rate or its log follow a unit–root process at daily or monthly frequency, we conduct our analysis on the first differences of the log of the exchange rate. We will use the following notation:

$$De_t = \log s_t - \log s_{t-1},$$

where s_t is the average spot rate on date t on either Kronor/Dollar or Kronor/Euro markets.

The data on transaction includes type of contracts, volume and two parties. The contracts are

aggregated for each day, so that we do not know how many contracts of a given type occurred in a given day, we only know the total volume. See Appendix for the detailed description of transaction data. These data covers the sample of January 4, 1993 — June 28, 2002.

We use Riksbank press releases to gather the information on changes in repo rate for 1993-2005. We also use the press releases to identify the nature of Riksbank interventions in the foreign exchange market. For instance, a number of Euro purchases by the Riksbank are conducted on a regular basis in order to provide the government with currency necessary to pay Sweden's dues to the EU, and for other foreign exchange expenses. These purchases tend to be of a regular size are usually followed by an off–setting forward. Figures 2 and 3 present the frequency distribution of the Riksbank transactions for each of the years in our sample.

To identify the Riksbank interventions in the foreign exchange market that were driven by the exchange rate dynamics and not merely the need for foreign currency, we construct the variable for extraordinary sales and purchases of currency by the Riksbank for each year. We confirm through press releases that interventions such as on October 7, 1998 and June 15, 2001, were indeed intended to support the value of the Kronor. Figure 4 presents all the transactions by the Riksbank alongside the exchange rate. The ovals indicate the interventions for the purpose of supporting the Kronor. The Data Appendix lists extraordinary interventions by the Riksbank.

We aggregate the transaction data to the monthly level by taking daily average transactions and summing up the transactions by type. The monthly exchange rate figures are just the mean exchange daily exchange rate for the month.

We collected monthly data for Sweden, the United States and Germany on the CPI from Ecowin. The US CPI was series was for all urban consumers. The monthly trade balance for all countries also come from Ecowin though Ecowin's sources are Statistics Sweden, Deutche Bundesbank, and the US Department of Commerce. Monthly net government surplus was also available on Ecowin, which obtained the data for all countries from the OECD. We used one month maturity interest rates for Germany and Sweden from Ecowin. We used the one 30 day Treasury Bill middle rate for Sweden and the one month Euro/Mark middle rate for Germany. We obtained a one month rate on certificate of deposits from the US treasury website for the United States. Finally, we obtained

the money supply (M3) from the Riskbank and Federal Reserve websites and for Germany from the Bundesbank in a private communication.

3 Methodology

We use exchange rate variation and the variation in the transaction activity to test whether the behavior of the Swedish Kronor (Kronor) exchange rate is consistent with learning and heterogeneity of the information among the market participants.

3.1 Learning

Our first goal is to investigate whether the exchange rate adjustment to shocks is immediate, as models without learning would suggest, or slow, as learning models (with either homogeneous or heterogeneous information) would imply.

In particular, we estimate an augmented AR(1) model of the changes in the exchange rate where we allow the autocorrelation coefficient to change in the aftermath of large changes in exchange rate as well as after the transactions that carry informational innovation.

To this end, we estimate the following equation:

$$De_t = \alpha + \rho De_{t-1} + \beta X_{t-1} + \gamma X_{t-1} De_{t-1} + \varepsilon_t,$$

where X is an indicator of an informative innovation. If the learning behavior is present, we will expect that (a) autocorrelation of De is positive, or (b) informative innovations lead to excess serial correlation in the exchange rate, or both.[1]

Thus, our non–exclusive null hypotheses consistent with learning are as follows:

$$\text{H0:} \quad \rho > 0,$$

[1] See Harris and Raviv (1993) and Shalen (1993) for the models that generate positive serial correlation in exchange rate changes.

or

$$\text{H0: } \gamma > 0.$$

We will use two types of indicators of informative innovation: a large change in the spot rate itself (1% tail on each side); and a large intervention by the Riksbank that was not preannounced as intervention for transaction purposes.[2] Figures 1-3 show the distribution of the Riksbank transactions.

3.2 Heterogeneous information

Following the series of papers by Evans and Lyons, we use foreign exchange transaction data to test for possible heterogeneity of information. If order flows (transaction) have an effect on the exchange rate, it is indicative of the presence of private information. We refine the methodology by subdividing the transactions into those that we believe have informational content and those we believe do not have informational content. In addition, we divide the transactions into demand side and supply side order flows.

We lag our transaction data one period, because our data on spot rate represents the average over period t. Our main specification is then

$$De_t = \alpha + \beta(PT_{t-1} - NT_{t-1}) + \varepsilon_t,$$

where PT are "positive" transactions (buy orders) and NT are "negative" transactions (sell orders). In addition to main specification, we subdivide the transactions in the following ways:

Small versus large transactions One can think of small transactions as being liquidity transactions, while large ones having fundamental reasons. We analyze the impact of small and large

[2]Every year since 1996, towards the end of the year Riksbank would announce the amount it is planning to buy on the foreign exchange market in a subsequent year for the debt service purposes. The press releases specify the time of these transactions and promise them to be completely transparent. We code these transactions in our data set as 'announced', i.e. publicly known as such and expected in advance, since all the market participants had easy access to these press releases. Other transactions by Riksbank and other market participants we assume to be un-announced and thus only a subset of investors would be aware of the informational value of these transactions.

transactions on the exchange rate separately. We expect large transactions to have a larger effect than small transactions. We define large transactions as transactions in the top 1% of the distribution.

Domestic- versus foreign–initiated transactions One would expect that the transactions initiated by foreign agents are more likely to be liquidity transactions, since foreigners are less likely to be informed about the fundamental shocks to the exchange rates. In addition, since the Kronor is not a major speculative currency, one would not expect foreign agents to trade Kronor for any other than liquidity reasons. Thus, we would expect the transactions initiated by foreign agents to have a smaller effect than the transactions initiated by domestic agents.

Transactions with and without offsetting forward Our transaction data contains spot transactions and transactions in exchange rate derivative. We match the spot and forward transactions of the opposite sign and same size from the same type of agents. Since the transactions with offsetting forward are more likely to be liquidity transactions and do not affect the long–run demand and supply of currency, we would expect the transactions with offsetting forward to have a smaller effect on the exchange rate than transactions that were not matched with a forward deal.

Bank- versus customer–initiated transactions Private transactions in our data fall into two main groups: transactions between two banks and transactions between a bank and its customer. In the second group, the customer almost always the one initiation transactions. We assume that customers trade currency mainly for liquidity purposes and thus their sales and purchases would not be informative of the fundamentals driving the exchange rates. Transactions between two banks, on the other hand, might carry informational content, if they are speculative — two banks might be interested in a trade if they have different expectations of the future exchange rate behavior. Such transactions would provide information to other market participants about the beliefs of these banks and would therefore have a larger effect on exchange rate than customer–initiated transactions.

