Sources of Information Advantage in the Foreign Exchange Market

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Abstract

This paper examines the sources of private information in the interbank foreign-exchange market using a transactions database that includes trading-party identities. We show that sustained post-trade returns rise with bank size, implying that larger banks have an information advantage. The larger banks exploit this information advantage in placing limit orders as well as market orders. We also show that the bank's private information does not come from their corporate or government customers or from some asset managers. Instead, the bank's private information appears to come from other asset managers, including hedge funds, and from the bank's own analysis.

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Introduction

This paper provides evidence that large banks have a substantial information advantage relative to their smaller counterparts. It then traces that information advantage to two sources: (i) the larger banks' more extensive network of financial customers and (ii) the banks' own insights. This analysis has numerous interconnected implications for our understanding of the microstructure of currency markets. It implies that private information is an important source of the positive influence of interbank order flow on returns. It implies that banks of different sizes adopt different business models. It implies that currency dealing banks are not simply conduits for private information generated by end users, but also generate private information of their own. Finally, our analysis indicates that banks use information in placing limit orders as well as market orders, which implies that order books should carry information.

We analyze the complete interbank trading record of an active Scandinavian foreign-exchange dealing bank over a total of four weeks. Our dataset includes over 10,000 trades with roughly 300 other dealing banks worth over €15 billion. Uniquely among comparable datasets, ours includes counterparty identities. Our records are also uniquely comprehensive insofar as they include the bank's interbank trades in all four of the trading venues used by foreign exchange dealing banks during our sample period. Comparable datasets cover at most one of these interfaces. The trading records we study naturally reflect market-wide patterns because interbank trading generally takes place on electronic platforms where dealers cannot direct order flow to specific counterparties.

Our disaggregated data permit us to compare post-trade returns for banks with varying amounts of information. Since the literature suggests that information comes from bank customers, we initially identify a bank's information by the size of its customer base according to contemporary estimates from *Euromoney*. At the top of our four size categories

are *Euromoney*'s largest twenty banks; at the bottom are the banks *Euromoney* ranked below 100 or didn't rank at all.

We document that large banks do have an information advantage relative to small banks in two ways. We use simple averages of post-trade returns, following Anand *et al.* (2005), and structural vector autoregressions (SVARs) between post-trade returns and order flow, following Hasbrouck (1991). The SVARs indicate that a trade's maximum price impact is achieved after roughly five subsequent trades and is sustained indefinitely.

Our evidence suggests that big and small banks operate under different business models. Big, informed banks profit from interbank trading as well as the bid-ask spreads earned from servicing customers. Small banks profit from servicing customers, but loose money on their interdealer trading. They use the interdealer market, nonetheless, because it is the most efficient way to adjust their currency exposure after servicing customers, and because foreign exchange services are a necessary part of any commercial bank's suite of corporate products. Small banks profit on their FX activity as long profits from other customer service activities exceed losses from interdealer trading.

These results are also relevant to our understanding of the nexus between order flow and returns. Three factors potentially explain why order flow has a strong contemporaneous effect on returns: inventory effects, finite elasticity of demand and supply, and private information. Distinguishing among these hypotheses has been difficult because all three have the same first-order implication: positive order flow (stronger net purchases) is associated with a strengthening currency. Our analysis examines a more nuanced contrast. Under the information hypothesis order flow from informed banks should have a stronger relation to post-trade returns than order flow from uninformed banks. Under the inventory and liquidity hypotheses, by contrast, the relation between order flow and returns is determined by factors relevant to all traders and thus should not vary across banks. Under the inventory hypothesis

the key factors are the extent of inventory risk and the market's aversion to such risk (Stoll 1978). Under the liquidity hypothesis the key factor is the elasticity of demand.

The relevance of information to returns gains further support from our finding that trading is positively correlated among informed banks and negatively correlated between informed and uninformed banks. This is consistent with the information hypothesis but inconsistent with the inventory and liquidity hypotheses, which predict zero correlation.

Our evidence complements other new evidence indicating that information is relevant to the nexus between order flow and contemporaneous returns. Indirect support for this hypothesis is presented in Evans and Lyons (2007), who show that the trading of Citibank's end users has predictive power for macroeconomic developments. Evans and Lyons (2005) show that end-user order flow also has predictive power for exchange rates per se. While Evans and Lyons (2007) focus on fundamental information, we take no position on the nature of the information on which banks are trading. Our analysis extends the results from existing studies showing that dealers' information is positively related to their interbank trading activity (Menkhoff and Schmeling 2010; Moore and Payne 2010) and quoting frequency (Phylaktis and Chen 2010).

An important focus of our analysis is the origins of banks' private information. We examine how average post-trade returns for each individual bank is related to the bank's share of business from nine different customer types plus a variable intended to capture the bank's own information: non-financial ("corporate") customers, governments including central banks, unit trusts, mutual funds, insurance firms, pension funds, investment managers, hedge funds, and non-market making banks. All shares are taken from the *Euromoney* FX Survey for 1999. The bank's own information is proxied by the extent of its interbank trading that is orthogonal to its customer market shares.

We find that the banks do not gain information from the trades of corporate customers, governments, unit trusts, mutual funds, and insurance firms. By contrast, the

trades of pension funds, investment managers, hedge funds, and non-market-making banks may bring information to the market. We refer to these customers as "potentially-informed investors." The gains to increasing market share among informed customers can be substantial. Consider a bank like ours, that trades a few billion euros per week. If it gained one percentage point of market share with these potentially-informed financial customers, it could expect to earn an extra €3 million in profits annually from interbank trading. By contrast, raising a bank's share of corporate, government, or uninformed business does not appear to enhance its profitability from interbank speculation, though it could well enhance customer-service income. Among asset managers, our evidence points suggestively towards hedge funds and investment managers as relatively informed.

Our analysis also indicates that the dealers themselves may be an important source of private information in currency markets. We find that a bank with "unexplained" interbank trading one standard deviation higher than the average earns an extra 0.23 basis points per trade or, for a bank of moderate size, an extra €5.7 million per year from interdealer trading.

We provide further support for these conclusions by examining closely why larger banks tend to rely more heavily on aggressive trades (e.g., market orders), rather than passive trades (e.g., limit orders). We regress the banks' share of aggressive trades on their customer market shares plus their residual interbank market shares. The results suggest that a bank's tendency to place aggressive orders is not influenced by its share of corporate, government, or real-money financial customers but intensifies with the bank's share of investment managers and hedge funds. These results also support our previous conclusion that some banks bring their own information to the market: banks with higher residual interbank market share have a stronger tendency to place aggressive orders.

Our evidence suggests that currency dealers aggregate the information in customer order flow as hypothesized by Lyons (2001) and Evans and Lyons (2005, 2007). There are three hypotheses, however, about the nature of the information embedded in customer order

flow. It could be that the trades of corporate customers unintentionally reflect information about the current state of the real economy (Evans and Lyons 2005). The irrelevance of corporate market shares to dealer's returns indicates the information embedded in customer currency trades does not concern the state of the real economy. This is consistent with the limited evidence on this topic (Carpenter and Wang, 2003; Osler et al., 2009; and Osler and Vandrovych, 2009). Alternatively, the trades of an institutional investor might unintentionally reflect information about the current state of investor wealth or risk tolerance. Finally, the trades of the active trading community (hedge funds and the like) might carry information actively acquired through intentional investigation of available data (Osler 2009). The agents that most aggressively seek currency-relevant information are reported to be currency-focused hedge funds and CTAs (commodity trading advisors). Thus the strength of the relation between aggressive trades, on the one hand, and a bank's market share among hedge funds and investment managers, on the other, is consistent with this hypothesis.

None of the extant theories of information – for any type of financial market – envisions dealers as originating private information. The only evidence of which we are aware for dealer-provided information in any market is provided in Valseth (2010), which concerns the Norwegian bond market. The currency-relevant information originated by banks could conceivably reflect the extensive research staffs hired by large dealing banks, with access to the best available data. Dealer comments reported in Oberlechner (2004) suggest, instead, that it reflects dealers' intuition, and research in cognitive psychology confirms that with long experience individuals become intuitively aware of patterns that help forecast outcomes (Gladwell, 2005). Such patterns might not be apparent to researchers far away from the market and focused on data, but might nonetheless become apparent to dealers.

The evidence we present supports the price discovery hypothesis presented by Osler et al. (2009), who suggest that dealers tend to place market orders in the interbank market parallel to the trades of their informed customers and that financial customers bring more

information to the market than corporate customers. Our results also support the strategic dealing hypothesis (Naik et al. 1997) as applied to foreign exchange (Osler et al. 2009; Ramadorai 2008), which states that dealers set narrow spreads to customers who are most likely be informed, with the goal of attracting such trades and potentially inferring the associated information. In order for such behavior to be rational there must be profitable uses for the information. Our paper also confirms Osler et al.'s suggestion that profits from informed interbank trading can motivate the narrow spreads quoted to informed customers.

Our analysis suggests that information influences the placement of limit orders. In recent years it has become widely understood that some informed agents will rationally use limit orders (Kandel and Liu 2006; Bloomfield, O'Hara, and Saar 2005). We find that large banks earn higher returns to their limit orders than small banks, which suggests that banks exploit available information when placing limit orders as well as when placing market orders. These results parallel the findings of Linnainmaa (2010), who contrasts returns to limit orders placed by individual and institutional investors on the Finnish Stock Exchange. These results suggest that there may be information in the order book as well as in order flow (Anand and Subrahmanyam 2008). Empirical evidence that information can be extracted from equity order books is provided in Härdle et al. (2009) and Latza and Payne (2010).

Section 1 describes our data. Section 2 provides evidence that large banks have a significant information advantage in the interbank foreign-exchange market and that their information is fundamental. Section 3 provides evidence that the banks gain their information advantage from their large share of financial-customer business and from their own insights, but not from their corporate-customer business. Section 4 concludes.

1. Background

This section introduces the interbank market, describes our data, motivates our focus on bank size, and shows that interbank trades at our bank reflect previous findings in the literature.

1. Aggressive and Passive Trades: The Structure of the Interbank Market

The structure of the foreign exchange market, though changing rapidly, still has at its core two tiers. In one tier, customers trade with dealers at banks; in the other, dealers trade with each other. A new, third tier has been added within the past decade, in which retail investors trade with trade "aggregators" who, in turn, trade with the dealing banks. Thirty percent of customer trades are intended to cover the transaction needs of firms importing or exporting products for use in production or trade (B.I.S. 2010). Most of the other customer trades are placed by financial firms, a category that includes hedge funds, investment managers, mutual funds, pension funds, endowments, insurance firms, and non-dealing banks. Additional customers include governments, including central banks, and governments. These customer trades are only observed by the parties to the trades, since there are no disclosure requirements in foreign exchange markets.

