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by

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Liquidity provision in the overnight foreign exchange market

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Abstract

We presents evidence that non-financial customers are the main liquidity providers in the overnight foreign exchange market using a unique daily data set covering almost all transactions in the SEK/EUR market over almost ten years. Two main findings support this: (i) The net position of non-financial customers is negatively correlated with the exchange rate, opposed to the positive correlation found for financial customers; (ii) Changes in net position of non-financial customers are forecasted by changes in net position of financial customers, indicating that non-financial customers take a passive role consistent with liquidity provision.

Key words: Microstructure, International finance, Liquidity
JEL Classification: F31, F41, G15

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1 Introduction

The provision of liquidity is important for well-functioning asset markets. Liquid markets match counterparties well (immediacy), have low transaction costs (tight spreads), and are less volatile (O'Hara, 1995).

In this paper, we study liquidity provision in the foreign exchange market. A central question raised is the following: Who is providing liquidity? The conventional wisdom is that market making banks are the main liquidity providers in floating exchange rate regimes. However, from the studies by Lyons (1995) and Bjønnes and Rime (2004) we know that dealers of market making banks have only limited overnight positions and cannot be expected to take lasting open positions. Hence, market making banks provide liquidity intraday, but are less likely to provide liquidity on longer horizons. In this paper, we empirically investigate whether there is a particular group of market participants that act as liquidity providers overnight. To address this question, we use a unique data set from the Swedish krona (SEK) market that contains observations of 90-95% of all transactions in five different instruments on a day-to-day basis from the beginning of 1993 up to the summer of 2002.

The study of liquidity in the foreign exchange market is particularly interesting for at least two reasons. First, our understanding of the movements of floating exchange rates is rather poor, and better knowledge of how the market works may improve our understanding. Second, as a largely unregulated market, patterns of liquidity provision have evolved endogenously. This is in contrast to several equity markets where, e.g., market makers have obligations to provide liquidity. Daníelsson and Payne (2002) study intraday liquidity in an electronic FX order book. The present paper is to the best of our knowledge the first to study liquidity in a longer perspective for the foreign exchange market.

Our data allow us to distinguish between four distinct groups of market participants: (*i*) Market making banks; (*ii*) Financial customers; (*iii*) Non-Financial customers; and (*iv*) the Central Bank (Sveriges Riksbank). Currently there is no other data set on the foreign exchange market that gives such broad overview of the trading of a single currency. A notable feature of our data is that the flows of different customers (Financial, Non-Financial, and the Central Bank), will equal the flow of Market making banks. [1] If flows of one group

[1] We use the term "flow" for changes in position.

of participants are positively correlated with changes in the foreign exchange rate, we will see a negative correlation for another group, or groups, of participants.

How can we identify the liquidity provider? The theory of market making predicts that a positive demand shock (i.e., a purchase by the aggressive part in the trade) will lead the market maker to revise prices upwards, hence a positive contemporaneous correlation between the trading decision of the aggressive part and the change of the exchange rate. [2] The supplier of the asset, e.g., a market maker, will fill the role of liquidity provider. There are in particular two characteristics of liquidity providers: (a) The net flow of liquidity providers will be negatively correlated with the change in the value of the currency; and (b) Liquidity providers match others' demand and supply passively.

These two predictions are borne out in the data. Our findings suggest that Non-Financial customers are the main liquidity providers overnight. First, we find a negative correlation between the net purchases of foreign currency made by Non-Financial customers and changes in the exchange rate. This negative correlation is matched by a positive correlation between net purchases of Financial customers and changes in the exchange rate. The coefficients of the two groups are not only similar in absolute value, but is also very stable. These findings lead us to conclude that the Non-Financial customers we observe fulfill requirement (a) above, while Financial customers do not. The fact that the foreign exchange rate and positions held by Financial and Non-Financial customers are cointegrated suggest that the price effect is permanent.

Second, requirement (b), that the presumed liquidity providers passively match changes in the demand and supply of others, is tested using Granger causality. We find that the trading of Financial customers tends to forecast the trading of Non-Financial customers. This suggests that the Non-Financial customer group is *not* in the active end of trading.

These results are not obvious. Four important issues might come to mind. First, if these are liquidity effects, how can they be permanent? It is important to remember that it is not liquidity effects that cause the change in the exchange rate. The exchange rate change is due to a portfolio shock by the Financial customers. We identify the supply of liquidity that meets this portfolio shock (more on the economic intuition for the permanent effect

[2] Using the terminology of microstructure, a purchase by the aggressive part in the trade is a positive *order flow*, while a sale is negative. We use the phrase "aggressive part" instead of "initiator" or "aggressor" which is more common in microstructure, because a non-market making liquidity provider may also "initiate" trades. Strictly speaking, only market makers do not initiate trades.

below). Second, it might seem counter-intuitive that Non-Financial customers should provide liquidity. However, one should note that Non-Financial customers in our data behave like profit-takers; they react to a change in the exchange rate. A liquidity provider, as used here, is one who enters the market as a reaction to the action of others. It is not necessary for the Non-Financial to perceive themselves as liquidity providers.

Third, it is clear that the group of Financial customers must be very diversified. It should contain a spectrum of customers from hedge funds to portfolio managers. Especially hedge funds might use a range of trading strategies. If anything, this could weaken our findings relative to a data set were we could identify hedge funds specifically. Last, if Non-Financial behave like profit-takers, are they then “Friedman speculators”? The positions of a Friedman speculator will be negatively correlated with the exchange rate when the level is moving away from equilibrium, while the positions will be positively correlated with the exchange when the rate is moving towards the equilibrium level. Hence, the liquidity providers do not necessarily act as “Friedman speculators.”

Closest in spirit to this paper are those by Froot and Ramadorai (2002) and Fan and Lyons (2003). Froot and Ramadorai (2002) have data from the global custodian State Street Corporation, covering transactions over a period of seven years in 111 currencies. Given the source of the data, it is reasonable to believe that the transactions are those of financial customers. Fan and Lyons (2003) use data on customer trading from Citibank. Both studies find results similar to ours for financial customers. While the data employed by Froot and Ramadorai (2002) and Fan and Lyons (2003) only represent a small market share of total currency transactions in a currency, our data reflect entire market activity. Also in contrast to these studies, our data allow us to directly test how flows of different groups of customers are related to changes in the foreign exchange rate.

To give a brief theoretical interpretation of our results, we may consider the model by Evans and Lyons (2002). A trading day is split into three trading rounds. In the first round, market making banks provide liquidity to customers. To offload their inventories after trading with non-bank customers in round 1, dealers trade among themselves in round 2. However, if there is excess demand for one currency after the round of interdealer trading, the market making banks must induce the customers to hold this. The customers in round 3 then need a risk premium to be willing to change their portfolio holdings. Hence, one expects to see a positive correlation between round 1 excess demand for a currency and the value of this currency. Using data from the interdealer market, Evans and Lyons (2002) find strong empirical support for such a positive correlation.

In the Evans and Lyons (2002) model, market making banks provide liquidity intraday to round 1 customers, while round 3 customers are compensated for providing overnight liquidity. In this model net purchases of all customers sum to zero after the third round of trading. However, this does not mean that net purchases of a particular group of customers must sum to zero. In light of the Evans and Lyons (2002) model, it is possible to interpret our results such that the typical aggressive round 1 customer is financial, while the typical liquidity providing round 3 customer is non-financial.