Private transactions versus transactions with Riksbank Since the majority of the Riksbank transactions are for liquidity purposes as described in Riksbank press releases, we would

expect private transactions to have a larger effect on exchange rates.[3]

3.3 Effects of public announcements

Using our daily data, we also test whether public announcements by the Riksbank regarding the Repo rate have an effect on the exchange rate. We distinguish three types of announcements: increase in the repo rate, decrease in the repo rate, and repo rate remains unchanged. For the same reasons as above, we lag the announcements by one day. We also combine them with the transaction data. At the monthly frequency, we use macroeconomic data as public signal and study their effects using both single–equation specification and the vector autoregressions (VARs).

3.4 Vector autoregressions

We use three specifications for each of the two currency pairs (Kronor/Euro and Kronor/Dollar). All VARs are reduced form and include only lags on the RHS in each equation. The first VAR, a UIP VAR, includes the first difference in the exchange rate and the contemporaneous interest rate. The second VAR is a transactions VAR including the first difference in the exchange rate, net customer order flow and net Riksbank order flow. The last VAR is a size order flow using the first difference in the exchange rate, a dummy for the 1% largest positive changes in the exchange rate and a dummy for the 1% smallest changes in the exchange rate. In other words, we regress

$$X_t = \alpha + \rho X_{t-1} + \beta X_{t-2} + \varepsilon_t$$

where

$$X_t = \begin{pmatrix} De_t \\ Y_t \end{pmatrix}$$

and Y_t is a scalar consisting of the interest in the first VAR and a vector consisting of both net customer and net Riskbank order flow in the second regression and both a dummy for large positive and a dummy for large negative changes in the exchange rate in the third regression.

[3] We exclude the large interventions by the Riksbank from this set of Riksbank transactions.

3.5 Forecasting

For each regression, we test the forecasting power by comparing the mean square error (MSE) of a recursive out–of–sample forecast from our model to the MSE of the random–walk–based forecast. For daily regressions, we construct 1-, 5- and 25- days ahead forecasts; for monthly regressions, due to more limited data, we only make out of sample forecasts one period (one month) in advance. We report the ratio of the MSE our forecast to the MSE of random–walk–based forecast.[4] We use Diebold and Mariano (1995) technique to calculate standard errors for this ratio.

In addition, we use the methodology proposed by Evans and Lyons (2005) paper, for an alternative comparison of our forecast performance relative to random walk. This test represents a regression of predicted changes in the exchange rate on actual ones with the Newey-West (1987) estimator. A null hypothesis of our model performing better than a random walk is then

$$\text{H0:} \quad \beta > 0,$$

where β is the estimated slope of the regression.

For the VARs, we estimate the coefficients using monthly data but then forecast 1, 3, and 6 months in advance respectively. We report both ratios of MSEs to the random walk and the Evans and Lyons projection statistics for each forecasting exercise.

4 Empirical results

We report our results in the same order as described in the methodology part.

4.1 Learning

Tables 1 and 2 presents our results regarding learning, for daily and monthly frequencies, respectively.

[4]Following Mark (1995), we remove a trend from the random–walk–based forecast. Since the Kronor exchange rate does not appear to have trend, this does not make much of a difference.

For daily frequency we can see that, unlike the learning hypothesis would suggest, the autocorrelation in De is significantly negative in almost all specifications on both Kronor/Euro and Kronor/Dollar spot markets. The autocorrelation coefficient is around -0.03. This negative autocorrelation could be due to measurement error associated with high–frequency noise trading that does not carry any information: with a substantial amount of noise trading, the data tends to exhibit mean–reversion which induces negative serial correlation in first differences. Thus, even if there is learning on a daily basis, we are unable to detect it due to noise trading.[5]

Day trading as well as other forms of inattention suggest that large changes in exchange rate movements may generate larger effects than smaller changes. Columns (2) and (5) present the results of our analysis where the indicator of informative innovation is a large change in exchange rate. We separate large depreciations and large appreciations. We can see that neither the indicator itself, nor its interaction with lagged De have a significant effect. Thus, this test does not support our learning hypothesis either.

Columns (3) and (6) present our results where the indicator of informative innovation is an especially large purchase or sale of Kronor by the Riksbank.[6] We find that while the transaction involving the Kronor purchase tends to appreciate the Kronor/Euro exchange rate (which is expected), it also increases the autocorrelation of De, which is consistent with learning. The effects on the Kronor/Dollar exchange rate are basically the same. However, since the Kronor/Dollar market is more volatile, some of the coefficients are not statistically significant.

The presence of noise trading is evident also in the performance of the out-of-sample one-day-ahead forecast. At the daily frequency, our regressions perform equally or worse than the random walk with ratios of the MSE of the regression forecast to that of the random walk forecast ranging from 0.999 to 1.005 for both Kronor/Euro and Kronor/Dollar markets. Using the Evans–Lyons test, we cannot reject the hypothesis that the predictions based on the regressions are different from the random walk forecast.

At the monthly level, however, the noise trading effects average out and we are able to find evidence

[5] We experimented with different number of lags on the right–hand side, but the results basically remain the same, with most lags not entering significantly. We also experimented with GARCH specification, and found that our story is unchanged.

[6] See the Data section for the definition.

in support of the learning hypothesis. As reported in Table 2, the autocorrelation coefficient in all the specifications is positive and significant, ranging from 0.2 on Kronor/Euro market to 0.3 on Kronor/Dollar market — this results is consistent with the findings by Bacchetta and van Wincoop (2006). This positive autocorrelation also helps us forecast the exchange rates at monthly frequency. The relative MSE of the one–month-ahead forecast is significantly less than 1 for the Kronor/Euro market. Although we fail to reject the hypothesis that our forecasts predict better than the random walk forecast using Evans–Lyons tests, Diebold-Mariano standard errors on our relative MSE all have P-values less than 5%. In our best specification, column (2), we beat the random walk by 6.5%.

Surprisingly, separating the indicator of big changes into positive and negative does not improve the fit of the model. Furthermore, adding the transaction data does not appear to make any difference in the rest of the coefficients, but significantly worsens the forecasting ability of the model. Whereas adding weakly correlated variables to a regression always improves in-sample fit, it often worsens out of sample prediction. Estimates are often quite imprecise and this can lead to large variations in prediction.

The evidence of learning at the monthly frequency is also apparent in Tables 8 and 9, which present the results of our vector autoregression analysis. In all the exchange rate equations, there is a large positive autocorrelation in changes in the exchange rate, both on Kronor/Dollar and on Kronor/Euro markets. Columns (6)-(8) also include the indicators for big changes. However, as in the single–equation regressions, they do not help much, possibly due to endogeneity of these variables. These last regressions' out-of-sample forecast beats that of the random walk, but the difference is not large or significant.