Individual bank dealers use the interbank market to unload inventory accumulated in customer trades, and they typically do so within just a few minutes. One of their standard responsibilities, however, is to speculate via the interbank market with the bank's own funds. Each dealer has his/her own separate account which is constrained by intraday and overnight position and loss limits. Most dealers begin and end the day with zero inventories.

There are two primary routes for interbank trading. Dealers can call each other directly to request quotes, like regular customers. Far more commonly, however, dealers trade via brokers. In our sample period the major currency markets had already shifted away from voice brokers relied primarily on two electronic brokerages that exclusively served foreign exchange dealers, Reuters Matching and EBS.[1]

[1] The market structure has changed somewhat since the time of our sample, but not in ways that challenge our analysis. Selected large, active hedge funds are now permitted direct access to the interdealer market, but their presence has not affected the basic structure of trading. Further, the

The possibility of both direct and indirect interbank trading complicates our nomenclature. Most readers will be familiar with the simple dichotomy of order-driven markets: limit orders and market orders. In the foreign exchange setting, however, we must generalize these concepts to "aggressive trades" and "passive trades." The aggressor is the bank placing the market order or the bank that calls another bank directly. The passive counterparty is the bank placing the limit order or the bank that provides a quote when called directly by another bank.

2. Data

Our data include detailed information on the interbank transactions of three spot traders working for a large Scandinavian bank. We focus on the dealers' dollar-mark trades during March 2 through March 6, 1998 and their euro-dollar trades during August 2 through August 20, 1999.[2] (The change of currency reflects the adoption of the euro in January 1999.) Results from the two samples are entirely consistent, though the latter sample provides greater precision since it has many more observations. The key features of the market that would create information asymmetries, including the extent frequency of a bank's customer trades and the nature its customers, have not changed over the intervening years, despite the market's many other changes. Thus data from 1998 and 1999 should be fully suitable for examining our core questions.

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largest dealing banks have been enlisted to provide liquidity on ECNs (e.g., Hostpot FXi). However, since the banks' role there is primarily to place limit orders they are unlikely to trade much with each other in those settings.

[2] One of the dealers examined in Bjønnes and Rime (2005) is not included here because he had only a limited number of dollar-mark trades.

We believe this is the first interbank transactions dataset that includes counterparty identities and that comprehensively covers all interbank trading venues.[3] Most microstructure datasets include trades through just one exchange, but our data cover trades with electronic brokers, trades with voice-brokers, and internal trades (trades within the bank). For each trade we know the time of the transaction; the name of the counterparty; the trade initiator; the quantity traded; and the transaction price. Our analysis uses transaction time and trades are in correct chronological order. Hence, we can also track each dealer's inventory position.

The 1998 data include 2,043 transactions worth in aggregate roughly $4 billion. The 1999 dataset is substantially larger, with 9,306 transactions worth in aggregate almost €15 billion. For both samples the frequency of trades is on the order of one transaction per minute. There were 259 counterparty banks in 1998 and 287 in 1999. In both years, over 90 percent of trades were entered electronically and the majority of these were executed through an electronic broker.

The dealers start trading between 8 am and 9 am local time, which corresponds to GMT+2 hours for the data set from August 1999 and GMT+1 hour for the data set from March 1998 (Central European Summer Time and Central European Standard Time, respectively). The dealers typically stop trading between 4 pm and 6 pm local time. The dealers are active throughout the trading day as illustrated in Figure 1, which compares our dealers' trading with overall trading on EBS during the 1999 sample period, focusing on European trading hours: 6 am to 4 pm GMT. For each hour we calculate the number of trades by our dealers and divide by their total number of trades between these hours during the sample period. Similarly, we calculate the number of trades on EBS for each hour and divide

[3] Evans and Lyons (2007), Carpenter and Wang (2007), Bjønnes, Rime and Solheim (2005), and Osler et al. (2009) study customer data disaggregated into different groups, like financial and non-financial.

by the total number of trades during these hours during the sample period. Trading intensity by our dealers is highly correlated with overall trading intensity on EBS. Activity is quite high between 6 am and 9 am; it falls from 9 am to noon, when the US market opens, and then increases rapidly. The modestly lower share of our dealers' trading between 6 am and 7 am, and again between 2 pm and 4 pm (GMT), suggests that the correlation between our dealers' trading pattern and that of other European dealers would be stronger, if data on European dealers per se were available. Early in the European morning many Asian traders are still active; likewise, in the European afternoon many US traders have entered the market.

Our other important source of data is the *Euromoney* Annual Foreign Exchange Survey, specifically those of 1998 and 1999. This survey, which is widely respected within the practitioner world, solicits information about foreign-exchange dealers from their customers. The information includes the volume of the customer's business with a dealer and that dealer's rating on a number of different client service dimensions.

3. Information and Bank Size

The nature of information differs between equity and currency markets. In currency markets, much of the relevant asset-specific information concerns a country's aggregate macroeconomic conditions and is therefore revealed publicly in macro statistics.[4] A casual observer might wonder whether private information is even a well-defined concept in currency markets. Substantial evidence now shows, however, that there is private information in currency markets. Evans and Lyons (2005) show that customer order flow has predictive power for exchange rates. Evans and Lyons (2007) show that customer order flow also has predictive power for macroeconomic variables. As discussed in Osler et al. (2009), dealers

[4] There are minor exceptions, such as inside information that a central bank is about to intervene.

make great efforts to gather information from customer trades, even subsidizing the trades of informed customers with relatively narrow spreads.[5]

Dealers appear to aggregate information from the customer trades and then profit from that information in their interdealer trading (Osler et al. 2009). This could explain the consistent claim, by practicing foreign exchange dealers, that larger banks – which have more customers from whom to gather information – are better informed than others (see, e.g., Cheung and Chinn 2001). We asked the three foreign exchange dealers studied here to rank their interbank counterparties on a scale of 1 – best informed – to 5 –uninformed. Our dealers strongly agreed with each other, as indicated by the fact that the three correlations among their individual rankings were all 0.90 or higher and statistically significant. These information rankings are also strongly related to bank size, which we measure using estimates from *Euromoney*: the Spearman rank correlation between the average of the three dealers' informativeness ratings and the banks' *Euromoney* size ranks is 0.82.[6]

To search for information asymmetries in the foreign exchange market we therefore group the banks into four size categories according to the *Euromoney* size estimates. The "Immense" banks are among those ranked from 1 to 20, inclusive. The "Big" group includes banks ranked from 21 to 50. We refer to the Immense and Big banks jointly as "larger banks." The "Medium" group includes banks ranked from 51 to 100; the "Small" group includes banks ranked higher than 100 or not ranked at all. We refer to banks in the two lowest size categories as "smaller" banks.

[5] According to a Citibank manager in the *Financial Times*, April 29, 1991: "if you don't have access to the end user, your view of the market will be severely limited."

[6] To rank a bank's overall size we used the overall assessment of the top 100 foreign exchange banks of 1998 (since our questionnaire was done in 1998), or, if a bank was not ranked in 1998, the 1999 rank.

A more concrete description of the banks in each size group may be helpful. In *Euromoney*, the Immense banks include such household names as Deutschebank and Citibank, along with slightly less familiar names such as Standard Chartered Bank. *Euromoney*'s Big banks include Dresdner Bank, Lloyds Bank, and Sumitomo. *Euromoney*'s Medium banks include ANZ (Australia and New Zealand Bank), Bank of Nova Scotia, and Mitsubishi Trust Bank. According to a market insider unconnected to our bank, the Small bank group could include such institutions as the Landesbank of Rheinland, Moscow Narodny Bank, or the Maruitius Commerce Bank.[7]

Our own bank is a Big bank in terms of this ranking. Since our results largely measure performance of other banks *relative to our bank*, the key inference is that our bank's customer business is neither extremely large nor extremely small. Our bank's interbank trading, by contrast, might be ranked higher: de Jong, Mahieu and Schotman (1998), which study the same bank, documents that during the mid-1990s it was among the nine most active banks in posting indicative quotes on Reuters. While this is a noisy signal in today's market, during that period it was fairly reliable. Further, we have been told informally that our dealing bank ranked among the largest ten users of one electronic foreign exchange broker and among the fifteen largest users of the other. The results presented below consistently support the Big ranking based on customer trading.

Table 1A provides descriptive statistics for electronic trades between our bank and the other banks in these four size categories. The mean number of trades per bank is monotonically related to size: during the 1999 sample our bank traded on average 148 times with each immense bank but only 12 times with each small bank.[8] Table 1B shows that trade

[7] These banks need not be included in our sample; their names are included here purely for illustration.

[8] Individual trader strategies; which are addressed in Bjønnes and Rime (2005), are not central to our

sizes are fairly consistent across banks of all sizes. The median trade size is 1 million for all bank groups in both sample periods (trades were denominated in US dollars in 1998 and in euros in 1999), confirming earlier evidence that trade size is fairly standardized. Mean trade size generally rises modestly with bank size: the Immense banks' mean trade is only 16 percent larger than the Small banks' mean trade in the 1998 sample and 27 percent larger in the 1999 sample.

Table 1A also reveals how little concentrated the foreign exchange market was during this period (it is more concentrated today). There were more banks in the Smallest category than the total number of banks in the larger three categories combined.

4. Standard Order-Flow Regressions

To show that our data reasonably represent the entire interbank market we run standard order-flow regressions, in which returns are regressed against contemporaneous order flow. Returns are measured as log changes in mid-quotes.[9] Order flow is measured as net aggressive buys against our bank (i.e., net purchases at our bank's quoted prices). We choose a half-hour time horizon, though this is immaterial: the results barely change if we choose an hourly time horizon.[10] In Table 2, Panel A, all order flow is aggregated into a single variable; in Panel B, order flow from each bank category is included separately.

The results confirm that our data display the same positive relation between returns and contemporaneous order flow documented elsewhere (e.g., Evans 2002; Evans and Lyons 2002; Hau, Killeen and Moore 2002; Payne 2003). We also replicate the typical finding that

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analysis.

[9] Our dataset only contains traded prices. In order to create midquotes, to avoid bid-ask bounce in the estimation, we subtract (add) one pip from ask (bid) prices since the interbank quoted spread was between 2 and 3 pips in 1998 and 1999 (see Bjønnes and Rime 2005; Goodhart *et al*. 2002).

