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PRICE IMPACTS OF DEALS AND PREDICTABILITY OF THE EXCHANGE RATE
MOVEMENTS

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Price Impacts of Deals and Predictability of the Exchange Rate Movements
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ABSTRACT

This paper examines the price impact and the predictability of the exchange rate movement using the transaction data recorded in the electronic broking system of the spot foreign exchange market. The number of actual deals at the ask (or bid side) for a specified time interval may be regarded as "order flows" to buy (or sell) in Richard Lyons' work. First, the contemporaneous impact of order flows on the quote and deal prices are analyzed. Second, the price predictability is examined. Our forecasting equations of the exchange rate for the next X minutes ($X=1, 5, 15, 30$) show that coefficients are significantly different from zero in both 5-min and 1-min forecast horizons, but the significance disappears in the 30-minute interval. The t -statistics become larger as the prediction window becomes shorter. Price impacts of deals at one side of the market are significant but short-lived. Market participants, if they can observe and analyze all the transactions information in real time, may be able to extract information to predict the price movements in the following next few minutes.

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1. Introduction

The overwhelming majority of the spot foreign exchanges are now transacted through the global electronic broking systems—EBS and Reuters D3000.¹ This contrasts to the situation fifteen years ago, when brokers in the interbank market were mostly human and direct dealings between dealers also had a substantial share in the spot market. The Euro/dollar and dollar/yen are the key currency pairs that traded mainly on EBS, whereas Reuters have strengths in transactions of sterling/dollar, CAD/dollar, AUD/dollar, and NZD/dollar.

The EBS system works as follows.² A bank dealer places a “firm” limit order, either ask or bid, with specified price and units that the dealer is ready to trade if hit. A member bank set credit limit to each of possible trading partners in the EBS system when it joins the system. The credit/counterparty risk is controlled by the EBS computer automatically. The computer collects these orders and show on the screen of each member the following information, “best ask”, “best bid”, “best ask for the member”, and “best bid for the member.” The former two do not necessarily agree with the latter two, respectively, because the EBS system controls for the bilateral credit lines and show the best available for each institution. Hence, if the member does not have a credit line with the market maker(s) that is (are) posting the “best” ask/bid in the market, then the individually-available best quotes deviate from the market best quotes. The computer continuously clear the order whenever the sell and buy order matches at the same price—this could happen either a buyer hits the ask quote posted in the system, or a seller hits the bid quotes posted in the system. The electronic broking system is a centralized network of traders. In a sense, the electronic broking system can be regarded either as a collection of large numbers of market makers or as a continuous (Walrasian) auctioneer. We will use the dollar/yen and euro/dollar data sets provided by EBS.³

Retail customers place their buy or sell orders via banks, based on their private information. Then, banks transmit those customers’ orders to the electronic broking system. Banks may add their own proprietary trading positions onto the customer orders. As the trading system is highly computerized, trading strategies of banks have evolved

¹ For papers that use electronic broking systems, see Goodhard, Ito, and Payne (1996), Goodhart and Payne (1996), Berger et al.(2005) and Chaboud et al.(2004).

² Details of the EBS system and characteristics of the data are explained in Ito and Hashimoto (2004).

³ The data set was provided for fee by the EBS Co., for the use at the University of Tokyo, Graduate School of Economics. The authors are grateful to EBS for such an arrangement.

too. Until several years ago, bank dealers who received customers' orders were allowed by bank policy to hold their own proprietary positions for profit-taking. They tended to add their own positions when they executed the customers' orders if they felt that customer' orders contained some valuable information. Receiving customers' orders meant a special information advantage in forecasting the direction of the foreign exchange rate. See Lyons (1995, 1996, 1997, 1998, 2001) for modeling this line of reasoning. In line with the information and pricing in market, Lyons and Moore (2005) applied the information model to the transactions in a triangle of markets, USDJPY, EURUSD and EURJPY and found the transaction affected prices.