Overall, we conclude that while we cannot detect the evidence of learning at the daily frequency, we find it at monthly frequency. We believe there are two reasons for this result: first, as discussed above, the negative bias induced by noise trading in a first difference equation might be obscuring any positive autocorrelation that might exist due to learning at the daily frequency; however, it cancels out at the monthly frequency. Second, with highly volatile exchange rates, daily fluctuations might not carry sufficient information to induce any learning, while large month-to-month

fluctuations are sufficient to induce lower–frequency threshold-based learning.

In this section, we presented the evidence of learning behavior. However, this learning is based on the information about the exchange rate changes, which are publicly observable, and therefore does not provide the evidence regarding the heterogeneity of information, to which we turn now.

4.2 Heterogeneity of information

In this section we analyze the effects of private and public information more closely. We start by studying the reaction of the exchange rates to the order flows, which we separate into informative and non–informative, as described above. We then investigate whether the exchange rate reacts to public information, such as changes in repo rates by the Riksbanks and lagged macroeconomic fundamentals.

Private information Tables 3 and 4 present the results of our regressions involving different types of transactions at the daily, for Kronor/Euro and Kronor/Dollar rates, respectively. Table 5 presents our results for different types of transactions for monthly frequency.

Looking at the monthly frequency first, we note that the forecasting power of our model through autocorrelation in the changes in exchange rates does not go through order flows — as Table 5 demonstrates, order flows do not explain the exchange rate at monthly frequency (none of the coefficients are statistically significant), and do not help us forecast the exchange rate out of sample. The same is true if we employ the VAR technique — as column (3)-(5) in Tables 8 and 9 show, net Kronor sales by customers or Riksbank have no effect, at any lag on Kronor/Euro exchange rate, and only a tiny effect on Kronor/Dollar exchange rate. Thus, although we find the evidence of learning at the monthly frequency, this learning is homogeneous and is not driven by private information, but by private processing of publicly available information.

Turning to daily data, we see that net order flows have significant effects on the Kronor/Euro exchange rate. While the coefficient estimates are very similar for our Kronor/Dollar regressions, they are less precisely estimated because the Kronor/Dollar market is more volatile.

We net out the order flows because buy and sell orders are very highly correlated, as reported in

the bottom of Table 3. The exceptions are transactions that have a matching forward transaction and the interventions by the Riksbank. For these types of transactions we attempted to include the buy and the sell orders separately, but we obtained results that are qualitatively the same as the results with net transactions.

As expected, net purchases of Kronor appreciate the Kronor (lower the exchange rate). However, we do not see significant differences in the effects of different types of transactions. This suggests that the market participants cannot distinguish well between informative and non-informative transactions and are more likely reacting to total order flow effect or to intra-day prices. Like the monthly frequency regressions, the daily frequency regressions do not support our hypothesis of information heterogeneity. It is not surprising, therefore that the addition of transaction data does not help us forecast the exchange rate at daily frequency either. As Tables 3 and 4 show, the MSE of the forecast relative to that of random walk is always greater than 1 for 1- or 5-day-ahead forecasts.[7]

Public information Table 6 presents the results of our analysis of the exchange rate reaction to the Riksbank announcements about the changes and the lack of changes in the repo rate. It represents the reaction of the exchange rate to the public announcements.[8]

We can see in columns (1)-(3) that the Kronor/Euro spot rate tends to depreciate in the aftermath of an increase in the repo rate, which is consistent with uncovered interest parity; an increase in the repo rate today should lead to an instantaneous depreciation followed by a depreciation (positive coefficient) afterwards so long as the interest rate change persists. Since we are looking at daily levels, it certainly persists over the relevant horizon. Interestingly, announcements of a lowering of interest rates seem to have no significant effect. This is hard to explain; yet, it is consistent with announcement studies which use intra-day changes in exchange rates (e.g. Andersen *et al.*, 2003).

As we can see in columns (4)-(6), repo announcement effects are not significant nor are they at all sizeable for the Dollar/Kronor exchange rate. The one specification where announcements do have a significant effect in the Dollar/Kronor exchange rate is when we use closing as opposed to

[7]These results are at odds with Evans-Lyons results, which show that order flows help forecast exchange rate.

[8]We added interest rate differentials and stock market series to our regressions as well, but found that they do not enter significantly and have no effect whatsoever on our regressions.

average daily rates on the left–hand side (column(7)). The change in the closing exchange rate measures the within day impact of an announcement, as opposed to across–days effect measured by the changes in the average exchange rate. We find that Kronor depreciates following an announced decrease in the repo rate, again consistent with the literature.

We would expect the magnitude of the intraday effect to be much larger than that of the across–days effect, due to the mean-reverting nature of high frequency exchange rates and also because the average rate on the day of the announcement is affected by the announcement already. We find indeed that the magnitude of the intraday announcement effect in the Dollar/Kronor market is smaller than the magnitude of the across–days effect on the same market. However, it is similar in size to the magnitude of the across–day effect on the Euro/Kronor market. We attribute this to the fact that the Dollar/Kronor exchange rate is much noisier.[9]

We also note, from columns (2)-(3) and (5)-(6) that private signals still have a significant impact on the exchange rate, but are not affecting the impact of the public information or the predictive power of our model. In fact, in none of the regressions involving the repo rate announcement we are able to forecast the exchange rate better than the random walk would.

Turning now to Table 7, we fine that the relationship between the macroeconomic fundamentals and the exchange rate is very weak, which is consistent with the literature. The interest rate differential has a slightly negative effect — which is what the literature on UIP tends to find. The rest of fundamentals have no effect on the exchange rate, with the exception of the CPI, again, consistent with the literature.

We refine the UIP analysis in columns (1)-(2) of Tables 8 and 9, using VAR. We find persistence in both exchange rate and interest rate differential series, but very little relationship between the two variables. The Granger causality tests, presented in Table 10, confirm that interest rate differential Granger–causes exchange rate, but not vice versa. In both Kronor/Euro and Kronor/Dollar market, our VAR allows us to predict the exchange rate at 3-months-ahead horizon better than the random walk would. Although we cannot use Diebold-Mariano methodology for the VARs, we can confirm, using Evans–Lyons test, that for the Kronor/Dollar market, the improvement over the random

[9]Unfortunately, we were not able to use closing rates for the Kronor/Euro market because we were unable to find the data.

walk is statistically significant, albeit not very large.