[10] These results, suppressed to save space, are available upon request.

order flow can explain sizable amount of the variation in return. The estimated coefficients suggest that every additional net market buy order – each of which is typically worth between €1 and €2 million – strengthens the euro by one-half to one basis point.

We also run regressions in which order flow from different-sized banks is included separately (Panel B). These indicate that order flow of Immense and Big banks has a strong and significant relation with contemporaneous returns while order flow from Medium and Small banks does not. The negative coefficient on the Medium (1998) and Small (1999) banks can be interpreted as a liquidity-providing role for these banks. Though these regressions suggest that bigger banks are relatively informed, their support for this hypothesis is weak since it is difficult to discern causality at half-hour intervals. A half-hour is a very long time in currency markets, where trading exceeds $4.0 trillion daily (B.I.S. 2010) and euro-dollar is traded on average more than once per second in the interbank market. With half-hour time intervals, any causal relation between returns and order flow could be masked by feedback effects. To identify structural relations it is necessary to tease out lead-lag relations for individual transactions, and this in turn requires data on individual trades. The next section undertakes such an analysis.

2. Information and Bank Size

This section examines post-trade returns and structural VARs to show that large banks have an information advantage relative to their smaller peers in interbank currency trading.

1. Post-Trade Returns

We calculate average signed post-trade returns (positive if the counterparty bank buys, negative otherwise) for banks in each size category. This is inspired by the analysis of Anand et al. (2005), though there are some noteworthy methodological differences. First, we measure returns as the log change in the bid (ask) quote if a trade is settled at the bid (ask) while Anand et al. measure returns as the change in the mid-quote. More critically, we only

calculate returns to realized trades while Anand et al. include returns to all submitted limit orders. Since limit orders are subject to picking-off risk this adjustment can have significant impact on measures of returns, as documented in Linnainmaa (2010). Finally, Anand et al. focus on returns at the five-minute horizon while we focus on returns at the one-minute horizon. This choice is motivated by the fact that dealers at our bank close their positions within thirty seconds on average (Bjønnes and Rime 2005).

We first carry out this analysis for all trades with our bank; we then repeat the analysis separately for other banks' aggressive trades against our bank and other banks' passive trades against our bank. The independent variable is always coded one (negative one) if a bank buys from (sells to) our bank.

The average signed returns following all trades, shown in Table 3A, rise strongly with bank size. Indeed, the Immense banks' net purchases against our bank tend to be followed by price increases while the smallest banks' net purchases against our bank tend to be followed by price decreases. The difference between the Immense- and Small-bank coefficients exceeds one-half basis point and is highly statistically significant in both samples. Using the 1999 sample, we find that if an Immense-bank dealer trades €2 billion per week (our dealers traded an average of €1.6 billion per week in the 1999 sample), it would earn an extra €7.3 million per year for its bank compared to its earnings if it traded the same amount at a small bank.

Table 3A shows that larger banks typically place more aggressive trades, as a share of all trades, which further supports our hypothesis that banks with the more customer business are better informed. The literature shows that when traders have short-lived information their optimal strategy is to trade aggressively, thereby increasing the chance that they can exploit the information before it becomes embedded in price (Kaniel and Liu 2006). Banks that have access to more information, on average, should thus rely more heavily on aggressive trades, and indeed, the share of aggressive trades among all trades varies positively with bank size.

In the 1999 figures, for example, the share of aggressive trades exceeds 60 percent for Immense banks, and falls below one-third for Small banks.

We next calculate post-trade returns separately for the other bank's aggressive and passive trades, with the results shown in Table 3B. Post-trade returns tend to be much higher after aggressive trades than passive trades, consistent with the hypothesis that banks rely relatively heavily on aggressive trades when they are informed. Indeed, average returns after aggressive trades are positive and significant for banks of all sizes in the 1999 sample and for the three largest sizes in 1998; by contrast, average returns after passive trades are negative and significant for banks of all size categories in both samples. We interpret the negative returns to other bank's passive trades as indicating that our own bank – who is the aggressive counterparty on every such trade – tends to use aggressive trades when it is informed. We note that even smaller banks are sometimes informed: post-trade returns associated with aggressive trades are positive and statistically significant in both samples for Medium-sized banks and in the (larger) 1999 sample for Small banks.

Average-post trade returns remain broadly consistent with the idea that the trades of larger banks carry more information, on average, since post-trade returns are significantly higher for immense banks than small banks for both types of trades (aggressive, passive) and in both sample periods. The fact that larger banks lose less than smaller banks following our bank's aggressive trades indicates that larger banks use their information in structuring their passive trades and are therefore better protected vis-à-vis our bank when it is informed.

Since bigger banks tend to make bigger trades, one might wonder whether the bigger banks' higher average post-trade return to aggressive trades is due solely to larger trade sizes. However, the size differential for trades is a small fraction of the size differential for price impact. Immense-bank trades are only about 20 percent bigger than Small-bank trades while the proportionate price impact of Immense-bank trades is at least twice as large as that of Small-bank trades. Since price impact has a concave relation with trade size (Hasbrouck

1991, Osler and Vandrovych 2009), we infer that trade size is unable to account for the higher price impact of the Immense-bank trades.

The foreign exchange literature has generally focused on the information content of order flow, which means it focuses on aggressive trades. While the broader microstructure literature initially assumed that informed trades were always aggressive (e.g., Glosten 1994), it is now understood that limit orders can be a rational choice for informed traders. Informed banks might rationally place limit orders when they expect their information to affect prices slowly (Kaniel and Liu, 2006). Alternatively, they might serve as liquidity providers – hoping to capture the spread – when their information indicates that the market is fairly priced and picking-off risk is relatively low (Bloomfield, O'Hara, and Saar 2004). Our evidence complements existing evidence emerging from stock markets that there is information in limit orders (Linnainmaa 2010) and limit-order books (Härdle et al., 2009; Payne and Latza 2010).

2. SVARs

The post-trade returns examined in the previous subsection correspond to very short time horizons, leaving open the possibility that they reflect inventory or liquidity pressures rather than information. For example, if the larger banks are splitting large orders, they themselves may follow up a given trade with another in the same direction, generating their own positive post-trade returns. To examine more carefully whether the exchange-rate impulse from individual dealer trades is transitory or permanent we next examine how returns respond to order flow using Structural Vector Auto Regressions (SVAR). For banks in each size group we measure order flow once again as aggressive purchases from our bank and run two SVARs, one for each sample period.

Each SVAR has a structure with exchange rate return ordered last, hence responding to shocks to all of the four order flow measures.[11] The four groups of order flow are treated

[11]Overnight-returns are excluded from all samples. Since we have transaction prices and not

symmetrically, so they only respond to their own shocks and to lags of all variables.[12] The SVARs have two lags, with lag length chosen according to the Schwartz criterion. Following the recommendation of Hasbrouck (1991) and consistent with Payne (2003), every trade is one observation, so order flow for a specific bank group is always +1 (aggressive buy), -1 (aggressive sell), or 0 (no transaction). If information is the source of the larger banks' higher post-trade returns, their higher initial price impact will be sustained indefinitely.

The impulse-response patterns revealed by these regressions, shown in Figures 2A and 2B, are quite similar across our two sample periods, though the confidence intervals are narrower for the large 1999 sample. Consistent with previous results, returns respond positively to order flow from banks of all sizes. The response is initially small but rises quickly to a sustained level.

If the exchange rate's response to order flow stems only from liquidity effects, the dynamic relation between order flow and returns would be the same for banks of all sizes. However, the strength of the response rises monotonically with bank size consistent with our maintained hypothesis of information asymmetries in the FX interbank market.[13] In the more-

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midpoints, we used the following procedure to calculate midpoints: For the data set for 1998 we subtracted 0.75 pips from prices on buy market orders and added 0.75 pips on prices from sell market orders. Similarly, for the data set from 1999 we subtracted 0.5 pips from prices on buy market orders and added 0.5 pips on prices from sell market orders. The spread was estimated using the Huang and Stoll (1997) model. See Bjønnes and Rime (2005) with regards to the data set from 1998. Results for the data set from 1999 are available upon request.

[12] Alternatively one could use a block-triangular structure, e.g. with the Immense banks at top, and the Small banks last, but before return. Results, which are very similar, are available on request.

[13] In unreported results we aggregate the banks and estimate just one SVAR between order flow and returns per sample period. The cumulative impact of a positive shock is between 0.4 and 0.5 basis

precise 1999 results, an unexpected one unit positive shock from the Immense banks increases the mid-quote by 0.8 basis point while a one unit shock from the Small banks increases the mid-quote by 0.3 basis point. Table 4 confirms that the difference is statistically significant. Additional evidence consistent with the information hypothesis is provided in Payne (2003), Evans (2002), Evans and Lyons (2002), and Hau, Killeen and Moore (2002).

In all cases the response of returns to order flow appears to be sustained indefinitely after about five transactions. This suggests that the information included in order flow is fundamental. Since our bank trades roughly once per minute, it appears that the exchange rate during this period responded fully to information within about five minutes.

The relevance of information for passive trades, including limit orders, is indicated yet again by a second SVAR analysis, where the focus this time is the other banks' passive trades or, equivalently, our own bank's aggressive trades (Figure 3). As noted earlier, if the relation between order flow and returns is driven solely by liquidity the responses to these trades should be similar across bank size groups. We find, however, striking differences across bank size groups. When our bank trades aggressively against Immense banks, the trade's price impact is significantly negative, while it is significantly positive when our bank trades aggressively against Medium and Small banks. Table 4 shows that Immense and Small banks are also significantly different in the 1998-sample. This is consistent with the hypothesis that the Immense banks' limit orders (and other passive trades) are better informed than those of the Medium and Small banks, on average. It further indicates that our bank's aggressive trades are less informed than the passive trades of the Immense banks and better informed than the passive trades of the Medium and Small banks. The average return following an aggressive trade by our bank with another Big bank is about zero, once the price

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points for both sample periods, which is comparable to the effect of 0.5 basis points found by Payne (2003) for the overall market.

settles down. This indicates that our bank, whose size puts it in the "Big" category, is about equally informed as the other Big banks.

3. Correlated Trading and Position-Taking

We finish this section by examining two extensions of the hypothesis that large banks are better informed than smaller banks. The first concerns correlations between the net purchases of our four bank groups, using an half-hourly time horizon, and the second concerns price dynamics when banks take positions.

Trading Correlations: If bank size and information vary positively, then purchasing patterns should vary predictably across bank size groups. To fix ideas, suppose two banks learn that the euro is likely to appreciate while all other banks remain uninformed. The informed banks will try to buy euros and will also try to avoid selling euros. The uninformed banks, in their ignorance, will continue both buying and selling. The informed banks would be unlikely to trade with each other and would be more likely to trade with uninformed banks. If the size differences do not reflect information then there is no reason these correlations would be anything but zero.