Dealers in banks now have only very small amounts of their own proprietary positions. Responsibility of proprietary trading has been shifted to an independent department, sometimes characterized as an in-house hedge fund. A proprietary trading section uses more computer modeling than private information possibly extracted from customers' trading. Spending millions of dollars on programmers (often physics Ph.D.s) and high-speed computers is necessary for high-frequency trading strategy. Clearly they see profit opportunities by betting on directions of the exchange rate in the very short-run, that is, a few minutes to several hours.

In contrast, many economists still believe that the exchange rate is basically a random walk, and it would be a profitless effort to conceive a model that can predict an exchange rate movement. The gap between the academic random walk and millions of dollars invested for a bet on predictable movements in the real world is remarkable, as pointed out by Ito (2005a, b). Evans and Lyons (2005a), for example, examine daily Euro/USD exchange rate returns based on the trades by the end-user and find a persistent (days) effect in currency market induced by news announcement. Still, it is our view that foreign exchange rate modeling in the academic literature is lagging behind the reality.

Conventional wisdom in the academic literature is that the exchange rate follows random walk for frequencies less than annual, e.g., daily, weekly, or even monthly, whereas it shows some time trends, cyclicity, or in general history dependence at lower frequencies. For example, Evans and Lyons (2005b) show forecasting performance of a micro-based model against a macro and a random walk model using end-user exchange rate. Some studies in the microstructure focuses on very high frequency movements of the exchange rate and show that the exchange rate may

respond to pressures of customers' orders. Evans and Lyons (2002), for example, reported a positive relation between daily exchange rate returns and order flows for Deutsche mark/dollar. Berger et al. (2005) also showed a positive contemporaneous relationship between order flows and the exchange rate, while they reported no evidence of the predicting power of order flows for future exchange rate. In Evans and Lyons (2005c), heterogeneity of order flow was considered in estimating the price impact. Based on the end-user order flow data, they show order flow provides information to market makers.

In this paper, we will examine the relationship between pressures of seller-initiated orders or buyer-initiated orders and the resulting price movements in the following few minutes to half an hour. Although direct observations of customer order flows to banks are not available, deals initiated by sellers and those by buyers in the EBS system are observable. Order flows and executed prices give the information on customers and bank proprietary desks.

Given the organizational change in creating proprietary trading departments in banks, customer orders have to contain both retail customers and bank proprietary positions. Retail customer orders contain information, but orders from computer-generated programs in an in-house proprietary trading department are equally important. It is best to exact information of order flows from seller-initiated and buyer-initiated deals in the system. Therefore we take actual deals done in the market as the buying or selling pressures in the market.

The EBS data record the ask-side deals or bid-side deals for every second. (Lowest given or highest paid are recorded for each second, when at least one deal on either side was executed during the second.) An ask-side deal means that the ready-to-sell quote was hit by a buyer, thus it represents a buyer-initiated deal, that is, a piece of buying pressure. A bid-side deal means that the ready-to-buy quote was hit by a seller, thus it represents a seller-initiated deal, that is, a piece of selling pressure. Therefore by taking the difference between the number of ask-side deals and the number of bid-side deals in the time frame of X minutes, we can quantify the buy pressure or sell pressure during the X minutes. Then we will measure an impact of buy (sell) pressure to drive up (down) the price contemporaneously or with lags.

The EBS data were exploited in two papers written by Federal Reserve Board

economists. Chaboud, et al. (2004) analyzed the relationship between macro news announcement and trade volume, and found news releases tend to raise trade volume. Berger et al. (2005) showed the correlations between order flows and exchange rate movement. The trading volumes of the buyer-initiated trades (ask-side deals) in excess of the seller-initiated deals (bid-side deals) are considered to be order flows. They examined whether the exchange rate appreciates if there are more buyer initiated trades in several time aggregation, 1 minute, 5 minutes, 10 minutes, 1 hour, and 1 day. They find strong association of order flows and exchange rate changes, namely, an excess of buyer-initiated trades is associated with a rising price. The contemporary association is strongest in the shortest horizon. Although Berger et al. (2005) find a positive contemporaneous price impact of order flow, they argue that there is little evidence for predictability, namely lagged trades impacting on the price change in the next minute.