5 Conclusion

In this paper, we use both prices and signed quantities of foreign exchange in addition to announcement data and macroeconomic variables in order to try to improve both in-sample and out-of-sample fit. Unfortunately, we can not improve much over the random walk as a prediction device. We do better at the monthly level than at the daily level. We attribute this to uninformative noise trading which averages out to a greater degree over the monthly time horizon.

At the monthly frequency, micro-measures perform better than macro measures. Macro measures are only weakly correlated with exchange rate movements and incorporating them causes a decline in out-of-sample predictive power. However, micro-based measures are significantly correlated in sample with non-zero R^2 and they are slightly useful in out-of-sample prediction as well. The best predictor of future exchange rate changes is actually the lagged exchange rate.

In general, public information seems to be more useful in prediction out of sample as well as more highly correlated in sample with exchange rate movements. We take this as evidence in favor of homogeneous learning models of exchange rate determination in contrast to heterogeneous information models. Nevertheless, private information can be present and useful but not show up in correlations between order flow and future exchange rate movements. Future research should look at other micro-based measures. Also, it would be interesting to understand why private information seems not to be useful in prediction in the Swedish foreign exchange market but useful in other markets.

References

[1] Andersen, Torben, Tim Bollerslev, Francis Diebold, and Clara Vega (2003), "Micro Effects of Macro Announcements: Real-Time Price Discovery in Foreign Exchange," *American Economic Review* 93, pp. 38-62.

[2] Bacchetta, Philippe, and Eric van Wincoop (2006), "Can Information Heterogeneity Explain the Exchange Rate Determination Puzzle?" *American Economic Review*, vol.96, pp.552-276.

[3] Diebold, Francis and Robert Mariano (1995), "Comparing Predictive Accuracy," *Journal of Business and Economic Statistics 13*, pp. 253-265.

[4] Dominguez, Katherine (2003a), "The Market Microstructure of Central Bank Intervention," *Journal of International Economics*, Vol. 59, pp. 25-45.

[5] Dominguez, Katherine (2003b),"When Do Central Bank Interventions Influence Intra-Daily and Longer-Term Exchange Rate Movements?," working paper.

[6] Eichenbaum, Martin and Charles Evans (1995), "Some Empirical Evidence on the Effects of Monetary Policy Shocks on Exchange Rates," *Quarterly Journal of Economics* 110, pp. 975-1009.

[7] Engel, Charles, and Kenneth D. West (2004), "Accounting for Exchange-Rate Variability in Present-Value Models When the Discount Factor Is Near 1," American Economic Review, Papers and Proceedings 94, pp. 119-125.

[8] Evans, Martin and Richard Lyons (2002), "Order Flow and Exchange Rate Dynamics," *Jounral of Political Economy* Vol. 110, pp. 170-180.

[9] Evans, Martin and Richard Lyons (2005), "Meese-Rogoff Redux: Micro-Based Exchange Rate Forecasting," *American Economic Review*, forthcoming.

[10] Faust, Jon, John Rogers, Eric Swanson and Jonathan Wright (2003), "Identifying the Effects of Monetary Policy Shocks on Exchange Rates Using High Frequency Data," *Journal of the European Economic Association* 1, pp. 1031-1057.

[11] Harris, Milton, and Artur Raviv (1993), "Differences of Opinion Make a Horse Race," *Review of Financial Studies*, Vol. 6, pp. 473-506.

[12] Mark, Nelson (1995), "Exchange Rates and Fundamentals: Evidence on Long–Horizon Predictability," *American Economic Review*, vol. 85(1), pp. 201-218.

[13] Meese, Richard A., and Kenneth Rogoff (1983), "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample," *Journal of International Economics*, 14, pp. 3-24.

[14] Newey, Whitney K. and Kenneth D. West (1987), "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, Vol. 55 (3), pp. 703-708.

[15] Shalen, Catherine (1993), "Volume, Volatility and the Dispersion of Beliefs," *Review of Financial Studies*, Vol. 6, pp. 405-434.

6 Data Appendix

The data set on foreign exchange transactions comes from the Riksbank. The Riksbank receives daily reports from 13 Primary Dealers (i.e. reporters) on both purchases and sales of five instruments against seven types of counter–parties. The seven counterparties are: Swedish customers, Foreign customers, Swedish reporters, Foreign reporter, Swedish other bank, Foreign other bank, The Riksbank.[10]

The institutions identity is anonymized. We know however whether they are Swedish reporters or Foreign reporters, and if it is a Branch of these. There are five Swedish reporters, among them the four large Swedish banks, five foreign banks, and two branch-reporters. Branch describes a foreign bank which has a subsidiary in Sweden. The set of reporters changes occasionally as documented in the Riksbank press releases.[11]

We use data on spot and forward transactions. All volumes contain all currencies against Kronor, measured in Kronor. When it comes to interbank trading all of it is Kronor/Euro(DEM), while for spot trading with customers 80–90% is Kronor/Euro(DEM).

Extraordinary sales and purchases by the Riksbank

Date	Purchase	Date	Sale
25.02.1993	2852	18.05.1993	10803
25.01.1994	965	17.03.1994	4210
22.02.1994	1191	30.03.1994	4495
19.08.1994	1004	21.04.1994	4187
03.10.1994	964	19.05.1994	5134
03.11.1994	874	15.09.1994	4749
10.03.1995	1186	23.09.1994	4696
23.01.1997	2734	04.01.1995	2235
07.10.1998	1397	19.01.1995	2249
15.06.2001	2829		
18.06.2001	2212		
25.06.2001	1189		

[10]The issue of nationality is determined by address, so the investment department of ABB, which is situated in the Netherlands, is a Foreign customer. The reporters sometimes have problems determining whether their counterparty is swedish or not, due to branches, mergers etc.

[11]The number of banks in the different categories vary over time.