The hypothesis that larger banks are better informed than smaller banks has three predictions for trading correlations, all of which are confirmed by the actual correlations across groups (Table 5).[14] These patterns are most pronounced for the banks in the extreme size categories.

1. *Implication: Net purchases of informed bank groups should be positively correlated with each other.* Finding: The correlation between the Immense and Big banks is positive and statistically significant in both samples.

2. *Implication: Net purchases of the informed banks should be negatively correlated with net purchases of the uninformed banks.* Finding: All the correlations between the

[14]The strength of these patterns suggests that our sample is indeed representative of the broader market.

Medium and Small banks with the Immense and Big banks are negative, and most of these are statistically significant. The negative correlation between banks in the extreme size categories is always statistically significant.

3. *Implication: Net purchases of uninformed banks should be either uncorrelated with each other (since their trades are unrelated to information) or positively correlated with each other (since they will tend to trade against the informed larger banks).* Finding: The correlation between Medium and Small banks is positive and significant in the 1998 sample while in the 1999 sample it is economically and statistically insignificant.

Position Taking: It is also instructive to examine our bank's counterparties when it is most likely to be informed. This analysis (which does consider the likely motivation of each trade, unlike the earlier analysis) assumes that dealers are most likely to be informed when they expand an inventory position. The basis for this assumption is the fact that FX dealers typically carry zero inventory when they are not speculating, which implies that aggressive interbank trades undertaken to expand an inventory position are more likely to be speculative than aggressive interbank trades to reduce an inventory position.[15] We cumulate the observed trades of our individual dealers to assess their inventory position throughout, on the basis of which we distinguish aggressive trades that are inventory-accumulating or inventory-de-cumulating. Earlier published research shows that our dealers' inventory-accumulating trades tend to be quite profitable, which suggests that they are informed. (The profitability of such trades is documented for the 1998 sample in Bjønnes and Rime (2005); profitability in the 1999 sample is comparable.)

[15]In studying our dealers' accumulating trades, we noticed that occasionally the resulting position is immediately unwound via an offsetting customer trade or direct interbank trade. Since this type of inventory accumulation seems unlikely to represent speculation, we further narrow the set of trades on which we focus to those that are not immediately followed by a customer or direct interbank trade of the opposite sign, though we continue to refer to these as "accumulating" trades.

Suppose our bank has information and makes an aggressive accumulating trade. If all banks are equally informed, the likelihood that it trades with banks of any given size should be the same as that group's share in any other type of trade. If large banks are better informed, by contrast, when our bank is informed it would trade relatively more frequently with smaller banks and less frequently with other large banks.

Table 6 shows the share of each bank group in our own bank's accumulating trades and also, as a point of reference, in our bank's de-cumulating trades. The pattern conforms to the predictions of the hypothesis that large banks are relatively well informed. In 1999, for example, 37 percent of our bank's accumulating trades but only 21 percent of our bank's de-cumulating trades were with Small banks; similarly, Immense banks accounted for only 25 percent of our bank's accumulating trades but for a full 36 percent of our bank's de-cumulating trades. More broadly, the ratio of our bank's accumulating trades to de-cumulating trades is inversely related to counterparty-bank size and the differences are statistically significant.

3. Sources of Private Information in FX

So far this paper has shown that bigger banks have an information advantage relative to their smaller peers when trading in the interbank foreign-exchange market. This raises a fundamental question: Which agents bring private information to the market?

At present there is only limited evidence about which customer types bring information to the market. Evans and Lyons (2005) suggest that corporate firms unintentionally bring information to the market because their trades passively reflect the state of the economy. Individual firms cannot generalize from their own situation to that of the economy as a whole, but dealers can discern economy-wide patterns after observing myriad corporate trades.

Financial order flow could logically anticipate upcoming exchange-rate returns since international asset managers have an incentive to predict how that value will change. That incentive is intensified by their tendency to trade in large amounts (Osler et al. 2009). Hedge funds and other members of the "active trading community" are known to aggressively seek profitable currency trading strategies, in part by hiring "quants" and members of the academic elite to advise their asset-allocation decisions. Practitioners report, however, that some asset managers – generally real-money funds – tend to ignore the currency component of their returns. For example, a report on currency management by Taylor and Farstrup (2006) states:

> [T]here are key participants in foreign exchange markets … that are not always seeking profit derived *from their currency positions* …. [I]n this category are international equity managers. While some managers factor in currency positions as they go about picking foreign stocks, most are attempting to add value through stock, sector, and region bets rather than currency plays (p. 10, italics in original).

The interaction between banks and customers has become technologically more sophisticated during recent years. Most notably, many transactions now take place over multi-bank portals, the advent of which has brought tighter spreads and less loyalty among customers. Nonetheless, the nature of end-users in currency markets, and their relation to information, has been fairly stable. By the mid-1990s currency-focused hedge funds were already a major presence in the market and they have remained so. A bank's customer trades still provide noisy but private signals of any information possessed by the customers, and trading with more informed customers seems likely to improve the precision of the bank's overall information.

To investigate the source of banks' currency-relevant information, we turn again to the *Euromoney* Foreign Exchange Survey. This provides estimates of the dollar value of each bank's business with nine customer types: corporations, governments (including central banks), trusts, mutual funds, insurance firms, pension funds, investment managers, hedge funds, and non-dealing banks. From these we calculate each bank's share of the customer

business for each customer type. We then evaluate how the banks' market shares influence their information in regressions where a bank's information is measured by its market-relevant information, which in turn is measured in terms of average one-minute post-trade returns or "price impact." In this context, however, we take an average return across the trades of each individual bank, denoted with a subscript "*b*": PI_b. After excluding banks with fewer than 20 trades we have a sample of 108 banks.

As shown in Table 7, correlations among market shares tend to be fairly high. Positive correlations among market shares are expected since big banks tend to have higher market shares in all customer segments when compared with small banks. This raises concerns about multicollinearity which lead us to adopt the following estimation strategy. We run a number of regressions, in each of which the dependent variable is the bank's average post-trade returns and the independent variables include market shares for corporate (*CORP*) business and government business (including central bank trades; *GOV*), as shown below:

$$PI_b = \alpha + \beta_1 CORP_b + \beta_2 GOV_b + \beta_3 Type_b + \beta_4 IBK_b + \eta_b \ . \qquad (1)$$

Each regression also includes the market share for one type of financial customer: $Type \in$ {Unit Trusts, Mutual Funds, Insurance Firms, Pension Funds, Investment Managers, Hedge Funds, and Non-Dealing Banks}. If the market-share variable is insignificant it seems reasonable to infer that such customers do not bring information to the market. However, inference here is not symmetric: if the market-share variable is significant we cannot assert that such customers do bring information to the market, only that such customers might bring information to the market.

Each regression also includes a variable that allows us to examine the possibility that banks bring their own information to the market. Existing research focuses almost exclusively on the contribution of customers to private information. The one exception of which we are aware is Valseth (2010), which finds that bond dealers in Norway contribute

information beyond that provided by their customers. Reasoning that the extent of a bank's own insights will be reflected in the extent to which it trades in the interbank market beyond that required to handle its customer business, we regress the banks' share of total interbank trades (in our sample) on the same customer market-share categories included in Equation (1). We include the residuals from this regression in Equation (1) as IBK_b.[16]

We use weighted least squares, using a bank's total number of interbank trades as weights, with Newey-West HAC-adjusted standard errors and covariance matrix. The weights compensate for the presumably inverse relation between measurement errors in the dependent variable and a bank's total number of trades. The relevant descriptive statistics are presented in Table 8. The banks' market shares naturally average a bit below 1 percent, given our sample size of 108. (The residual interbank market shares change across regressions so the descriptive statistics, which are intended only to be indicative, are taken from the regression in column (8) of Table 9, Panel A.)

The results, provided in Table 9A, indicate strongly that corporate and government trades do not bring information to the market. Coefficient on these market shares are economically and statistically insignificant in almost every regression. The results also indicate that the trades of certain financial customers, specifically unit trusts, mutual funds, and insurance firms, likewise do not carry information. This seems inconsistent with standard models of asset managers, which assume perfect rationality, and it could conceivably reflect imperfect rationality at such institutions given the strong evidence for irrationality among the forecasts of professional exchange-rate watchers (MacDonald 2000). Alternatively, it could reflect a superior rationality, given the literature's robust finding that the major exchange rates are well-approximated as a random walk.

The regression coefficients are positive and significant for pension funds, investment

[16] Results are qualitatively similar if we use actual market shares rather than the residuals from the regression. These results are available upon request.

managers, hedge funds, and non-market-making ("non-dealing") banks, consistent with the hypothesis that these agents bring information to the market. Because of the high correlations among market shares of financial customers shown in Table 7, however, we cannot conclude that all these groups bring information to market. We suspect, in particular, that pension funds and non-dealing banks bring little information to the market, and their coefficients are significant because the market shares of these groups are strongly correlated with the market shares of hedge funds and investment managers. (Our suspicion is based in part on the higher explanatory power for hedge funds and investment managers and in part on the insignificance of pension funds and non-dealing banks in the regressions of Table 9C.) Market participants suggest that the information brought to the market by investment managers would essentially be an extension of the information brought by hedge funds, since some significant hedge funds trade through the broker dealers included in the category of investment managers.

The final regression in Table 9A includes all customers, but groups them into four categories: corporate customers, governments, previously-insignificant financial customers (*No-Info Fin*) and previously-significant financial customers (*Info-Fin*), which we interpret as potentially informed. This regression confirms that corporate customers, governments, unit trusts, mutual funds, and insurance firms do not bring information to the currency market, and confirms that some of the remaining four financial-customer groups – pension funds, investment managers, hedge funds, and non-dealing banks – are informed.

These results confirm the conclusion of Section 2.2 that trade splitting is not a major influence on our results. If autocorrelation associated with trade splitting generates the positive influence of market share on post-trade returns, it will have roughly the same effect for all customer types. However, the coefficient on customer market share is only significant for the potentially-informed financial customers.

To get a sense of the economic magnitude of the information brought to the market by customers, consider a dealer that raises its market share among informed financial customers

by one percentage point (roughly half of a single standard deviation). Column 8 in Table 9A indicates that returns in the first minute after its interbank trades are 0.12 basis points higher, on average, which implies the bank would earn an extra €12 per €1 million traded. During our 1999 sample, our bank's three euro dealers traded an average of €4.8 billion per week in the interbank market (together). Thus, an extra €12 per €1 million traded would have meant additional profits of roughly €57,120 per week or €3 million per year.