Our results also have implications for the exchange rate determination puzzle (see, e.g., Meese and Rogoff, 1983; Frankel and Rose, 1995). A better understanding of the role played by different market participants may be necessary to understand the movements of exchange rates. We document cointegration between the exchange rate and net currency positions held by Financial and Non-Financial customers, which suggests that price effects are permanent. We also show that net flows are able to explain changes in the foreign exchange rate at frequencies commonly used in tests of macroeconomic models. The explanatory power is very good. Flows by Financial or Non-Financial customers combined with interest rate differentials explain roughly 70% of changes in the foreign exchange rate at the 90-day horizon. As mentioned, the coefficient for the net flow of Financial or Non-Financial customers is also remarkably stable over the sample.

The paper is organized as follows. Section 2 discusses liquidity provision in FX markets. Our data is presented in Section 3. Section 4 reports the results on our attempts to identify the liquidity provider. Section 5 provides a discussion of our results, while Section 6 concludes.

2 Liquidity provision in FX markets

FX dealers provide liquidity by offering bid and ask quotes to other dealers or non-bank customers. The aggressive part in a trade buys at the ask and sells at the bid (ask $>$ bid). Microstructure models predict that a buy initiative will increase price, while a sell initiative will decrease price. Two main branches of models give different explanations for this. Inventory control models (e.g., Amihud and Mendelson, 1980; Ho and Stoll, 1981) focus on how risk-averse dealers adjust prices to control their inventory of an asset. In these models, a purchase by the aggressive trader will push up prices because the dealer typically will increase price to attract sellers when his inventory is smaller than desired. This effect is only temporary. When the dealer has reached his target inventory, the effect disappears. Information-based models (e.g., Kyle, 1985; Glosten and Milgrom, 1985) consider learning and adverse selection problems when some market participants have private information. When a dealer receives a trade, he will revise his expectations (upward in the case of a buy order and downward in the case of a sell order) and set spreads to protect himself against informed traders. The information effect is permanent. The microstructure theory predicts that the flow by the aggressive trader will be positively correlated with contemporaneous price changes. Flows of liquidity providers, however, is expected to be negatively correlated with contemporaneous price changes.

Dealers provide liquidity in the FX market, but mostly intraday. Dealers usually do not take large overnight positions (see Lyons, 1995; Bjønnes and Rime, 2004). This means that dealers will offload most of their inventories to non-bank customers before they end the day. [3] Can we expect any particular group of market participants to systematically fill the role of overnight liquidity provider?

Evans and Lyons (2002) develop a model with three trading rounds each day. Before quoting in round 1, all dealers receive public (macroeconomic) information r ($R = \sum^t r_\tau$). After quoting in round 1 ($P_{i1} = P_1$ because all dealers have the same information), each of the N dealers receives market orders from his own customers that aggregates into c_1 $\left(\sum_{i=1}^N c_{i1}\right)$. A dealer's customer order is not observed by other dealers, and hence are private information.

Round 2 is the interdealer trading round. After quoting in round 2 (dealers do not want to reveal their information, hence $P_{i2} = P_2$), the dealers trade among themselves to share inventory risk and to speculate on their (private) information from their round 1 customer trades. Net interdealer trades initiated by dealer i (T_{i2}) is proportional to his customer orders in round 1 ($T_{i2} = \gamma c_{i1}$). At the close of round 2, all dealers observe the net interdealer order flow ($x = \sum_{i=1}^N T_{i2}$). The order flows in the interdealer trading mirrors the customer trading in round 1. In FX markets, dealers obtain estimates of interdealer order flows from the brokers.

In round 3, dealers use information on net interdealer order flow in round 2 to set prices

[3] Mean reversion in dealer inventories is much faster in FX markets than in equity markets (Bjønnes and Rime, 2004).

such that the public willingly absorbs all dealer imbalances. To set the round 3 price, dealers need to know (i) the total flow that the public needs to absorb, which they learn by observing x, and (ii) the public's risk-bearing capacity. If dealers (on average) are long in dollars, they must reduce the price for dollars to induce customers to buy dollars. The round 3 price is

$$P_{i3} = P_3 = P_2 + \beta x, \tag{1}$$

where β is some constants depending on the customers' demand and the dealers' trading strategy.

If customers net buy, e.g., euros in round 1, the aggregate interdealer order flow observed at the end of round 2 will be positive because dealers try to buy back euros. Since dealers lay off all their inventories during round 3, this means that aggregate customer orders in round 1 and round 3 must be of similar size and with opposite sign. We thus have

$$c_1 = \frac{1}{\gamma}x = -c_3. \tag{2}$$

Evans and Lyons (2002) test their model using data on interest rates and order flows from the interdealer market. They show that the interdealer flows can explain a large proportion of daily changes in foreign exchange rates (JPY/USD and DEM/USD). Without customer data they are not able to examine the trading in round 1 and 3 directly. So far, this trading is a black box.

In this paper, we focus on round 1 and 3. If the typical round 1 customer is different from the typical round 3 customer, we may say that different types of customers fill different roles. Round 1 customers are the active ones because they are first and because they are responsible for the dealers' inventory imbalances. Round 3 customers are passive because they absorb the dealers' imbalances.

It is important to understand that the Evans-Lyons model is a very stylized description of the foreign exchange market. In the real-world, trading takes place continuously. At any point throughout the trading day, dealers can trade with one another and receive customer orders. Customer trades are executed with a wide bid/ask spread. Some dealers will want to close out immediately the positions that results from executing a customer order, earning money on the bid/ask spread. Other dealers will speculate on intraday price movement. If there is excess supply or demand for a currency, which means that dealers as a whole are not willing to keep the net position of a currency, dealers will adjust their prices. When adjusting prices up or down, some customers will be induced to place orders because they find the price attractive, and thus absorb some of the excess supply or demand. Eventually, the price of the currency has adjusted to a level such that dealers as a whole are willing to hold their remaining positions overnight. The price may indeed have adjusted to a price where dealers as a whole have a zero net position.

An alternative to the first round-third round framework may be to think of the different customers as either pushing the market or being pulled by the market.[4] Push-customers initiate price rises or falls through their net buy or sell orders. Their trading will be positively correlated with price movements. Pull-customers are customers that are attracted into the market by prices which suit them because they wish to trade on a certain side of the market and decide to act now rather than postpone the trade in the hope of achieving a better price. Their trading will be negatively correlated with price movements.

3 Data from the Swedish krona vs. euro market

The Riksbank receives *daily* reports from a number of Swedish and foreign banks (*primary dealers* or market makers, ten as of spring 2002) on their *buying and selling* of *five different instruments* (spot, forward, short swap, standard swap and option). In our sample, stretching from January 1993 to June 28, 2002, a total of 27 reporting banks are represented. Only five banks are represented in the whole sample, and there are never more than 15 at any point of time. The reporting banks are anonymized, but we know whether they are Swedish or foreign. The two largest Swedish banks conduct about 43% of all gross trading in the market. The reported series is an aggregate of Swedish krona (SEK) trading against all other currencies, measured in krona, and covers 90–95% of all worldwide trading in SEK. Close to 100% of all interdealer trading and 80–90% of customer trading are in SEK/EUR. In our analysis we will therefore focus on the SEK/EUR exchange rate.

Aggregate volume information is not available to the market. Foreign exchange markets are organized as multiple dealer markets, and have low transparency. The specific reporter only knows his own volume and a noisy signal on aggregate volume that it receives through brokers. Reporting banks obtain some statistical summaries of volume aggregates from the

[4] We are grateful to professor Mark P. Taylor for suggesting the terms “push”- and “pull”-customers.