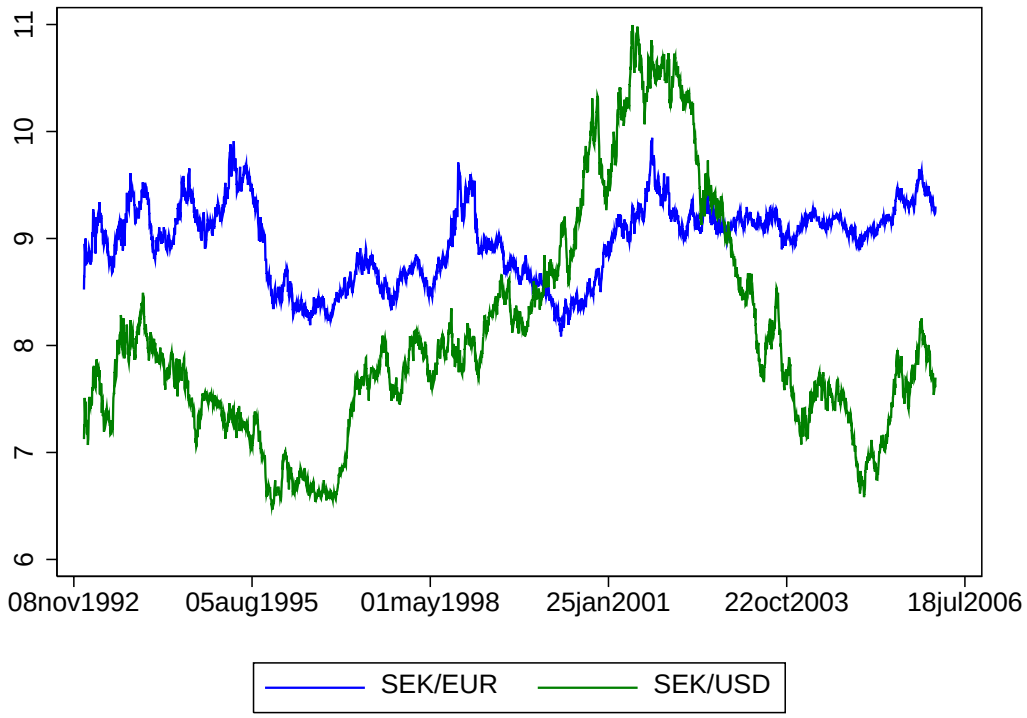

Figure 1: Kronor/Euro spot and RB transactions

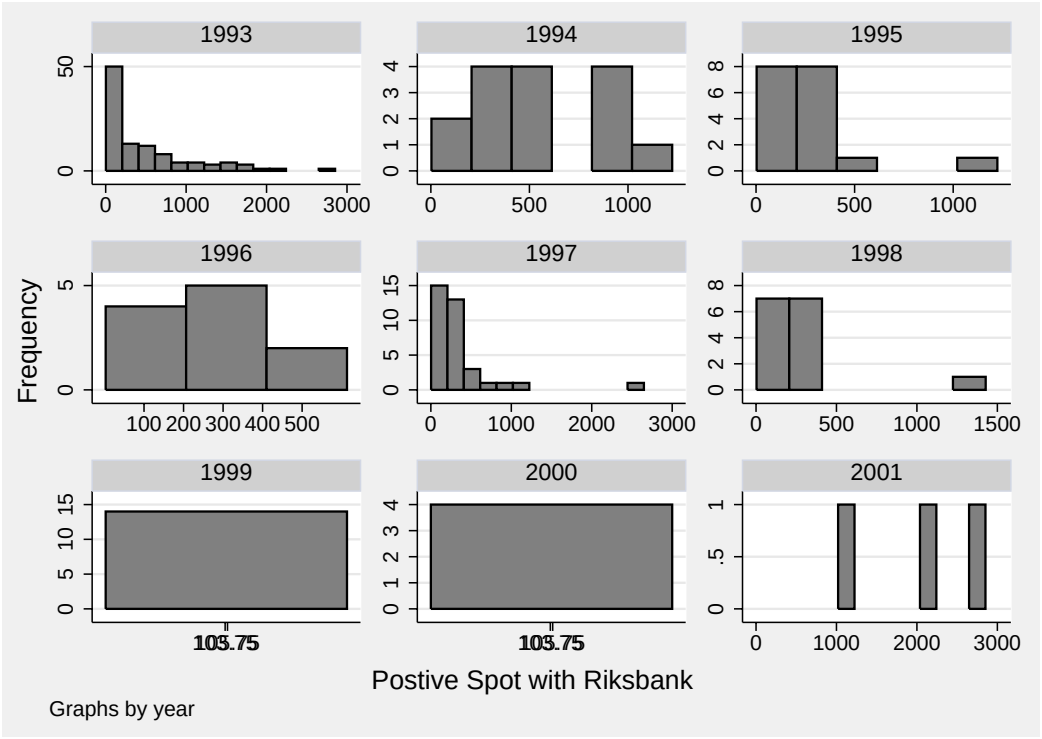

Figure 2: RB purchases of Kronor by year

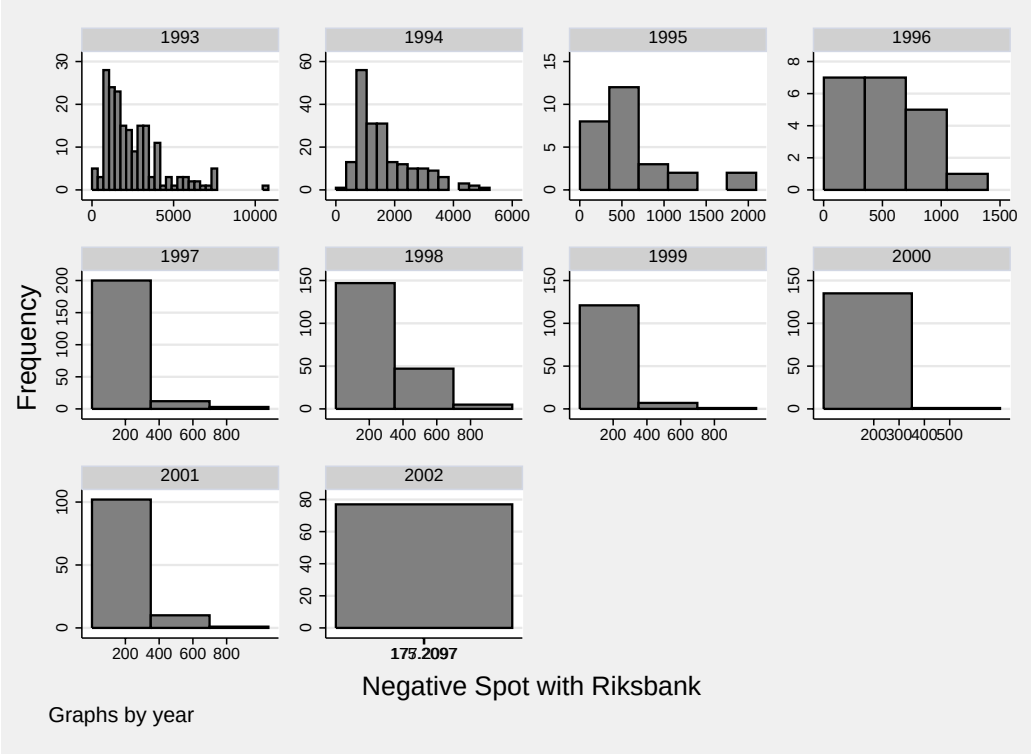

Figure 3: RB sales of Kronor by year

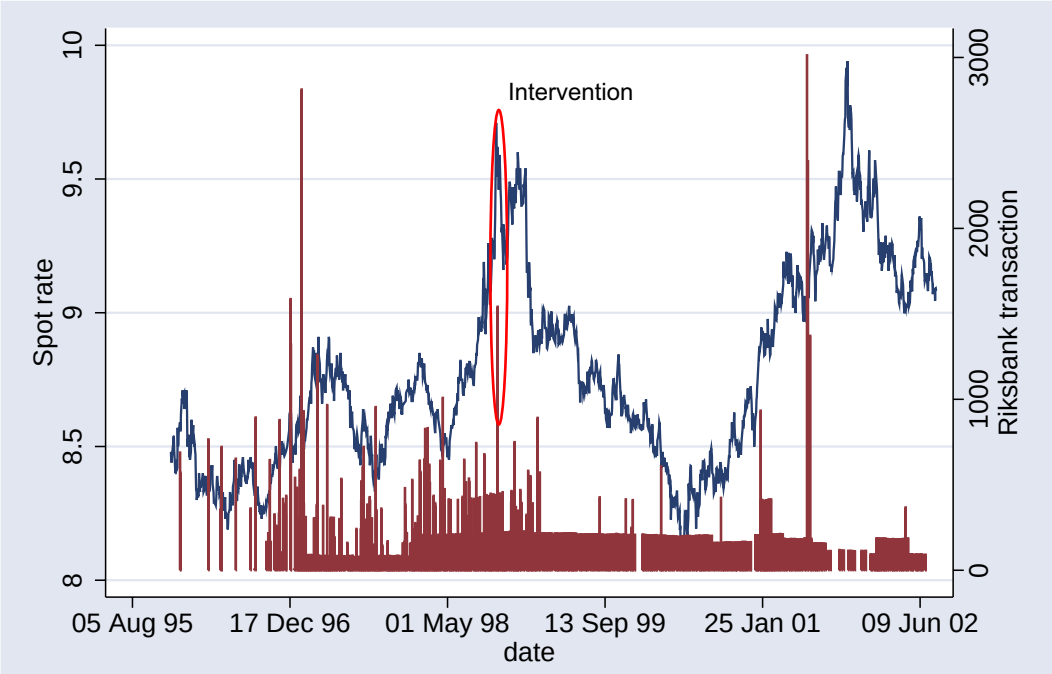

Figure 4: Kronor/Euro spot and RB transactions

Table 1: Learning. Daily

	Kronor/Euro			Kronor/Dollar		
	(1)	(2)	(3)	(4)	(5)	(6)
LDe	-0.037*	-0.031	-0.005**	-0.036*	-0.028	-0.004*
	(0.020)	(0.024)	(0.002)	(0.020)	(0.021)	(0.002)
L.Big "+"change		0.003			-0.000	
		(0.003)			(0.001)	
L.Big "-"change		0.004			-0.002	
		(0.004)			(0.002)	
L.Big "+"change*LDe		-0.029			-0.016	
		(0.019)			(0.012)	
L.Big "-"change*LDe		0.033			-0.009	
		(0.025)			(0.014)	
L.Big RB Kronor purchase			-0.003*			-0.001
			(0.002)			(0.002)
L.Big RB Kronor sale			-0.002			-0.006***
			(0.002)			(0.002)
L.Big RB Kronor purchase*LDe			0.058**			0.038
			(0.026)			(0.033)
L.Big RB Kronor sale*LDe			-0.033			0.019
			(0.050)			(0.048)
Adjusted R^2	0.004	0.005	0.004	0.001	0.001	0.001
Relative MSE (forecast)	0.999	1.004	0.9999	1.0001	1.004	1.005
EL β	0.0008	0.0011	0.0024	0.0013	0.0009	0.0005
EL P-value	0.49	0.65	0.30	0.24	0.61	0.82

Dependent variable is De. 2473 observations.
Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2: Learning. Monthly

	Kronor/Euro				Kronor/Dollar			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LDe	0.209***	0.211***	0.240**	0.236**	0.298***	0.298***	0.296***	0.283**
	(0.079)	(0.079)	(0.078)	(0.093)	(0.076)	(0.077)	(0.098)	(0.118)
L.BIG		-0.004				-0.001		
		(0.004)				(0.006)		
L.Big "+" Change			-0.014***	-0.014**			-0.000	-0.004
			(0.005)	(0.006)			(0.010)	(0.011)
L.Big "-" Change			0.005	0.005			-0.001	-0.001