To assess the value of bank-originated information we examine the coefficient on the residual portion of the interbank market share in the comprehensive regression (column 8). This suggests that a one-percentage-point increase in this residual market share is associated with an additional 0.23 basis points per trade, which would be associated with an estimated €5.7 million in extra profits annually at our bank. We hasten to qualify this figure in two ways. First, the standard deviation of residual interbank market shares is roughly half as large as that of the potentially-informed customers. Second, care needs to be taken when inferring causality. While it seems reasonable to think that customer market share causes higher trading profits, it seems unlikely that residual interbank market share causes trading profits. Instead, residual interbank market share and trading profits seem likely to be jointly caused by higher bank-generated information.

It could be argued that big banks might have a larger average price impact because they place more market orders (Table 3A) and market orders have bigger average price impact (Table 3B). We therefore re-calculate post-trade returns, subtracting from each aggressive trade the average price impact of all aggressive trades and subtracting from each passive trade the average price impact of all passive trades. The results from running Equation (1) with adjusted returns are shown in Table 9B. The coefficients on all market-share variables drop noticeably, as one would expect, but our qualitative conclusions are unchanged. The coefficients for corporate customers, governments, unit trusts, mutual funds, and insurance firms remain statistically insignificant, indicating that these groups do not

bring information to the market. The coefficients for pension funds, investment managers, hedge funds, and non-dealing banks remain positive and significant, marking these financial customers as potential sources of information. As before, the explanatory power is roughly 10 percentage points higher for hedge funds and investment managers, suggesting that they bring more information to the market than pension funds and non-dealing banks. The comprehensive regression in column (8) suggests that a bank with an extra 1 percentage point market share for potentially-informed customers would bring extra returns of 0.06 basis points per trade, on average. At our bank this implies additional profits of €1 million annually. A bank with an extra one-percentage-point residual interbank market share would earn an extra 0.12 basis points on its trades, on average, and an additional €3 million annually.

We next look for evidence of information in the frequency with which a bank makes aggressive trades. If aggressive trades tend to be placed when banks are informed, then a given bank's share of aggressive trades should rise with the extent of its information sources. We run the same set of regressions just described but with the share of aggressive trades in a bank's total trades as the dependent variable. We rely once again on weighted least squares with Newey-West HAC-adjusted standard errors and covariance matrix:

$$ShrAgg_b = \alpha + \beta_1 CORP_b + \beta_2 GOV_b + \beta_3 Type_b + \beta_4 IBK_b + \eta_b$$

The results of these regressions, shown in Table 9C, continue to indicate that corporate customers, governments including central banks, and many real-money asset managers do not bring information to the currency markets. (Though the corporate-customer market share is often significant when some other customer categories are excluded, it becomes insignificant when all customers are included.) These results are also consistent with our conclusion that banks bring their own original information to the market. Consistent with the R^2s of the previous regressions, the regression coefficients suggest that, among financial customers, only investment managers and hedge funds bring information to the market. A

one-percentage point increase in the bank's share of potentially-informed customer business (defined, as earlier, to include pension funds and non-dealing banks) is estimated to raise a bank's tendency to place aggressive orders by 1.7 percentage points relative to the overall average of 50 percent. A similar increase in the bank's unexplained share of interbank trading would raise the bank's tendency to place aggressive orders by 4.3 percentage points.

One difficulty with the regressions reported above is the high correlation among a given bank's market share among different customer types. As a robustness check we thus examine regressions that include a bank's overall market share and plus the gap between that overall share and its share for one of the three main customer types – corporate, informed financial, and uninformed financial. We also include the bank's residual interbank trading share:

$$PI_b = \alpha + \gamma OverallShare_b + \delta_1 NetType_b + \delta_2 IBK_b + \eta_b \ . \qquad (1)$$

Only one of the three types is included in a given regression because the "*NetTypes*" necessarily have a strong negative correlation. Strikingly, the strongest negative correlation – -0.77 – is between more and less informed financial customers. The correlation between corporate customers and more (less) informed financial customers is -0.31 (-0.28). This suggests that the dealing banks tend to specialize in certain types of financial customers.

The results, shown in Table 10, indicate that corporate trades carry statistically significantly less information than those of both types of financial customers. When "No-info financial" is included as independent variable the coefficient is negative (but not significant), while the coefficient on "Info financial" is positive and highly significant when included as independent variable.[17] The coefficients on total market share and residual interbank trading

[17] Unreported results provide further evidence that hedge funds and investment managers are better informed than pension funds and non-dealing banks. When informed financial customers are defined to include only the hedge funds and investment managers, the coefficient on their market share is positive and statistically significant. When informed financial customers are defined to include only

share are both positive and highly significant in all regressions.

This final section has examined the sources of information for currency-market dealing banks. One approach to this analysis focused on the banks' average price impact; the other focused on the strength of the banks' tendency to place aggressive orders. These two approaches direct us to similar findings. First: Non-financial corporations, governments, and certain financial customers – specifically unit trusts, mutual funds, and insurance firms – do not bring private information to the market, on average. Second: Other financial customers do bring private information to the market; included in this category could be hedge funds and investment managers. Third: The banks themselves bring substantial private information to the market.

4. Conclusion

This paper examines sources of information advantage in the foreign-exchange market. It first shows that large banks have an information advantage, relative to small banks, in the foreign exchange interdealer market. It then traces that advantage to two sources of private information: the larger banks' more extensive network of hedge funds and other relatively aggressive financial customers, and the large banks' own ability to generate market insights.

Our data comprise the complete record of interbank transactions at a big Scandinavian bank during four weeks of 1998 and 1999. Using the methodology of Anand et al. (2008), we document the information advantage of large banks by comparing average post-trade returns to banks of different sizes. We also use structural VARs, as in Hasbrouck (1991), to show that the big banks' larger post-trade returns are sustained indefinitely, which suggests that the returns are indeed driven by information and their is fundamental.

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the pension funds and non-dealing banks, the market share coefficient is insignificant and the regression's explanatory power is substantially lower.

We evaluate the information content of order flow from nine types of customers, using cross-sectional regressions in which the dependent variable is each bank's average post-trade return and the key independent variables are its customer market shares. We find that at least five customer types do not bring information to the market, namely non-financial corporations, governments, unit trusts, mutual funds, and insurance firms. Information comes from a group of financial customers that includes hedge funds, investment managers, pension funds, and non-dealing banks. Private information in the foreign-exchange market also seems to be originated by the banks themselves.

We are able to quantify the information advantage from different sources. The results suggest that if an average bank examined here were to increase its market share with informed customers by one percentage point, its euro traders would each earn an extra 0.12 basis points per trade or about €12 per million. Our bank's three euro dealers traded an average of €4.8 billion per week. An extra €12 per million would earn an extra €3 million per year. A one-standard-deviation rise in the banks' own residual market share would be associated, at our bank, with extra profits of €5.3 million per year.

We are the first to suggest that currency banks bring their own information to the market. The literature uniformly assumes that all private information in currency markets originates with end users. Valseth (2010) provides evidence that bond dealers in Norway bring information to the market, but otherwise the literature generally assumes that dealers are simply conduits for information brought to the market by end users.

Our conclusions have implications for many current questions in the microstructure of currency markets. First, they show that private information is one of the forces driving short-run exchange-rate dynamics. Though there is a consensus that macro-based exchange-rate models have not successfully identified these forces so it is fortunate that close scrutiny of the market's microeconomics is proving fruitful. This microstructure approach, pioneered by Goodhart (1988) and Evans and Lyons (2002), shows that one important force driving returns

is contemporaneous order flow. Among the three prominent explanations for the relation between order flow and returns - inventories, liquidity (or finite elasticity of demand), and information - only the information hypothesis is consistent with our finding that there is a stronger relation between order flow and returns for some banks than others.

Our results are also relevant to understanding the price discovery process in currency markets. The price discovery mechanism proposed in Osler et al. (2009) implies that banks that trade most heavily with informed customers tend to rely most heavily on aggressive trades, consistent with our results. Finally, our results are relevant to ongoing investigations about the extent to which information influences liquidity provision or, more prosaically, the placement of limit orders. We find that limit-order placement is strongly influenced by information: the biggest banks have the most positive post-trade returns to limit orders as well as aggressive orders.

References

Anand, Amber, Sugato Chakravarty, and Terrence Martel (2005). Empirical Evidence on the Evolution of Liquidity: Choice of Market versus Limit Orders by Informed and Uninformed Traders. Journal of Financial Markets 8: 289-309.

Anand, Amber and Avanidhar Subrahmanyam (2008). Information and the Intermediary: Are Market Intermediaries Informed Traders in Electronic Markets? Journal of Financial and Quantitative Analysis 43: 1-28.

Berger, David W., Alain P. Chaboud, Sergey V. Chernenko, Edward Howorka, Raj S. Krishnasami Iyer, David Liu and Jonathan H. Wright (2008). "Order Flow and Exchange Rate Dynamics in Electronic Brokerage System Data," Journal of International Economics, 75(1), pp. 93-109.

B.I.S (2010). Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in April 2010 –. Bank for International Settlements.

Bjønnes, Geir H. and Dagfinn Rime (2005). Dealer Behavior and Trading Systems in Foreign Exchange Markets. Journal of Financial Economics, 75(3), pp. 571–605.

Bjønnes, Geir H., Dagfinn Rime and Haakon O. Aa. Solheim (2005). Liquidity Provision in the Overnight Foreign Exchange Market. Journal of International Money and Finance, 24(2), pp. 177–198.

Bloomfield, Robert, Maureen O'Hara and Gideon Saar (2005). The "Make or Take" Decision in an Electronic Market: Evidence on the Evolution of Liquidity. Journal of Financial Economics, 75, pp. 165-199.

Carpenter, Andrew and Jianxin Wang (2007). Herding and the information content of trades in the Australian dollar market, Pacific-Basin Finance Journal, Vol. 15, 173-194.

Cheung, Yin-Wong and Menzie D. Chinn (2001). Currency Traders and Exchange Rate Dynamics: A Survey of the U.S. Market. Journal of International Money and Finance, 20(4), pp. 439–471.

de Jong, Frank, Roland Mahieu and Peter Schotman (1998). Price Discovery in the Foreign Exchange Market: An Empirical Analysis of the Yen/Dmark Rate. Journal of International Money and Finance, 17, pp. 5–27.

Evans, Martin D. D. (2002). FX Trading and Exchange Rate Dynamics. Journal of Finance, 57(6), pp. 2405–2447.