Riksbank, but only with a considerable lag. The data set used in this paper is not available to market participants.

The trades of a Market making bank i (MM_i) can be divided into (i) trades with other Market making banks (*MM-trade*), (ii) trades with Financial customers (FIN), (iii) trades with Non-Financial customers (NON-FIN), and (iv) trades with Sveriges Riksbank (CB). The sum of this trading will amount to the change in the currency position (flow) of the Market making bank. Throughout, we will let these names indicate net positions, where accumulation of flows begins January 2, 1993. By definition we have

$$\Delta(MM\text{-}TRADE)_i + \Delta(FIN)_i + \Delta(NON\text{-}FIN)_i + \Delta CB_i = -\Delta MM_i, \tag{3}$$

where all positions are measured as a more positive number if holdings of foreign currency increase.

Our data also let us know whether a counterparty is Swedish or foreign. In this paper, nationality is not an important distinction when addressing our research question. In the traditional portfolio balance model, however, the focus is on nationality. This is probably mainly a reflection of data availability. As there has been no data on actual currency transactions, researchers have used the current account as a proxy for portfolio shifts over time. As we have data on currency transactions, we need not consider this limitation. However, we do test for the importance of nationality as an explanatory factor in our models (see Section 5).

Swedish Market makers have 74% of the Financial customers' trading and 83% of the Non-Financial customers' trading. The Financial market share of all customer trades is 60% for our data set (the market share of Non-Financial customers is thus 40%). These numbers are very close to the market shares reported by the triennial statistics published by the Bank for International Settlements for all currency markets, in which the customer market share of Financial customers has increased from 43% in 1992 to 66% in 2001. Measured over all years, their market share is 56%. The central bank is barely present in the sample, only 0.4% of total trades. Most of the transactions by Sveriges Riksbank in our sample are related to Swedish government debt. [5]

[5] Our data allows us to separate central bank interventions from other types of central bank trades. In our data set, there are only a few episodes with interventions (see Solheim, 2004, for more details).

In this paper we focus on net changes in currency positions, or *currency risk* (for a discussion of gross flows, see Bjønnes, Rime, and Solheim, 2005). How should we measure currency positions? A swap is by definition a position that net itself out. In other words, we can ignore trading in swaps. Options may contain interesting information. However, the option market in SEK is limited. To get a picture of currency positions, we focus on the sum of net spot and forward positions. Only using spot positions would give a distorted picture of the risk the participants are willing to take. Our data shows a significant negative correlation between spot and forward positions for all types of participants. The correlation when measured in changes (flows) is about -0.7.

Table 1 presents some descriptive statistics for different groups at the 30-day horizon. None of the series are normally distributed. Most of the non-normality is due to skewness. We see that skewness for Financial and Non-Financial customers have opposite signs. Also, the standard deviations are of similar size.

Table 1
Descriptive statistics on currency flows at the 30-day horizon.

	Financial customers	Non-fin. customers	Market makers	Central bank
Mean	-0.56	-0.03	0.36	0.23
Std. Dev.	1.21	1.13	0.73	0.25
Skewness	0.34	-0.29	-0.41	0.12
Kurtosis	3.78	3.19	4.50	3.31

Sample: 1.1994-6.2002. All series are in SEK 10 billion.

From Table 1 we see that Market making banks (to some extent) tend to accumulate foreign currency (positive mean). To understand this finding, we should remember that the banks have operations other than market making. Market making dealers (and the proprietary trading desk) may hold some overnight positions, but the positions will not accumulate over time. This currency risk is probably held by the customers of the bank through different funds etc. offered by the bank. These customers can be both financial or non-financial.

Correlations between flows can give a first clue on liquidity provision. The correlation between the flows of Market making banks and Financial customers is negative, as we would expect, at -0.46. Note, however, the strong negative correlation, -0.80, between flows of Financial and Non-Financial customers.

Table 2 shows the correlation between flows and some macro variables at the quarterly frequency. By considering the quarterly frequency we may include the current account and the trade balance. We see that Financial customers tend to buy foreign currency when the bond returns in Sweden increase relative to German bond returns (return on ten-year bonds). For three-month interest rates this relationship is much weaker. We also see that Financial customers tend to buy Swedish kroner when the return on the Swedish stock market increases relative to the world stock market, and in particular when the Swedish stock market return increases. These stock market-FX correlations are well-known among FX dealers. For measures of inflation, current account and the trade balance, there are no significant correlations with flows of Financial customers. For Non-Financial customers we find a negative correlation between changes in relative bond returns and net flows. When the relative performance of the Swedish stock market increases, Non-Financial customers tend to sell Swedish kroner. Interestingly, we see that flows of Non-Financial customers are heavily correlated with the current account and trade balance. This suggests that, to some extent, these customers can be characterized as "current account traders." [6]

Table 2
Correlations between changes in net holdings of foreign currency and some macro variables at the quarterly horizon

	Financial customers	Non-Financial customers	Central Bank
Δ(RDIF10Y)	0.25	-0.13	-0.07
Δ(RDIF3M)	0.04	0.04	-0.21
Δ(STOCK_DIF)	-0.25	0.26	-0.25
Δ(STOCK_SWE)	-0.45	0.35	-0.10
Δ(CPI_SWE-CPI_GER)	-0.04	0.05	-0.20
Current account	0.01	-0.41	0.35
Trade balance	-0.05	-0.36	0.56

Sample: 1.1993-6.2002. Change in variable is indicated by "Δ." $RDIF10Y$ is the difference between the yield to maturity for Swedish and German bonds with ten years to maturity. Similarly, $RDIF3M$ is the difference between Swedish and German 3-month interest rates. $STOCKDIF$ is the difference between the return on Swedish and European (ex. Sweden) stock market indexes, while $STOCK\_SWE$ is the return on the Swedish stock market index. $D(CPI\_SWE) - D(CPI\_GER)$ measures the difference between Swedish and Foreign inflation.

While flows of Financial customers show no significant correlation with the current account and the trade balance, we see that flows of the central bank are positively correlated with the current account and trade balance. This may be explained by the increased foreign borrowing during the first half of the nineties by the central bank on behalf of the Swedish Debt Office. Table 2 suggests that Non-Financial customers are their (final) counterpart in these trades (the correlation between these flows is -0.28).

[6] We do not mean that their trades are only related to the current account. For instance, Non-Financial customers contribute to direct investments.

4 Empirical results

In this section, we provide our empirical results. First, we test for cointegration between the foreign exchange rate and positions held by Financial and Non-Financial customers (accumulated flows). Second, we examine the short-run dynamics at different horizons, from the daily to the 90-day horizon. We need to establish that there is a systematic correlation between the trading of a group and the exchange rate, and that this correlation is matched (and has the opposite sign) for some other group. Third, to convince the reader that the data matches the theoretical predictions about liquidity provision we need to establish that the flows of the group positively correlated with the exchange rate is actually the active part of the market (round 1 player), while the group with negative correlation between their flows and the exchange rate is on the passive side (round 3 player).

In all regressions, we use the log of the SEK/EUR measured at close of the Swedish market (shown in Figure 1). However, such a series is only available starting January 1, 1994. Hence, all regressions begin at this point. We use the 10-year bond yield differential and the 3-month interest rate differential as proxies for macroeconomic variables.The 10-year differential may capture long-term macroeconomic expectations while the 3-month differential captures short-term expectations.