			(0.005)	(0.006)			(0.009)	(0.013)
L. Net Customer				-0.002				-0.001
				(0.002)				(0.003)
L. Net Riksbank				0.000				-0.000
				(0.002)				(0.003)
Adjusted R^2	0.04	0.04	0.08	0.06	0.08	0.09	0.09	0.03
Rel.MSE(forecast)	0.977	0.983	0.925	1.088	1.029	1.062	1.141	1.178
EL β	0.586	0.579	0.886	0.564	0.245	0.144	0.020	0.043
EL P-value	(0.010)	(0.005)	(0.000)	(0.136)	(0.216)	(0.469)	(0.921)	(0.846)

Dependent variable is De. 156 observations, 112 observations in (4),(8).
Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Transaction regressions. Daily. Kronor/Euro

	(1)	(2)	(3)	(4)	(5)	(6)
Net purchase	-0.07*					
	(0.04)					
I =		large order	domestic	matching fwd	cust. initiated	Riksbank[a]
Net purchase (I)		-0.10*	-0.12**	-0.09	-0.09*	-0.14
		(0.06)	(0.05)	(0.23)	(0.05)	(0.11)
Net purchase(not I)		-0.07*	-0.04	-0.07*	-0.05	-0.10*
		(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
Correlation of buy and sell						
All transactions	0.974					
Transactions (I)		0.96	0.90	0.03	0.91	0.23
Transactions (not I)		0.95	0.98	0.98	0.98	0.83
Adjusted R^2	0.001	0.0001	0.002	0.000	0.001	0.001
Relative MSE (forecast)						
1-day ahead	1.0009	1.0008	1.0004	1.0011	1.0017	1.0011
5-days ahead	1.0076	1.0054	1.0020	1.0040	1.0065	1.010
Evans-Lyons test: H0: beat RW						
EL β 1-day ahead	0.0019	0.0018	0.0024	0.0019	0.0020	0.000
EL P-value	(0.29)	(0.31)	(0.19)	(0.31)	(0.29)	(0.96)
EL β 5-days ahead	0.0006	-0.0008	0.0047	0.0023	-0.0005	-0.0010
EL P-value	(0.89)	(0.77)	(0.20)	(0.47)	(0.83)	(0.67)

Dependent variable is De.
Standard errors in parentheses.
[a] versus domestic customers, excluding large interventions.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Transaction regressions. Daily. Kronor/Dollar