Evans, Martin D. D. and Richard K. Lyons (2002). Order Flow and Exchange Rate Dynamics. Journal of Political Economy, 110(1), pp. 170–180.

Evans, Martin D. D. and Richard K. Lyons (2005). Meese-Rogoff Redux: Micro-Based Exchange-Rate Forecasting. American Economic Review Papers and Proceedings, 95(2), pp. 405–414.

Evans, Martin D. D. and Richard K. Lyons (2007). Exchange Rate Fundamentals and Order Flow. Working Paper 13151, National Bureau of Economic Research.

Fan, Mintao, and Richard K. Lyons (2003). Customer trades and extreme events in foreign exchange, in: Paul Mizen (ed.), Monetary History, Exchange Rates and Financial Markets: Essays in Honour of Charles Goodhart (Northampton: Edward Elgar), 160-179.

Gladwell, Malcolm (2005). *Blink: The Power of Thinking Without Thinking*. (Little, Brown, and Company).

Glosten, Lawrence (1994). Is the electronic Open Limit Order Book Inevitable? Journal of Finance 49: 1127-61.

Glosten, Lawrence R. and Paul R. Milgrom (1985). Bid, Ask, and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders. Journal of Financial Economics, 14(1), pp. 71–100.

Goodhart, Charles (1988), "The Foreign Exchange Market: A Random Walk with a Dragging Anchor," *Economica* 55: 437-60.

Härdle, Wolfgang Karl, Nikolaus Hautsh and Andrija Mihoci (2009). Modelling and Forecasting Liquidity Supply Using Semiparametric Factor Dynamics. Presented at the Conference on Individual Decision Making, High Frequency Econometrics and Limit Order Book Dynamics, Warwick Business School, The University of Warwick, September 24-25, 2009.

Hasbrouck, Joel (1991). Measuring the Information Content of Stock Trades. Journal of Finance, 46(1), pp. 179–207.

Hau, Harald, William Killeen and Michael Moore (2002). How Has the Euro Changed the Foreign Exchange Market? Economic Policy, 17(34), pp. 149–192.

Huang R.D. and Stoll H.R. (1997). The components of the bid-ask spread: A general approach. *Review of Financial Studies*, 10(4), 995.1034.

Kaniel, Ron and Hong Liu (2006). So What Orders Do Informed Traders Use? Journal of Business, 79, pp. 1867–1913.

Kyle, Albert S. (1985). Continuous Auctions and Insider Trading. Econometrica, 53(6), pp. 1315–1335.

Latza, Torben, and Richard Payne (2010). Measuring the Information Content of Limit Order Flows. Mimeo.

Linnainmaa, Juhani T. (2010). ”Do Limit Orders Alter Inferences about Investor Performance and Behavior?” *Journal of Finance* 65: 1473-1506.

Lyons, Richard K. (2001). The Microstructure Approach to Exchange Rates (MIT Press: Cambridge, MA).

MacDonald, Ronald (2000), "Expectations Formation and Risk in Three Financial Markets: Surveying What the Surveys Say," *Journal of Economic Surveys* 14: 69-100.

Mende, Alexander and Lukas Menkhoff (2006). Profits and Speculation in Intra-Day Foreign Exchange Trading. Journal of Financial Markets, 9(3), pp. 223–245.

Menkhoff, Lukas, and Maik Schmeling (2010). Whose Trades Convey Information? Evidence from a Cross-Section of Traders.” Journal of Financial Markets 13: 101-28.

Moore, Michael, and Richard Payne (2010). On the Existence of Private Information in Foreign Exchange.” Forthcoming.

Naik, Narayan Y., Anthony Neuberger, and S. Viswanathan (1999). Trade disclosure regulation in markets with negotiated trades, *Review of Financial Studies* 12, 873-900.

Osler, Carol (2009). “Foreign Exchange Microstructure: A Survey,” Bruce Mizrach, Ed., Encyclopedia of Complexity and System Science (Springer: Englewood, NJ).

Osler, Carol L., Alexander Mende, and Lukas Menkhoff (2009). Price Discovery in Currency Markets. Mimeo, Brandeis University.

Osler, Carol, and Vitaliy Vandrovych (2009). Hedge funds and the origins of private information in the foreign exchange market, presented at the Third Annual Microstructure Workshop, Emerging Markets Group, Cass Business School, London, May 1, 2009.

Payne, Richard (2003). Informed Trade in Spot Foreign Exchange Markets: An Empirical Investigation. Journal of International Economics, 61(2), pp. 307–329.

Phylaktis, Kate, and Long Chen (2010). Asymmetric Information, Price Discovery, and Macroeconomic Announcements in FX Markets: Do Top Trading Banks Know More? International Journal of Finance and Economics 15: 228-246.

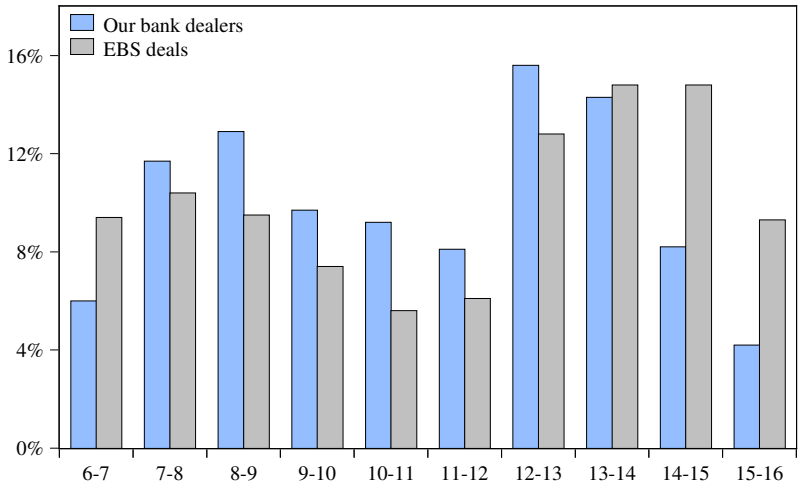
Ramadorai, Tarun (2008). What determines transactions costs in foreign exchange markets? International Journal of Finance and Economics, Vol. 13, pp. 14-25.

Stoll, Hans (1978). "The Supply of Dealer Services in Securities Markets." Journal of Finance 33: 1133-1151.

Taylor, Andrew, and Adam Fartstrup (2006), Active currency management: Arguments, considerations, and performance for institutional investors. (CRA RogersCasy International Equity Research: Darien, Connecticut).

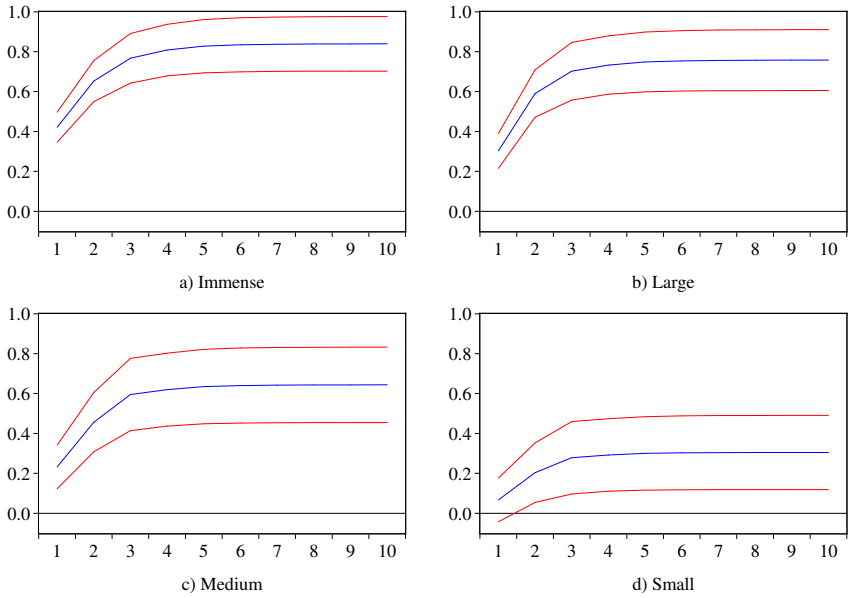
Valseth, Siri (2010), "Forecasting short-term yield changes using order flow: Is dealer skill a source of predictability?" Mimeo, Norwegian School of Management. Presented at the 6th Annual Central Bank Workshop on the Microstructure of Financial Markets, New York, New York, October 8, 2010.

Figure 1: Trading activity

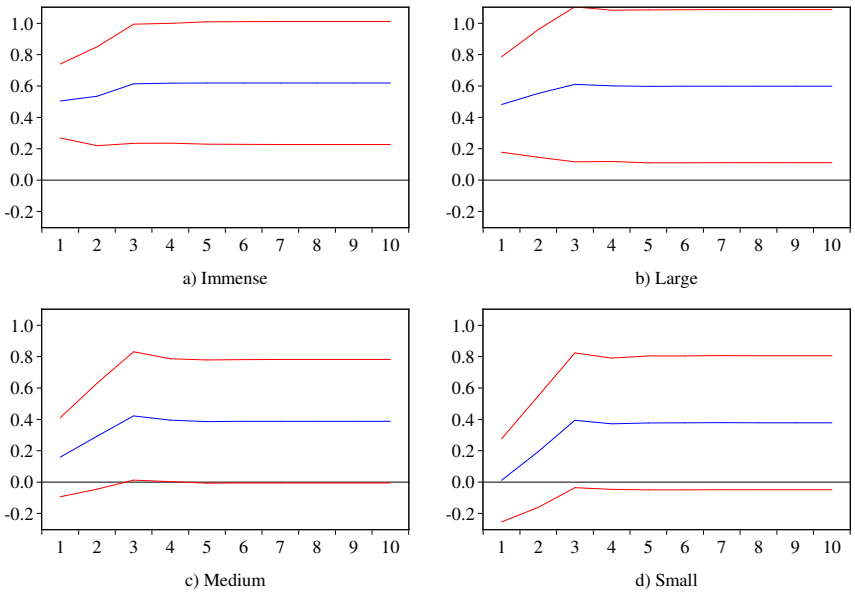


Note: Trading activity over the day in percentage of daily activity for our bank dealers (blue) and the EBS platform (grey). The blue bars are constructed as follows: For each hour we calculate the number of trades by our dealers and divide by their total number of trades between 6 am and 4 pm (GMT). The grey bars are calculated as follows: We calculate the number of trades on EBS for each hour and divide by the total number of trades on EBS between 6 am and 4 pm (GMT).