4.1 Cointegration

The Evans-Lyons model presented in Section 2 implies the following four testable implications,

$$P_t = \alpha \sum_{\tau=1}^{t} r_\tau + \beta_{c1} \sum_{\tau=1}^{t} c_{1,\tau}, \tag{4a}$$

$$P_t = \alpha \sum_{\tau=1}^{t} r_\tau + \beta_{x} \sum_{\tau=1}^{t} x_{\tau}, \tag{4b}$$

$$P_t = \alpha \sum_{\tau=1}^{t} r_\tau - \beta_{c3} \sum_{\tau=1}^{t} c_{3,\tau} \tag{4c}$$

$$c_1 = \frac{x}{\gamma} = -c_3, \tag{4d}$$

where P is the level of the exchange rate, r is public macroeconomic information, and c_1, x, and c_3 is round 1 customers' flow, aggregated interdealer order flow, and round 3

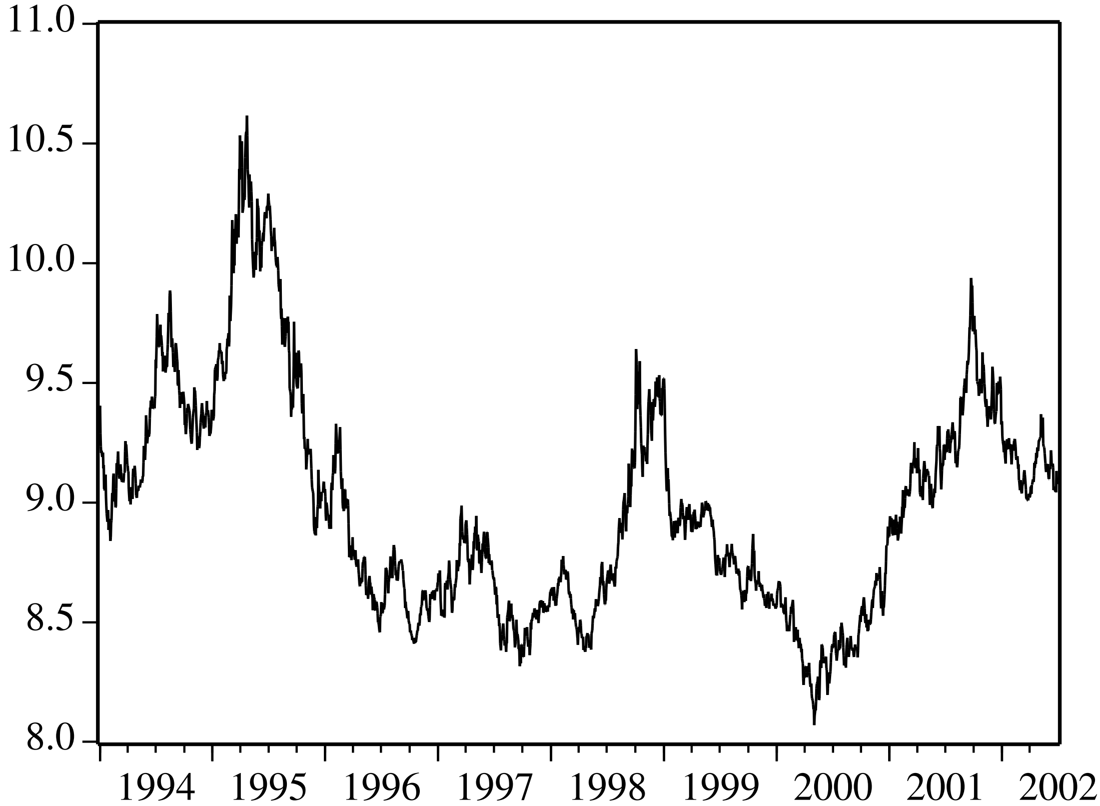


Fig. 1. The SEK/EUR exchange rate
Sample: 1.1994-6.2002. Note that for observations prior to January 1, 1999, we use DEM instead of EUR. Before January 1, 1999 the majority of SEK trading was conducted in DEM as it is currently conducted in EUR.

customers' flow, respectively. The three first equations are cointegrating relations (levels), while the fourth describes the relation between daily flows. Our data allows estimation of the three relations in Eqs. (4a), (4c), and (4d), and our discussion henceforth will therefore refer to these equations. [7]

As a set of predictions of a unified theory it is preferable to estimate the equations as a system. The two cointegrating relations in Eqs. (4a) and (4c) cannot, however, be estimated together because they would be expected to be identical. One could instead estimate one of the price relations together with the relation between daily flows of the customers, Eq. (4d). As discussed in Section 2, in reality the flows of the customers will not match perfectly on a day-to-day basis. One implications of this is that Eq. (4d) should rather be interpreted as a steady state relation, and hence could be estimated as part of a cointegrating system (with positions instead of flows). We therefore look at two equivalent versions of the same

[7] The cointegration vector with interdealer order flow is, however, analyzed by Killeen, Lyons, and Moore (2004). They find that the predicted properties hold.

system. In the first version, we estimate the price equation with the position of Financial customers, Eq. (4a), and the steady state relation between the two customer groups, Eq. (4d). In the second version we replace Financial customers with Non-Financial customers, Eq. (4c).

The cointegrating equations are estimated using the Johansen method on daily observations. We include the 3-month and 10-year interest rate differentials in the estimations. Interest-differentials are usually assumed to be stationary. However, in the sample they are clearly non-stationary. Including a stationary variable in the cointegration framework may affect the cointegration tests. On the other hand, treating a non-stationary variable, in the sample, as stationary in the cointegration framework may have implications for the inference. We therefore choose to treat the interest variables as non-stationary in order to get the correct inference.

Unit root tests (see appendix) show that all variables in the cointegrating vectors are non-stationary. [8] We only model the exchange rate and the two customer positions in the VAR, while the other variables in the cointegration analysis are restricted to be within the vectors. Differences of these other variables enter the VAR as exogenous.

Panel *a*) of Table 3 shows the final version of the two sets of cointegrating vectors. The price equations are normalized on the exchange rate, while the steady state position equation is normalized on Non-Financial customers' position. Panel *b*) reports the error correction terms. The columns refer to the cointegrating vector in question, while the rows represent the equations in the VAR where the vectors enter. The restrictions we impose are (a) that either Financial or Non-Financial positions are excluded from the cointegration vector and (b) that both Financial and Non-Financial positions are excluded from the error correction term of the equation standardized on the exchange rate. All restrictions are found to hold, as reported in panel *c*) of the table. [9]

From the two price relations, columns 2 and 4, we see that the two position coefficients are significant. As expected, Financial customers act as the aggressive traders, while the negative coefficient for the Non-Financial customers is consistent with these being liquidity

[8] An exception is the position of the Central Bank. While the Augmented Dickey-Fuller test rejects the null of unit root at the 10%-level, other tests like the Ng-Perron, Kwiatkowski-Phillips-Schmidt-Shin, and Elliott-Rothenberg-Stock test clearly indicate a unit root. The question is therefore unresolved. Excluding the Central Bank does not seem to affect the cointegration tests.

[9] A less restricted version is in the appendix.