	(1)	(2)	(3)	(4)	(5)	(6)
Net purchase	-0.05					
	(0.05)					
I =		large order	domestic	matching fwd	cust. initiated	Riksbank[a]
Net purchase (I)		-0.15**	-0.09	-0.02	-0.07	-0.18
		(0.07)	(0.07)	(0.31)	(0.07)	(0.15)
Net purchase (not I)		-0.04	-0.03	-0.05	-0.04	-0.04
		(0.05)	(0.05)	(0.05)	(0.06)	(0.07)
Adjusted R^2	0.001	0.0001	0.002	0.000	0.000	0.000
Relative MSE (forecast)						
1-day ahead	1.0022	1.0024	1.0027	1.0023	1.0028	1.0039
5-day ahead	1.0010	1.011	1.0058	1.0095	1.0024	1.0053
Evans-Lyons test: H0: beat RW						
EL β 1-day ahead	0.000	-0.0002	0.000	0.000	-0.000	-0.001
EL P-value	(0.96)	(0.77)	(1.0)	(1.0)	(0.85)	(0.27)
EL β 5-day ahead	-0.0026	-0.0018	-0.0005	-0.0031**	0.0054	0.0021
EL P-value	(0.36)	(0.55)	(0.82)	(0.028)	(0.20)	(0.49)

Dependent variable is De.
Standard errors in parentheses.
[a] versus domestic customers, excluding large interventions.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Transaction regressions. Monthly

	Kronor/Euro				Kronor/Dollar			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L. Buy Kronor (Cust)	-0.002	-0.002			0.002	-0.002		
	(0.002)	(0.003)			(0.001)	(0.004)		
L. Sell Kronor (Cust)	0.002	0.001			-0.001	-0.000		
	(0.002)	(0.002)			(0.001)	(0.003)		
L. Buy Kronor (Riks)		0.002				0.002		
		(0.005)				(0.007)		
L. Sell Kronor (Riks)		0.002				0.005		
		(0.003)				(0.004)		
L. Log Buy (Cust)			-0.008				0.010	
			(0.012)				(0.016)	
L. Log Sell (Cust)			0.010				-0.012	
			(0.011)				(0.017)	
L. Net (Cust)				-0.002				0.000
				(0.002)				(0.003)
Adjusted R^2	-0.01	-0.02	-0.01	-0.00	-0.00	-0.02	-0.01	-0.01
Relative MSE (forecast)	1.092	1.131	1.096	1.031	1.047	1.074	1.068	1.034
EL β	-0.038	0.063	-0.025	-0.006	0.006	-0.008	-0.002	0.003
EL P-value	(0.145)	(0.167)	(0.354)	(0.669)	(0.875)	(0.815)	(0.966)	(0.923)

Dependent variable is De. 114 observations
Standard errors in parentheses.
[a] versus domestic customers.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Repo rate

	Kronor/Euro			Kronor/Dollar			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)[a]
Increase in repo rate	0.008*	0.008*	0.008*	-0.000	0.000	-0.000	-0.0019
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Decrease in repo rate	-0.001	-0.002	-0.002	-0.001	-0.001	-0.001	0.009**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Repo rate unchanged	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.0018*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Net purchase (Any)		-0.072*			-0.052		
		(0.037)			(0.050)		
Net purchase (Domestic)			0.10**				
			(0.046)				
Net purchase (Large)						0.115*	
						(0.060)	
Adjusted R^2	0.000	0.001	0.003	0.000	0.000	0.000	0.0018
Relative MSE (forecast)							
1-day ahead	1.012	1.013	1.011	1.0069	1.0072	1.0070	1.0036
5-days ahead	1.030	1.034	1.031	1.0077	1.013	1.0076	1.013
Evans-Lyons test: H0: beat RW							
EL β 1-day ahead	-0.00011	-0.0010	-0.0015	-0.0008	-0.0005	-0.0008	0.0019
EL P-value	(0.95)	(0.87)	(0.71)	(0.39)	(0.68)	(0.39)	(0.27)
EL β 5-days ahead	-0.0031	0.0018	-0.0016	0.00025	-0.0011	0.00029	-0.0024
EL P-value	(0.35)	(0.80)	(0.71)	(0.93)	(0.76)	(0.92)	(0.34)

Dependent variable is De. 2275 observations
[a] End of the day exchange rate, rate changes not lagged.
If all the repo numbers are not lagged, all coefficients are zero
Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Macro. Monthly.

	Kronor/Euro				Kronor/Dollar			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L. Interest Diff.	-0.002**				-0.002**			
	(0.001)				(0.001)			
LD. log(SwedenM3)		0.005	0.008	-0.009		0.074	0.077	0.115
		(0.048)	(0.050)	(0.064)		(0.080)	(0.077)	(0.082)
LD. log(EuroOM3)		-0.179	-0.128	-0.206				
		(0.170)	(0.177)	(0.223)				
LD. log(USM3)						0.469	0.439	0.232
						(0.349)	(0.362)	(0.412)
L. SD CPI NADJ			-0.001	-0.001			-0.003***	-0.003***
			(0.001)	(0.001)			(0.001)	(0.001)
L. GER CPI NADJ			0.003*	0.004				
			(0.002)	(0.003)				
L. US CPI							0.002**	0.001
							(0.001)	(0.001)
LD. Sweden NX			0.028	0.009			0.062	0.075
			(0.034)	(0.048)			(0.053)	(0.064)
L. Sweden Govt. Bal.			-0.001	-0.001			0.002	0.001
			(0.001)	(0.001)			(0.002)	(0.002)
LD. Germany NX			0.018	0.010				
			(0.082)	(0.111)				
L. GER Govt. Bal.			0.001	0.001				
			(0.001)	(0.002)				
LD. US NX							0.106	0.075
							(0.094)	(0.127)
L. US Govt. Bal.							-0.004*	-0.001
							(0.002)	(0.005)
L. Buy Kronor (Cust.)				-0.003				0.004
				(0.003)				(0.004)
L. Sell Kronor (Cust.)				0.003				-0.005
				(0.003)				(0.004)
Adjusted R^2	0.03	-0.01	-0.01	-0.04	0.02	0.01	0.11	0.08
Relative MSE (forecast)	1.092	1.131	1.096	1.031	1.047	1.075	1.068	1.034
EL β	0.001	-0.023	-0.088	-0.128**	0.027	0.024	-0.006	0.011
EL P-value	(0.957)	(0.465)	(0.227)	(0.049)	(0.494)	(0.539)	(0.909)	(0.849)

Dependent variable is De. 156 observations.
If all the repo numbers are not lagged, all coefficients are zero
Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: VARs. Montly. Kronor/Euro