Figure 2: SVAR Analysis of Price Response to Banks' Aggressive Trades



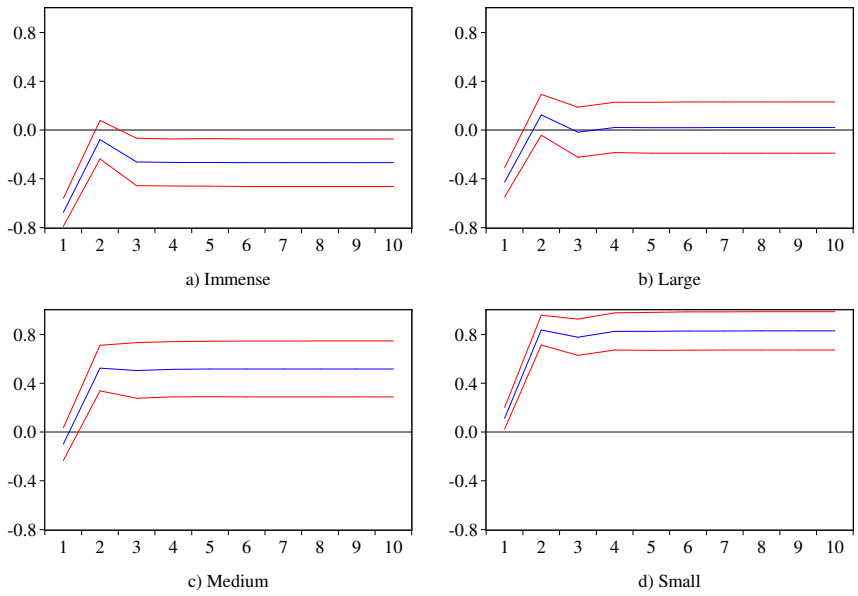
(a) 1999 Sample



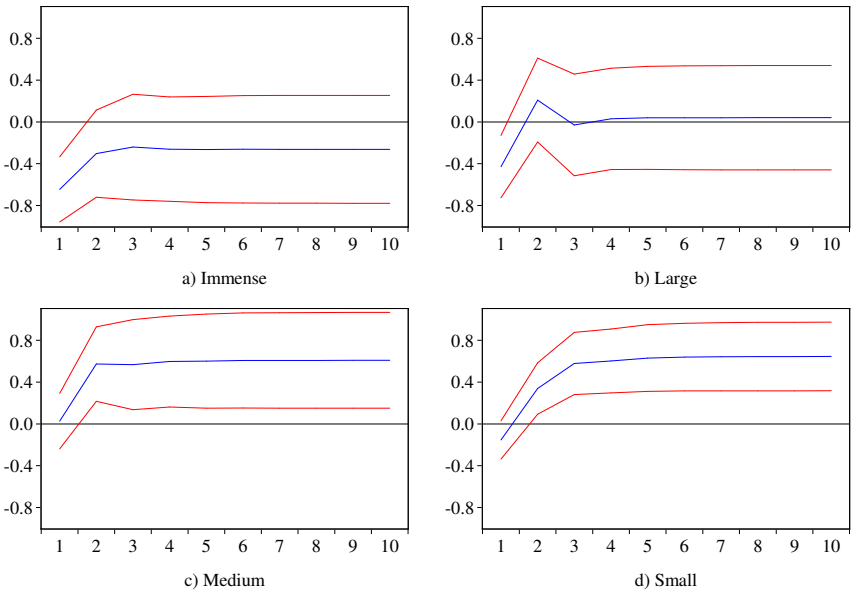
(b) 1998 Sample

Note: Accumulated impulse response of price to one unit innovations in incoming aggressive trades (at our dealers limit orders), together with two-standard-deviation bands. (Mid-point) Return (measured in basis points) is ordered last in a VAR together with the four order flows. The four order flows are treated symmetrically in that all influence return contemporaneously, but contemporaneous impact on *other* flows is restricted to zero. Data comprise entire trading record for major Scandinavian bank over one week in 1998 and three weeks in 1999. Individual banks are disaggregated into size groups according to contemporaneous Euromoney size rankings. Vertical axis shows returns in basis points. Horizontal axis is event time (transactions), approximately minutes.

Figure 3: SVAR Analysis of Price Response to Our Bank's Aggressive Trades



(a) 1999 Sample



(b) 1998 Sample

Note: Accumulated response of price to one unit innovations in outgoing aggressive trades (our dealers market orders), together with two-standard-deviation bands. (Mid-point) Return (measured in basis points) is ordered last in a VAR together with the four order flows. The four order flows are treated symmetrically in that all influence return contemporaneously, but contemporaneous impact on *other* flows is restricted to zero. Data comprise entire trading record for major Scandinavian bank over one week in 1998 and three weeks in 1999. Individual banks are disaggregated into size groups according to contemporaneous Euromoney size rankings. Vertical axis shows returns in basis points. Horizontal axis is event time (transactions), approximately minutes.

Table 1: Descriptive Statistics, Banks in Four Size Categories

Note: Table shows descriptive statistics for the complete dollar-mark or euro-dollar interbank trading record of a Scandinavian bank during one week in 1998 (dollar-mark) and three weeks in 1999 (euro-dollar). Panel A report the number of trades for four different size-groups based on rankings of banks. Panel B report the sizes of trades (millions $ in 1998, millions € in 1999). Ranks are from *Euromoney* in 1998 or 1999.

Table 1A: Number of trades

		1998 Sample			1999 Sample		
		Num. Banks	Trades/ Bank	Num. Trades	Num. Banks	Trades/ Bank	Num. Trades
Immense	(Rank 1-20)	18	26.3	473	20	147.8	2,955
Big	(Rank 21-50)	21	17.0	357	30	76.8	2,303
Medium	(Rank 51-100)	23	21.3	491	37	43.3	1,601
Small	(Rank >100)	197	3.7	722	200	12.2	2,447
Total		259	7.9	2,043	287	32.4	9,306

Table 1B: Trade sizes

	1998 Sample			1999 Sample		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Immense	1.77	1.00	1.20	1.80	1.00	1.86
Big	1.65	1.00	0.95	1.53	1.00	1.24
Medium	1.55	1.00	1.01	1.54	1.00	1.17
Small	1.52	1.00	0.89	1.42	1.00	1.09

Table 2: Standard order-flow regressions

Note: Table shows coefficients from a regression where the dependent variable is the half-hourly exchange-rate return (log change, measured in basis points) and the independent variable(s) are other banks' net aggressive trades with our bank over half-hour intervals. Other banks' net aggressive trades are largely other banks' market orders that hit our bank's limit orders at electronic brokers. In Panel A trades are aggregated across all banks, while panel B shows trades by group of banks. An entry of unity implies that one net buy order brings a currency appreciation of one basis point. Symbol *** indicate significance at the 1% level. Data comprise the complete dollar-mark or euro-dollar interbank trading record of a Scandinavian bank during one week in 1998 and three weeks in 1999.

	1998 Sample	1999 Sample
Panel A		
All banks	$0.97***$	$0.50***$
Adj.R^2	0.20	0.09
DW Stat	1.95	1.96
Panel B		
Immense (Rank 0-20)	$1.11***$	$0.92***$
Big (Rank 21-50)	$1.25***$	$0.69***$
Medium (51-100)	-0.07	0.07
Small (Rank>100)	0.56	$-1.10***$
Adj.R^2	0.22	0.22
DW Stat	1.94	1.90

Table 3: Returns immediately following a trade with our bank

Note: Table shows average (log) returns in the 1-minute period immediately following trades. Since we can identify the trade initiator, we measure returns as the (log) change in the bid (ask) quote if a trade is settled at the bid (ask). All returns are multiplied by 10,000, so an entry of unity represents one basis point. "Share Aggressive" is the share of aggressive trades as a percent of all trades between our bank and banks of that size group. Data comprise the complete dollar-mark or euro-dollar interbank trading record of a Scandinavian bank during one week in 1998 and three weeks in 1999.

Table 3A: Other banks' net purchases (aggressive or passive) from our bank

	A: 1998 Sample			B: 1999 Sample		
	Avg. return	*t*-stat	Share initiated	Avg. return	*t*-stat	Share initiated
Immense	0.25	2.71	66.1%	0.23	5.60	61.8%
Big	−0.09	−0.78	51.4%	0.16	3.22	57.3%
Medium	0.00	0.01	53.6%	−0.04	−0.61	51.3%
Small	−0.63	−7.20	37.7%	−0.47	−10.84	30.4%
Immense-Small	0.88			0.70		
p-value	0.00			0.00		

Table 3B: Other banks' net aggressive purchases and net passive purchases

	Other banks aggressive trades				Other banks passive trades			
	1998 Sample		1999 Sample		1998 Sample		1999 Sample	
	Avg. return	*t*-stat	Avg. return	*t*-stat	Avg. return	*t*-stat	Avg. return	*t*-stat
Immense	0.54	4.83	0.54	11.00	-0.30	-1.97	-0.51	-6.94
Big	0.36	2.20	0.55	9.17	-0.52	-3.66	-0.62	-7.59
Medium	0.62	3.64	0.38	5.29	-0.66	-3.78	-0.69	-7.24
Small	-0.01	-0.05	0.24	3.69	-0.99	-8.37	-0.92	-17.11
Immense-Small	0.55		0.30		0.69		0.42	
p-value	0.00		0.00		0.00		0.00	

Table 4: Long-run Impulse Response

Note: Table shows accumulated impulse response of price to one unit innovations in trades (in column $\beta(1)$), together with confidence interval based on two-standard-deviation bands (in column CI). Aggressive trades (first set of columns) and Passive trades are seen from the perspective of the counterparty banks of our dealers, i.e, other banks market orders and limit orders, respectively. The cumulative impulse response, $\beta(1)$, i.e, $\sum_0^\infty \beta_i$, is proxied using the first 10 MA-coefficients (as in Figure 2 and 3). Impulse-response functions are estimated from the following Structural VAR: (Mid-point) Return (measured in basis points) is ordered last in a VAR together with the four order flows. The four order flows are treated symmetrically in that all influence return contemporaneously, but contemporaneous impact on *other* flows is restricted to zero. Data comprise entire trading record for major Scandinavian bank over three weeks in 1999 (Panel A) and one week in 1998 (Panel B). Individual banks are disaggregated into size groups according to contemporaneous Euromoney size rankings.