Table 3
Cointegration results, daily observations

	Financial		Non-Financial	
a) Cointegration	SEK/EUR	Non-Fin pos	SEK/EUR	Non-Fin pos
Financial	0.0092	-1	0	-1
	(0.0036)	(–)	(–)	(–)
Non-Financial	0		-0.0063	
	(–)		(0.0021)	
10-year bond diff.	4.83	0	3.52	0
	(1.42)	(–)	(1.36)	(–)
3-month diff.	-1.89	0	-1.38	0
	(1.00)	(–)	(1.09)	(–)
CB-position	0	-1.68	0	-1.83
	(–)	(0.20)	(–)	(0.26)
MM-position	0	-0.65	0	-0.53
	(–)	(0.19)	(–)	(0.24)
Trend	0.00020	0	0	0
	(0.00006)	(–)	(–)	(–)
b) Error correction term				
ΔSEK/EUR	-0.0131	-0.000121	-0.0121	-0.000047
	(0.0029)	(0.000054)	(0.0030)	(0.000041)
ΔNonFinancial	0	-0.001863	0	-0.001635
	(–)	(0.000541)	(–)	(0.000473)
ΔFinancial	0	0	0	0
	(–)	(–)	(–)	(–)
c) Test	Test stat.	p-value	Test stat.	p-value
LR test of restrictions	4.84	0.85	8.09	0.62
No. Observations	2214		2214	

Sample: 1.1994-6.2002. Cointegration estimated with the Johansen-method. The VAR models the exchange rate change and the flow of the two customer groups. The other variables in the cointegrating vectors are not modeled. Differences of these, and one lag of differences, are included in the VAR. The VAR contains two lags, determined by F-test. Standard errors of coefficients in parenthesis. The SEK/EUR cointegrating vectors are normalized on the exchange rate, while the position cointegrating vectors in column Non-Fin pos are normalized on the position of the Non-Financial customers. Cointegration results are reported as if the normalizing variable is a left-hand-side variable. Panel *b*) reports the error correction term. The columns indicate the cointegrating vector, while the rows indicate which equation in the VAR the vector enters. All cells without standard error are the result of restrictions. The test of the restrictions is reported in panel *c*).

providers. Furthermore, the cointegrating equations for the positions, columns 3 and 5, show that the two groups indeed match each other, as predicted by Eq. (4d).

The restrictions on the error correction term indicate that the position of both groups of customers is weakly exogenous to the price. This is reasonable, given that we expect Financial customers to "push" the market utilizing private information. The fact that the effect from their trading is positive and persistent is an indication that there indeed is an information effect. The trend enters significantly in the price equation for the Financial customers, but not for the Non-Financial (restricted to zero). Engle and Yoo (1991) suggest that the trend captures other unobservable variables. If the trading of the Financial customers are partly driven by information that has not yet reached the market, while the Non-Financial customers act as liquidity providers, we would expect that the trend should enter the price equation with the position of Financial customers but not in the price equation of the Non-Financial customers. The intuition for the weak exogeneity of the position of Non-Financial customers is that the banks "pick" price-quantity combinations along their supply curve. One can think of this as if Non-Financial customers placed a limit-order schedule in the market in the morning. Weak exogeneity allows us to run single-equation error correction models with contemporaneous flow as an exogenous variable. We return to this below.

4.2 Regressing exchange rate changes on customers' flows and changes in interest rates

Having established that there is a long-term relation between the net positions of customers (accumulated flow) and the exchange rate, we proceed to look at the relation between net flows (changes in net positions) and changes in the exchange rate. The cointegration analysis established evidence of liquidity provision in the long run. By studying short-run dynamics we can say something about liquidity provision overnight.

In all regressions, we include the error correction term from the cointegration analysis presented above. As the two price cointegration vectors are equivalent, we use the vector estimated using Non-Financial positions, as presented in Table 3. Using the price vector with Financial positions would not alter any results. To utilize the fact that we have access to daily data, we apply a standard GMM procedure to account for the fact that we have overlapping observations when we look at changes beyond one day.

Table 4 reports regressions of changes in the foreign exchange rate on currency flows of Financial and Non-Financial customers for the 5-day, 30-day and 90-day horizon. As is clear from Table 4, the sign on the coefficient for Financial customers is positive and significant at all horizons reported. The coefficient increases from 0.37% at the 5-day horizon to 0.71% per SEK 10 billion at the 90-day horizon. These numbers are economically significant. For instance, at the 30-day horizon the standard deviation of currency flows of Financial customers is 12 billion SEK. An increase of one standard deviation in the net flow of Financial customers will then, on average, imply an increase in the foreign exchange rate of 0.66%. For comparison, the standard deviation for changes in the foreign exchange rate over the 30-day horizon is 2.33%.

Table 4
Flows and returns

	5 days			30 days			90 days		
	coef.	*t*-stat.		coef.	*t*-stat.		coef.	*t*-stat.	
Constant	0.11	4.23	**	0.49	4.86	**	1.13	6.57	**
ΔFinancial	0.0037	4.02	**	0.0055	5.41	**	0.0071	5.30	**
ΔRDIF10Y	3.18	12.61	**	3.08	7.50	**	2.99	7.13	**
ΔRDIF3M	0.80	2.88	**	0.79	1.79		0.64	1.58	
COINT(-n)	-0.05	-4.21	**	-0.21	-4.81	**	-0.49	-6.48	**
R^2	0.30			0.50			0.72		
	5 days			30 days			90 days		
	coef.	t-stat.		coef.	t-stat.		coef.	t-stat.	
Constant	0.11	4.10	**	0.48	4.34	**	1.14	5.85	**
ΔNon-Financial	-0.0030	-3.05	**	-0.0052	-4.85	**	-0.0067	-5.03	**
ΔRDIF10Y	3.19	12.19	**	3.22	7.18	**	3.23	7.05	**
ΔRDIF3M	0.83	2.93	**	0.88	1.83		0.74	1.55	
COINT(-n)	-0.05	-4.08	**	-0.21	-4.32	**	-0.50	-5.85	**
R^2	0.29			0.48			0.69		

Sample: 1.1994-6.2002. The table shows a GMM regression on $(log(SEK/EUR)_t - log(SEK/EUR_{t-n})$, where n indicate the number of days over which we measure the return; 5, 30 and 90 days respectively. Similarly, "Δ" in front of a variable indicates change from $t-n$ to t. Net positions in currency are measured in SEK 10 billion. "Financial" is net positions of Financial customers, "Non-Financial" are net positions of Non-Financial customers. $RDIF10Y$ is the difference between the yield to maturity for Swedish and German bonds with ten years to maturity. Similarly, RDIF3M is the difference between Swedish and German 3-month interest rates. Coint(-n) is the error correction term from the cointegration analysis.
The cointegration vector is lagged with n periods. Estimations are made using daily data and overlapping samples. They are estimated using GMM, with a weighting matrix that equals the set of exogenous variables, and standard errors are calculated using a variable Newey-West bandwidth.
**(*) Statistical significance at the 1%(5%) level.

The coefficient for the error correction term is negative and significant for all horizons reported. At the five-day horizon, return to the long-run equilibrium takes place by 5% in each period. For the 30-day and 90-day horizon, the adjustment to the long run equilibrium takes place by 21% and 49% in each period, respectively.

The coefficient for changes in the ten-year interest rate differential is positive and significant for all time horizons. An increase in the ten-year interest rate differential may signal expectations of higher inflation in Sweden relative to Germany and the other euro-countries. The strong correlation between the exchange rate and the 10-year interest rate differential in Sweden is well known in the Swedish market and is mainly due to the fact that when Sweden emerged from recession in the early 1990's, the interest rate spread narrowed and the exchange rate strengthened. The coefficient for changes in the three-month interest rate differential is only significant at the five-day horizon. The coefficient is positive, which means that an increased interest rate differential is consistent with a depreciating SEK.