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	De	Int. Dif.	De	Cust.	RB	De	Big +	Big -
LD. Log(€/Kr)	0.180**	1.576	0.235**	-3.377	0.278	0.123	3.392***	-1.796*
	(0.081)	(1.387)	(0.094)	(3.839)	(2.985)	(0.080)	(1.028)	(1.070)
L2D. Log(€/Kr)	0.017	-1.411	0.007	-2.372	0.197	0.007	1.172	-1.913*
	(0.082)	(1.409)	(0.096)	(3.883)	(3.020)	(0.084)	(1.078)	(0.360)
L3D. Log(€/Kr)	-0.004	0.219	0.019	7.116**	2.520	-0.025	-0.690	0.360
	(0.080)	(1.366)	(0.093)	(3.797)	(2.952)	(0.083)	(1.074)	(1118)
L. Int. Dif	-0.006	0.997***						
	(0.005)	(0.078)						
L2. Int. Dif	0.000	0.256**						
	(0.006)	(0.110)						
L3. Int. Dif	0.004	-0.270***						
	(0.005)	(0.078)						
L1 Net Cust. Sales			-0.003	0.255***	-0.006			
			(0.002)	(0.094)	(0.073)			
L2 Net Cust. Sales			0.003	0.195**	0.023			
			(0.002)	(0.098)	(0.076)			
L3 Net Cust. Sales			-0.002	0.244	0.001			
			(0.002)	(0.095)	(0.074)			
L1 Net RB Sales			0.003	0.073	0.468***			
			(0.003)	(0.115)	(0.089)			
L2 Net RB Sales			-0.004	0.036	-0.022			
			(0.003)	(0.127)	(0.099)			
L3 Net RB Sales			0.001	0.068	0.362***			
			(0.002)	(0.107)	(0.083)			
L1 Big '+' Change						-0.004	0.607***	0.004
						(0.006)	(0.0819)	(0.085)
L2 Big '+' Change						0.011	-0.046	-0.050
						(0.008)	(0.987)	(0.103)
L3 Big '+' Change						-0.022	0.031	-0.035
						(0.007)	(0.092)	(0.096)
L1 Big '-' Change						0.002	-0.023	0.616
						(0.006)	(0.078)	(0.081)
L2 Big '-' Change						-0.002	-0.023	-0.032
						(0.007)	(0.090)	(0.094)
L3 Big '-' Change						0.003	-0.007	0.024
						(0.006)	(0.077)	(0.080)
R^2	0.08	0.97	0.21	0.39	0.31	0.07	0.06	0.15
MSE Ratio 1	1.044			1.285			0.955	
MSE Ratio 3	0.972			1.036			0.953	
MSE Ratio 6	1.007			0.972			0.968	
EL 1 (P-Value)	0.016	(0.595)		-0.045	(0.243)		0.065	(0.119)
EL 3 (P-Value)	-0.008	(0.461)		-0.026	(0.001)		0.013	(0.592)
EL 6 (P-Value)	-0.017	(0.000)		-0.005	(0.123)		-0.002	(0.693)

Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: VARs. Montly. Kronor/Dollar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	De	Int. Dif.	De	Cust.	RB	De	Big +	Big -
LDe	0.332***	-1.793*	0.305***	-4.688*	0.923	0.386***	2.201**	-2.108**
	(0.080)	(1.016)	(0.095)	(2.801)	(2.219)	(0.102)	(0.880)	(1.017)
L2De	-0.245***	1.688	-0.101	-6.159	-2.792	-0.185*	1.373	1.032
	(0.082)	(1.036)	(0.098)	(2.908)	(2.304)	(0.103)	(0.893)	(0.427)
L3De	-0.031	-1.172	-0.061	1.386	1.596	0.025	-0.462	-1.158
	(0.079)	(1.006)	(0.095)	(2,.820)	(2.235)	(0.102)	(0.886)	(1.025)
L. Int. Dif	0.003	1.047***						
	(0.006)	(0.076)						
L2. Int. Dif	-0.012	0.251**						
	(0.009)	(0.110)						
L3. Int. Dif	0.007	-0.325***						
	(0.006)	(0.073)						
L2 Net Cust. Sales			-0.00	0.223**	-0.024			
			(0.003)	(0.095)	(0.075)			
L3 Net Cust. Sales			-0.001	0.234**	0.033			
			(0.003)	(0.097)	(0.077)			
L4 Net Cust. Sales			-0.004	0.238	0.001			
			(0.003)	(0.096)	(0.076)			
L2 Net RB Sales			0.002	0.122	0.467***			
			(0.004)	(0.115)	(0.091)			
L3 Net RB Sales			-0.010**	0.069	-0.002			
			(0.004)	(0.126)	(0.100)			
L4 Net RB Sales			0.010***	0.011	-0.347**			
			(0.004)	(0.107)	(0.085)			
L2 Big '+' Change						-0.003	-0.177	0.053
						(0.010)	(0.090)	(0.104)
L3 Big '+' Change						-0.002	-0.131	0.124
						(0.010)	(0.089)	(0.103)
L4 Big '+' Change						0.006	-0.035	0.136
						(0.009)	(0.083)	(0.097)
L2 Big '-' Change						0.000	0.087	-0.140
						(0.009)	(0.080)	(0.093)
L3 Big '-' Change						0.006	0.043	0.079
						(0.009)	(0.081)	(0.094)
L4 Big '-' Change						0.007	-0.079	-0.053
						(0.009)	(0.081)	(0.093)
R^2	0.18	0.99	0.21	0.62	0.49	0.15	0.08	0.06
MSE Ratio 1	1.008			1.124			1.273	
MSE Ratio 3	0.913			0.992			0.972	
MSE Ratio 6	0.977			1.020			1.024	
EL 1 (P-Value)	0.058	(0.270)		0.038	(0.337)		0.021	(0.727)
EL 3 (P-Value)	0.041*	(0.084)		-0.015	(0.558)		-0.009	(0.687)
EL 6 (P-Value)	0.022*	(0.077)		-0.012*	(0.097)		-0.014	(0.130)

Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10: Granger causality tests for VARs (P-Values)

	De	Int. Dif.	De	Cust.	RB	De	Big +	Big -
Euro/Kronor								
De		0.580		0.202	0.846		0.002	0.062
Int. Dif	0.087							
Net Cust. Sales			0.269		0.992			
Net RB Sales			0.521	0.350				
Big '+' Change						0.001		
Big '-' Change						0.946	0.909	0.778
Dollar/Kronor								
De		0.202		0.019	0.647		0.013	0.162
Int. Dif	0.042							
Net Cust. Sales			0.465		0.971			
Net RB Sales			0.029	0.200				
Big '+' Change						0.875		
Big '-' Change						0.831	0.532	0.396