	Aggressive trades		Passive trades	
	$\beta(1)$	CI	$\beta(1)$	CI
		A) 1999		
Immense	0.82	(0.69, 0.96)	-0.27	(-0.46, -0.07)
Large	0.75	(0.60, 0.91)	0.02	(-0.20, 0.23)
Medium	0.64	(0.45, 0.83)	0.51	(0.28, 0.74)
Small	0.30	(0.12, 0.49)	0.83	(0.67, 0.99)
		B) 1998		
Immense	0.62	(0.23, 1.01)	-0.26	(-0.78 0.25)
Large	0.60	(0.11, 1.09)	0.04	(-0.46, 0.54)
Medium	0.39	(-0.01, 0.78)	0.61	(0.15, 1.07)
Small	0.38	(-0.05, 0.81)	0.65	(0.32, 0.97)

Table 5: Net purchases: Correlation across bank groups

Note: The table shows how net purchases for each group is correlated with net purchases of other groups. Net purchases is measured as the number of purchases minus the number of sales over half-hourly time intervals. Symbols *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Data comprise the complete dollar-mark or euro-dollar interbank trading record of a Scandinavian bank during one week in 1998 and three weeks in 1999.

	Immense (Rank 1-20)	Big (Rank 21-50)	Medium (Rank 51-100)
A. 1998 Sample			
Immense	1		
Big	0.31***	1	
Medium	−0.62***	−0.28***	1
Small	−0.71***	−0.36***	0.36***
B. 1999 Sample			
Immense	1		
Big	0.12**	1	
Medium	−0.02	0.00	1
Small	−0.45***	−0.22***	0.01

Table 6: Position-taking against other banks

Note: "Accumulating trades" are trades through which dealers at our bank build speculative position, while "Decumulating trades" are trades through which these dealers reduce speculative positions. "Percent of trades" shows the percent of trades with the different categories of counterparts. "p-value: Accumulating−Decumulating" tests whether the percentage of accumulating trades is significantly different from the percentage of decumulating trades. Data comprise the complete dollar-mark or euro-dollar interbank trading record of a Scandinavian bank during one week in 1998 and three weeks in 1999. Numbers marked with "*" are statistically different from unity.

	Percent of Accumulating Trades	Percent of Decumulating Trades	*p*-value: Accumulating-Decumulating	Ratio: Accumulating over Decumulating
A: 1998 Sample				
Immense	18.4	29.8	0.00	0.62∗
Big	15.9	18.8	0.09	0.85∗
Medium	21.4	19.8	0.52	1.08
Smallest	44.4	31.6	0.00	1.40∗
B: 1999 Sample				
Immense	24.6	36.1	0.00	0.68∗
Big	22.1	25.5	0.00	0.87∗
Medium	15.9	17.6	0.04	0.90∗
Smallest	36.9	20.8	0.00	1.77∗

Table 7: Correlations among banks' market shares

Note: Correlations between banks' market shares with nine customer types. If correlation is e.g. 0.7 (such as between Insurance and corp.) this means that banks with a big market share of insurance-customers typically will also have a big market share of corporate customers. Since big banks typically have significant trading with all type of customers, correlations will be positive numbers. Market shares taken from Euromoney's 1999 Foreign Exchange Survey. Banks are those included in the complete euro-dollar interdealer trading record of a Scandinavian bank during three weeks in 1999. Banks with fewer than 20 trades excluded.

	Size	Corp.	Gov.	Trust	MF	Insur.	PF	Invest.	HF
Corporates	689.2	1							
Gov./CBs	138.6	0.02	1						
Unit trusts	0.4	0.02	0.02	1					
Mutual f.	265.6	0.35	0.53	0.11	1				
Insurance	235.2	0.73	0.12	0.00	0.56	1			
Pension f.	98.0	0.63	0.07	0.02	0.31	0.61	1		
Invest. Mgr	567.7	0.67	0.15	0.11	0.41	0.52	0.62	1	
Hedge f.	141.8	0.41	0.12	0.06	0.29	0.34	0.53	0.65	1
Non-dealing	321.8	0.58	0.11	0.10	0.19	0.20	0.47	0.69	0.50

Table 8: Descriptive Statistics: Sources of Information Analysis

Note: Table shows descriptive statistics for variables in the analysis of the relative information content of trades by different currency market participants. Price impact figures are for interbank trades a Scandinavian bank in euro-dollar (three weeks in 1999). Returns measured in basis points; market shares measured in percent. Market shares for the customer groups are taken from Euromoney's 1999 FX survey. Interbank market shares are based on the number of trades in our Scandinavian bank sample.

	Mean	Median	Max	Min	Std.Dev.	Skew	Kurt.
Raw post-trade returns	-0.18	-0.09	1.33	-1.56	0.57	-0.15	2.79
Adjusted returns	0.03	0.06	1.33	-1.29	0.42	-0.05	3.45
Market share							
Corporate	0.87	0.10	10.89	0.00	1.86	3.21	14.45
Gov./CBs	0.87	0.00	15.49	0.00	2.73	3.90	18.07
Unit trusts	0.50	0.00	26.18	0.00	3.10	6.74	50.33
Mutual funds	0.91	0.00	19.33	0.00	3.39	4.18	19.86
Insurance firms	0.77	0.00	11.23	0.00	2.15	3.04	11.75
Pension funds	0.85	0.00	15.77	0.00	2.34	3.77	19.82
Investment Mgr	0.88	0.00	12.93	0.00	2.24	3.47	16.09
Hedge funds	0.90	0.00	15.03	0.00	2.26	3.74	19.71
Non-dealing banks	0.79	0.00	7.94	0.00	1.63	2.69	10.11
Excess IB Mkt share	0.00	-0.18	3.72	-0.97	0.64	3.20	16.75
Share aggressive trades	0.54	0.57	0.83	0.03	0.21	-0.52	2.41

Table 9: Who brings information to the market?

Note: Panels A and B shows results from regression where the dependent variable is each bank's average post-trade return, measured in basis points. In Panel A the dependent variable is the raw return; Panel B the returns to market (limit) orders are adjusted by subtracting average returns to market (limit) orders across all banks. Explanatory variables represent a given bank's market share of different customer segments (except Resid IB). The different customer segments are Corporates; Governments and Central banks; Unit trusts; Mutual funds; Insurance firms; Pension funds; Investment managers; Hedge funds; and Non-dealing banks. Market shares taken from Euromoney FX Survey for 1999. The variable "No-info fin" refers to a bank's market share with respect to unit trusts, mutual funds, and insurance firms. "Info fin" Refers to a bank's market share with respect to pension funds, investment managers, hedge funds, and non-dealing banks. "Resid IB" is the residual from a regression of the banks' interbank trading shares on these customer market shares. In Panel C the dependent variable is the share of aggressive trades among each bank's total trades, and the independent variables are the market shares of panel A. Data comprise the complete euro-dollar interdealer trading record of a Scandinavian bank during three weeks in 1999. Only banks that have at least 20 trades in our sample are included. Weighted least squares where the inverse of total interdealer trades is the weight. All figures $E-2$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Raw returns				
Corporates	3.5**	3.3	2.8	0.7	−0.8	1.4	1.3	−2.2
Gov./CBs	0.4	0.4	0.4	0.4	0.2	0.3	0.3	0.2
Unit trusts	1.2							
Mutual f.		0.4						
Insurance			0.8					
Pension f.				3.5**				
Invest. Mgrs					5.0***			
Hedge f.						4.6***		
Non-dealing							5.6***	
No-info fin.								2.1
Info fin.								7.8***
Resid. IB	15.9***	15.6***	15.9***	15.2***	15.9***	15.9***	16.3***	16.6***
Adj.R^2	0.32	0.31	0.31	0.34	0.42	0.43	0.36	0.44
				Panel B: Adjusted returns				
Corporates	2.0	2.3	1.4	0.2	−1.5	0.4	0.2	−2.7*
Gov./CBs	0.2	0.3	0.2	0.2	0.0	0.1	0.2	−0.1
Unit trusts	0.7							
Mutual f.		−0.2						
Insurance			0.7					
Pension f.				2.8**				
Invest. Mgrs					4.1***			
Hedge f.						3.5***		
Non-dealing							4.5***	
No-info fin.								1.0
Info fin.								6.0***
Resid. IB	11.8***	11.3***	11.8***	11.2***	11.9***	11.8***	12.2***	12.1***
Adj. R^2	0.29	0.30	0.29	0.33	0.43	0.41	0.35	0.44

Table 9: Panel C: Whose Business Prompts Banks to Make Aggressive Trades?

Note: Se note to previous table.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corporates	1.4***	1.0**	1.3*	0.9*	0.7	0.9**	1.0**	−0.6
Gov./CBs	0.1	0.0	0.2	0.2	0.1	0.1	0.1	−0.0
Unit trusts	0.5							
Mutual f.		0.6						
Insurance			0.1					
Pension f.				0.7				
Invest. Mgrs					0.9**			
Hedge f.						1.1**		
Non-dealing							1.0	
No-info fin.								1.0**
Info fin.								1.7**
Resid. IB	3.9***	4.0***	3.9***	3.7***	3.9***	3.9***	3.9***	4.3***
Adj.R^2	0.22	0.22	0.20	0.22	0.22	0.26	0.21	0.26

Table 10: Who brings information to the market? Robustness check

Panels A and B shows results from regression where the dependent variable is each bank's average post-trade return, measured in basis points. In Panel A the dependent variable is the raw return; Panel B the returns to market (limit) orders are adjusted by subtracting average returns to market (limit) orders across all banks. Explanatory variables represent a given bank's total market share and measures of three different market segments. "Corporates" represents a bank's market share with respect to corporations minus total market share. "No-info fin" refers to a bank's market share with respect to unit trusts, mutual funds, and insurance firms minus total market share. "Info fin" refers to a bank's market share with respect to pension funds, investment managers, hedge funds, and non-dealing banks minus total market share. Market shares are calculated from Euromoney FX Survey for 1999. "Interdealer" is a bank's market share of interdealer trading in our data set minus total market share. Data comprise the complete euro-dollar interdealer trading record of a Scandinavian bank during three weeks in 1999. Only banks that have at least 20 trades in our sample are included. Weighted least squares where the inverse of total interdealer trades is the weight. All figures E-2.

	(1)	(2)	(3)	(4)
Panel A: Raw returns				
Total	16.7***	18.6***	16.3***	16.6***
Corporates		−7.2***		
No-info financial			−1.7	
Info financial				5.7***
Interdealer	14.7***	17.1***	13.9***	14.5***
Adj.R^2	0.34	0.43	0.35	0.39
Panel B: Adjusted Returns				
Total	11.8***	13.3***	11.2***	11.6***
Corporates		−5.7***		
No-info financial			−1.9	
Info financial				5.6***
Interdealer	10.8***	12.7***	10.0***	10.7***
Adj.R^2	0.30	0.40	0.34	0.40