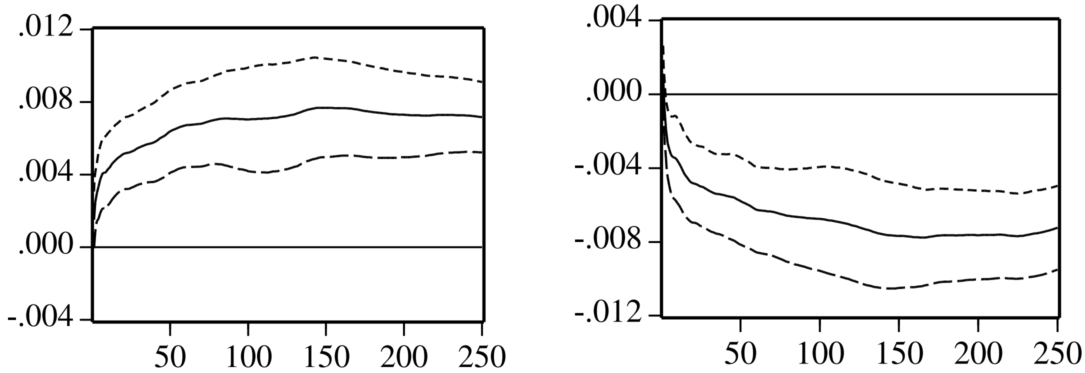
The explanatory power is very good. The regressions explain as much as 30-72% of all variation in the dependent variable.

In the lower part of Table 4, we replicate the estimations, only substituting flows of Financial customers with flows of Non-Financial customers. As we see, the coefficient for Non-Financial customers is also highly significant for all time horizons. The coefficient size changes from -0.30% at the 5-day horizon to -0.67% per SEK 10 billion at a horizon of 90 days. The coefficients for the error correction term and the macro variables are similar to those reported for the regressions with Financial customers. Again, the explanatory power is very good. Between 29% and 69% of all variation in the dependent variable is explained by the regressions. Furthermore, we notice that the coefficient for Non-Financial customers is almost exactly the opposite of the coefficient on Financial customers. This is an indication that Non-Financial customers also provide liquidity on shorter horizons.

It is sometimes argued that the relation between flows and changes in the exchange rate should be of a short-term nature. The cointegration results presented above suggest otherwise. This is also confirmed in a dynamic setting. As we can see from Table 4, both the size of the coefficient and the t-statistic on the flow actually tend to increase as we lengthen the horizon. This result is further confirmed in Figure 2. Here, we graph the coefficient for the flow variable for both Financial and Non-Financial customers when estimated at horizons from one day to 250 days. The regression is equivalent to the regressions presented in Table 4, and the sample covers the same period. As we can see, the absolute value of the coefficient increases in size for both variables when we move from returns measured from 1 to 100 days. Beyond 100 days, the coefficient size stabilizes. [10]

An interesting question is parameter stability. It is well known that coefficients from regression for exchange rates do not tend to be very stable when one changes the sample period under investigation. However, the findings in Table 4 are remarkably resilient to changes of this kind. In figure 3, we report the coefficient for both Financial and Non-Financial customers, when we use 30-day return. We estimate a rolling regression with a 3-year window. As one can see, the main result, that flows of Financial customers have a positive impact, while flows of Non-Financial customers have a negative impact, is valid for all possible 3-year samples from 1994 to 2002. This stability reflects significant differences in behavior between the two groups of customers.

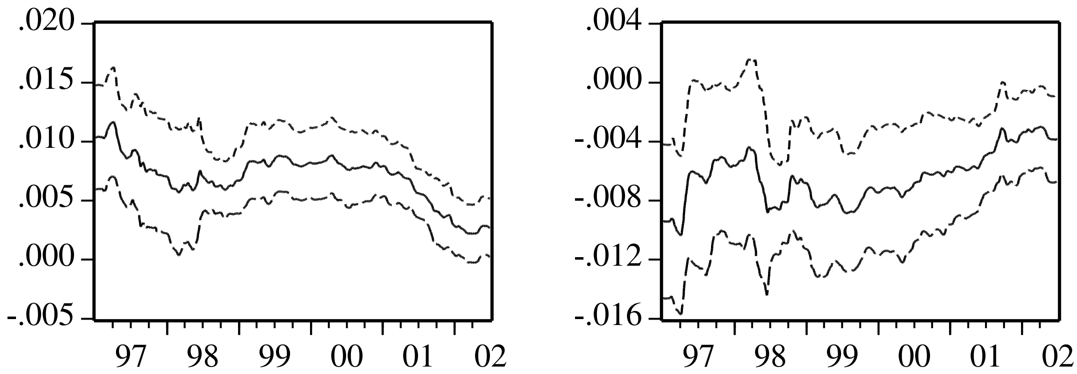
[10] This is consistent with results by Evans and Lyons (2004), who find that it takes more than a quarter for all information contained in order flow to be impounded in the exchange rate.



(a) Financial (b) Non-Financial

Fig. 2. The coefficient for flows of (a) Financial and (b) Non-Financial customers, respectively, for different time horizons

The figure displays the coefficient +/- 2 standard errors when we change the length of the overlap in the GMM regression from 1 to 250 days. The regressions estimated are equal to the estimations presented in Table 4. The time sample is Jan. 1, 1994 to June 28, 2002. Panel (a) shows the coefficient for Financial customers, while panel (b) shows the coefficient for Non-Financial customers.



(a) Financial (b) Non-Financial

Fig. 3. Rolling estimations of the coefficient (+/-2SE) using a 3-year window

The figure displays the coefficient +/- 2 standard errors when we estimate the GMM regression with a 30-day overlap, as described in Table 4, using a rolling regression with a 3-year window. The first coefficient is the value for a regression on the sample from Jan. 1, 1994 to Dec. 31, 1996. Panel (a) shows the coefficient for Financial customers, while panel (b) shows the coefficient for Non-Financial customers.

4.3 Short-run dynamics

This subsection addresses two questions: Do Non-Financial customers provide liquidity at all horizons, also the short term? And, do Market making banks only provide liquidity intraday, or also at lower frequencies? Table 5 addresses short run dynamics for horizons from one up to ten days. The regressions presented in Table 5 are similar to those reported in Table 4, except for the time horizons reported and that we may include flows of different market participants in a single regression (also Market making banks). We can not, however, include flows of Financial customers, Non-Financial customers and Market making banks in a single regression. This will give rise to high multicollinearity since flows of the central bank is small. We thus include only two groups in a single regression.

In Table 5, we separate between participants that push the market in the upper panel, and participants that pull the market in the lower panel. We run two regressions, one with both Financial and Non-Financial customers' flow (upper panel), and the second with Non-Financial and Market making banks' flow. "Financial" under the heading "Variable" means that we report the coefficient for net flow of Financial customers. We notice that Non-Financial customers are included as participants that both push and pull the market. As we will see, they push the market at the daily horizon, however, at all other horizons they pull the market (i.e., provide liquidity).

Table 5
Flows, returns and short run dynamics.

	Variable	1 day		5 day		10 day	
Push	Financial	0.0038	**	0.0034	*	0.0039	*
	Non-Financial	0.0034	**	-0.0004		-0.0005	
Pull	Non-Financial	-0.0008		-0.0041	**	-0.0044	**
	Market makers	-0.0053	**	-0.0011	**	-0.0005	**

The table displays the coefficients for the respective flow coefficients. All estimations follow the set up in Table 4, and are estimated using GMM, including the change in the 3 month interest differential, 10 year interest differential and the lagged cointegration vector. 1 day, 5 days and 10 days refer to 1, 5 and 10 day overlapping samples. We run two regressions, one with both Financial and Non-Financial customers' flow (upper panel), and the second with Non-Financial and Market making banks' flow (lower panel). "Financial" under the heading "Variable" means that we report the coefficient for net flow of Financial customers.
**(*) Statistical significance at the 1%(5%) level.

In the regression including both Financial and Non-Financial customers, the coefficient for Financial customers is 0.38% at the daily horizon. The coefficient for Non-Financial customers is 0.34% at the daily horizon. Thus, at the daily horizon, both Financial and Non-Financial customers are predominantly push customers. For the 5-day and 10-day horizon, the coefficient for Financial customers is still positive and significant. However, the significance level decreases from 1% to 5%. This is because we include flows by both Financial and Non-Financial customers in the regression. When the time horizon increases these changes become more similar in absolute value, but with opposite sign. Hence, including both in a single regression gives rise to multicollinearity. The coefficient for Non-Financial customers is insignificant at the 5-day and 10-day horizon in the regression including both Financial and Non-Financial customers.

In the regression including Non-Financial customers and Market making banks, we see that the coefficient for Non-Financial customers is insignificant at the daily horizon. This should be no surprise since we know that at this horizon the Non-Financial customers are predominantly push customers. The coefficient for Market making banks is -0.53% at the daily horizon. This result shows that Market making banks act as liquidity providers at the daily horizon. At horizons beyond one day, Non-Financial customers become more and more important as liquidity providers. The role of Market making banks as liquidity providers is decreasing with time horizon. The coefficient for Market making banks increases from -0.53% at the daily horizon to -0.05% at the 10-day horizon.

To sum up, we find a positive correlation between net currency flows and changes in the exchange rate for Financial customers at all horizons studied. At the one-day horizon, this positive correlation is matched by a negative correlation between the flow for Market making banks and changes in the foreign exchange rate. When the time horizon increases, Non-Financial customers become more important as liquidity providers.

4.4 Identifying "passive side": Granger causality — flows on flows

We continue by using the Granger causality test to address the other aspect of liquidity provision, that of matching trades "passively." The Granger causality test indicates the ability of one series to forecast another. The idea is that if the trading of Non-Financial customers forecasts the flow of Financial customers, we can hardly say that they are on the passive side.

Granger causality is estimated using a standard bivariate framework. This means that we estimate whether the flow of one group can forecast the flow of the other group. We report regressions estimated with 2 lags. However, the results do not change if we change to, e.g., 1 or 3 lags. No tests indicate other lag lengths than these. Results from the Granger causality tests are reported in Table 6.

Table 6
Granger causality tests using 2 lags. Daily observations

Does not cause:	Financial	Non-Financial	MM
Financial	na.	0.00	0.45
Non-Financial	0.72	na.	0.72
Market-mak.	0.34	0.00	na.

Sample: 1.1994-6.2002. Table presents the probabilities from Granger causality tests. The hypothesis tested is whether the variable in the left column does not cause the variable in the upper row. All variables included are first differential of net positions (i.e., flow). The estimations are based on bivariate estimations. We only report probability of rejection.

We *cannot* reject the hypothesis that flows of Non-Financial customers do *not* Granger-cause the other flows. However, we can reject that the Financial customers and Market making banks do not cause the flows of Non-Financial customers. This leads us to conclude that Non-Financial customers are on the passive side of the trading. Further, we cannot reject the hypothesis that no other group causes the change in the positions of Financial customers. Together with the regression results from the previous section this suggests the Financial customers are a first mover (push customers).

5 Discussion

Our results suggest that different market participants play different roles. Financial customers will typically "push" the market. Market making banks provide liquidity in the short run, while Non-Financial customers are important as liquidity providers in the longer run.

Nationality is not important when explaining our results. We experiment with regressions (See appendix) where we distinguish between Swedish and Foreign (i) Financial customers, (ii) Non-Financial customers, and (iii) Market making banks. Nationality does not make any significant difference in any of the regressions. Significant differences only exist between different groups of market participants. As we have seen, the relations between changes in the foreign exchange rate and the flow of Financial or Non-Financial customers is very stable.

To interpret our results, we may consider the fact that Financial and Non-Financial customers participate in other markets than the foreign exchange market. It may be reasonable to assume that a substantial amount of trading by Financial customers is related to portfolio investments. For these kinds of investments, stock markets are of special importance. Stock markets are volatile, and large price changes can occur at short notice. To give an example; the standard deviation of the Swedish stock index (daily data, from 1.1994 to 6.2002) was 1.6% compared with 0.5% for the exchange rate. [11] The maximum daily return in the stock market was 11.9% compared with 1.9% in the foreign exchange market. Given this kind of volatility, timing is extremely important. It is much more important to time correctly the investment in the stock market, than to wait for the appropriate exchange rate. Hence, it seems reasonable that they are push customers.

Trading in stock markets would not affect the exchange rate if currency positions are

[11] The stock exchange is measured by the log of the MSCI index for Sweden, and the exchange rate as the log of the SEK/EUR.

hedged. It is well known that investors in stock markets do not usually hedge currency risk.[12] Two possible reasons are that currency risk is small compared to overall risk, and that it may be difficult to hedge currency risk when future cash flows are uncertain.

Non-Financial customers, on the other hand, probably trade currency either to conduct current account trading, or to make foreign direct investments. For these kinds of transactions, the minute-to-minute considerations play a less important role in investment timing. In contrast to many asset prices, most prices for goods only change slowly. In this case, the FX part may be very important. For Non-Financial customers, the exchange rate may be viewed as an option, i.e., the customer can wait to make the transaction until the exchange rate becomes "sufficiently" attractive. For instance, if the dollar appreciates against the euro, US goods, like airplanes from Boeing, will become relatively more expensive compared to European goods, like Airbus. Assume the USD/EUR-rate is 1.40, and that most airline companies will choose to buy new airplanes from Boeing, hence buying dollars. However, if the dollar appreciates to 1.00 it is likely that many airline companies will exercise their option and rather buy from Airbus, and hence buy euros and sell dollars.

Assume that Financial customers buy dollars because they want to buy US assets. They are "pushing" the market, and the dollar will appreciate. The dollar will appreciate such that Non-Financial customers find it attractive to sell the dollars. They are pull customers. A stronger dollar makes it attractive for Non-Financial customers to sell dollars, and buy euros, because European goods become relatively less expensive.

A natural question to ask is whether a particular group is systematically making profits or losses. An implication of the above argument is that financial customers may be willing to pay a premium in the foreign exchange market in order to buy assets denominated in foreign currencies. Since Financial customers are willing to pay a premium, this means that Non-Financial customers can sell at high prices and buy at low prices. Non-Financial customers behave as profit takers. Non-Financial customers buy and sell at prices that suit them, that is, at prices at which they choose to exercise their option. They do not have to *perceive* themselves as liquidity providers to perform this role.

[12] In less volatile asset markets, we often see that currency risk is hedged.

6 Conclusion

The provision of liquidity is important for well-functioning asset markets. Still, the liquidity of the foreign exchange market, perhaps the most important financial market, is a black box. We know that market makers provide liquidity in the intraday market when exchange rates are floating. This paper addresses the issue of who provides liquidity *overnight* in the foreign exchange market.

To this end we use a unique data set from the Swedish foreign exchange market which covers the trading of several distinct groups over a long time span, from the beginning of 1993 to the summer of 2002. The distinct groups we analyze are: (i) Market making banks; (ii) Financial customers; (iii) Non-Financial customers; and (iv) the Central Bank.

We use the theory of market making to characterize what to expect of a liquidity providing group of market participants, if one exists. There are two characteristics of a liquidity provider: (a) The net currency position of the liquidity provider will be negatively correlated with the value of the currency; and (b) The trading of the liquidity provider will be result of passively matching others' demand and supply.

We have presented several findings supporting the proposition that Non-Financial customers are the main liquidity providers in the Swedish market. First, we confirm that there is a positive correlation between the net purchases of currency made by Financial customers and changes in the exchange rate. Thus, when Financial investors buy SEK, the SEK tends to appreciate. The correlation becomes stronger as we lower the frequency. These findings are consistent with the results of Froot and Ramadorai (2002) and Fan and Lyons (2003).

Furthermore, we find that the positive correlation between net purchases of currency of Financial customers and the exchange rate is matched by a negative correlation between the net purchases of Non-Financial customers and changes in the exchange rate. The coefficient is not only similar to the one of Financial customers in absolute value, but is also very stable. These findings lead us to conclude that Non-Financial customers fulfill requirement (a) above, while Financial customers do not.

Second, we also find that requirement (b), that the liquidity providers passively match changes in the demand and supply of others, is supported for the Non-Financial customers. We find that the trading of Financial customers and Market making banks can forecast the trading of Non-Financial customers, but not the other way. We interpret this as evidence that the Non-Financial customer group is *not* the active part in trading.

Third, in our cointegration analysis we find the two previous points supported for the steady-state long run. The permanent effect of Non-Financial customers' trading is negative, while the permanent effect of Financial customers' trading is positive. More important, we find that there is a close, but opposite, relation between the two flows in the long-run.

It appears that identifying a liquidity provider has been an important issue. Several authors, e.g., Hau and Rey (2002) and several papers by Carlson and Osler, utilize the idea of a liquidity provider comparable to the one identified here. In Carlson and Osler (2000) "current account" traders fill the role of liquidity providers. They assume that these "current account" traders' "demands for currency are [...] determined predominantly by the level of the exchange rate and by factors unconnected to the exchange rate which appear random to the rest of the market."

This paper is a first attempt to address the question of overnight liquidity provision in the foreign exchange market. To what extent can we expect these findings to be generalized to other currencies? The SEK is the eighth most traded currency according to the latest BIS survey of the foreign exchange market. The Swedish currency market is similar to other currency markets in many respects. The trading facilities are similar for most currency markets. Trading in e.g. USD/EUR, SEK/EUR and other currency crosses take place at the same systems. Also, the market shares of Financial and Non-Financial customers found for the Swedish currency market, are very similar to those found for other currency markets.

Our results have implications for the exchange rate determination puzzle. We document that changes in net positions held by Financial or Non-Financial customers are capable of explaining changes in the foreign exchange rate at frequencies commonly used in tests of macro economic models. Hence, it is important to acquire more knowledge about which factors determine different FX flows. This will be the focus of our future research in this area.

Acknowledgements

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Appendix A. Tables

Table 7
Augmented Dickey-Fuller unit root test. *t*-values

	Test include		
	constant	constant and trend	Lags
log(SEK/EUR)	-2.18	-2.14	0
	(0.21)	(0.52)	
Financial pos.	-0.95	-2.41	3
	(0.77)	(0.38)	
Non-Financial pos.	-0.40	-2.31	1
	(0.91)	(0.43)	
10-year differential	-0.96	-2.25	5
	(0.77)	(0.46)	
3-month differential	-0.91	-1.47	5
	(0.78)	(0.84)	
CB pos.	2.77	-3.29	6
	(0.07)	(0.07)	
interdealer pos.	0.55	-1.98	0
	(0.99)	(0.61)	
No. Observations	2215	2215	

Sample: 1.1994-6.2002. Lags determined by Schwartz criterion.

Table 8

Cointegration test

H_0: rank≤	Trace test	Prob
0	19246	0.000
1	32.149	0.006
2	10.878	0.093

Sample: 1.1994-6.2002. Cointegration-test estimated with the Johansen-method. The VAR models the exchange rate change and the flows of the two customer groups. The other variables in the cointegrating vectors are not modeled. Differences of these, and one lag of differences, are included in the VAR. The VAR contains two lags, determined by F-test. In the test the trend is restricted to lie in the cointegration space, while constants are unrestricted.

Table 9

Cointegration results with minimal set of restrictions. Daily observations

	Financial		Non-Financial	
a) Cointegration	SEK/EUR	Non-Fin pos	SEK/EUR	Non-Fin pos
Financial	0.0029	-0.6986	0	-0.61552
	(0.0048)	(0.3301)	(–)	(0.32255)
Non-Financial	0		-0.0021	
	(–)		(0.0034)	
10-year bond diff.	5.53	0	5.24	0
	(1.52)	(–)	(1.59)	(–)
3-month diff.	-2.24	0	-2.13	0
	(1.07)	(–)	(1.05)	(–)
CB-position	0	-1.80	0	-1.92
	(–)	(0.26)	(–)	(0.33)
MM-position	0	-0.81	0	-0.87
	(–)	(0.44)	(–)	(0.49)
Trend	0.00010	-0.008	0.00005	-0.011
	(0.00008)	(0.006)	(0.00003)	(0.006)
b) Error correction term				
ΔSEK/EUR	-0.0114	-0.000103	-0.0118	-0.000106
	(0.0027)	(0.000055)	(0.0028)	(0.000052)
ΔNonFinancial	-0.002692	-0.002692	-0.002606	-0.002606
	(0.001661)	(0.001661)	(0.001559)	(0.001559)
ΔFinancial	0.000319	0.000319	0.000428	0.000428
	(0.001695)	(0.001695)	(0.001591)	(0.001591)
c) Test	Test stat.	p-value	Test stat.	p-value
LR test of restrictions	2.19	0.70	2.20	0.70
No. Observations	2214		2214	

Sample: 1.1994-6.2002. Cointegration estimated with the Johansen-method. The VAR models the exchange rate change and the flows of the two customer groups. The other variables in the cointegrating vectors are not modeled. Differences of these, and one lag of differences, are included in the VAR. The VAR contains two lags, determined by F-test. Standard errors of coefficients in parenthesis. The SEK/EUR cointegrating vectors are normalized on the exchange rate, while the flow cointegrating vectors in column Non-Fin pos are normalized on the position of the Non-Financial customers. Cointegration results are reported as if the normalizing variable is a left-hand-side variable. All cells without standard error are the result of restrictions. The test of the restrictions are reported in panel *c*).

Table 10

Flows and returns and nationality.

	Customers		
	Financial Foreign=Swedish	Non-Financial Foreign=Swedish	Market Makers Foreign=Swedish
F-stat	0.89	0.11	0.01
Prob	0.35	0.74	0.92

	Foreign customers Financial=Non-Financial	Swedish customers Financial=Non-Financial	Swedish Non-Financial =Foreign Financial
F-stat	4.20	0.72	30.22
Prob	0.04	0.40	0.00

The table shows a GMM regression on $(log(SEK/EUR)_t - log(SEK/EUR_{t-30})$. All regressions are for 30-day horizon. In addition to flow variables we include three-month and ten-year interest rate differentials. We only report the test statistics from the test that coefficients are similar (e.g. Swedish=Foreign). Sample: 1.1994-6.2002.

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