The objective of our paper is to analyze the forecasting power of order flows (actual deals in the preceding 30 minutes) on future exchange rate movements at various frequencies: 1, 5, 15 and 30-minute windows. The data used in the analysis is extracted from the EBS spanning from January 1999 to October 2003. Our measure of order flows is the “net ask deals” that is defined as the difference between the number of ask deals and bid deals. In our paper, “deal” in one minute is the number of seconds in which at least one deals were done. Although this is not precisely the trading volumes, it is close substitutes.⁴

The prices used to calculate exchange rate returns are based on actual transaction prices, not quoted prices (bid or ask) which may not represent market clearing prices—this is the same as Berger et al. (2005) and Chaboud et al. (2004). We then estimate price impact of deals in the following time periods up to 30 minutes.

We find strong evidence that order flows (deals) have prediction power for the price movement of the following 1 minute to 5 minutes, while 30minute is found too long for prediction. The degree of price impact is found to diminish over time, although intervention may induce lagged price impact, and there may be an adjustment process in exchange rate movements.

⁴ Berger et al. (2005) and Chaboud et al. (2004) use the actual volume data, but the use of the data is restricted in the central bank community.

The rest of this paper is organized as follows: In section 2 we describe the data. Section 3 shows the estimation model and reports the results. Section 4 concludes the paper.

2. Data⁵

The data set includes information of quote prices and deal prices of the dollar/yen and the euro/dollar currency pairs. The sample period is from January 4, 1998 to October 31, 2003 for USD/JPY and from January 3, 1999 to October 31, 2003 for EUR/USD.⁶ It contains information of, among others, best bid, best ask, deal prices done on the bid side (lowest given) and deal prices done on the ask side (highest paid).⁷ It does not contain any information on the volume associated with bid, offer, or deal, or any information on the identity of bid, ask, or deal. The EBS global system consists of three regional computer sites, based in Tokyo, London, and New York, and each region covers Europe, North America, and Asia, respectively. The system matches orders either within the site or across different sites.

We exclude all data from Friday 22:00(GMT, winter, 21:00 in summer) to Sunday 21:59(GMT, winter, 20:59 in summer, respectively). If at least one of the three major markets has national (banking) holiday, then that day is dropped from the sample. In addition, if there is no trade recorded in the time window of the frequency, that particular time is dropped.

To analyze returns at various frequencies, we use the last deal price of the time interval. For the x-minute frequency, we use the last deal price within the x minute window ($x=1, 5, 15, 30$). The number of bid and ask deals are separately counted within each

⁵ The authors are grateful to EBS for providing a proprietary data set for this academic purpose and to EBS analysts in New York for guidance on the nature of the data.

⁶ Data are of the 1-second time slice. The system records, at every second, bid, offer, deals that are posted and carried out in the world-wide EBS system. Bid and offer rates are recorded at the end of time slice. For example, bid and offer rate at xx hour, yy minute, zz second. Fluctuations of the bid and offer rates within the second (in the time slice) are not recorded and cannot be inferred. It is theoretically possible that bid and offer rates move up and down within the second, but not shown in the data set. Deal rates are recorded on the basis of Highest Paid and Lowest Given in the 1-second time slice. See Ito and Hashimoto (2004) for details.

⁷ The deal (on either side) recorded at zz second includes those that took place between zz-1 second to zz second. When there are multiple trades within one second, “lowest given price” and “highest paid price” will be shown. A highest paid deal means the highest price hit (done) on the ask side within one second and the lowest given deal means the lowest price hit (done) on the bid side within one second.

frequency. For example, the number of bid deals in 5-minute equals the total number of seconds in which one or more deals took place.

The “ask quote” means that the institution with the quote is ready to sell (the dollar in exchange for the quoted yen) and the “bid quote” means that the institution with the quote is ready to buy (the dollar in exchange for the quoted yen). When the deal is done at the ask side—we call it “ask deal”—it means that the ask quote is “hit” by a buyer. When the deal is done at the bid side—we call it “bid deal”—it means that the bid quote is “hit” by a seller. Therefore the ask deal is a buyer-initiated deal, and the bid deal is a seller-initiated deal, according to the description in Berger, et al (2005).⁸

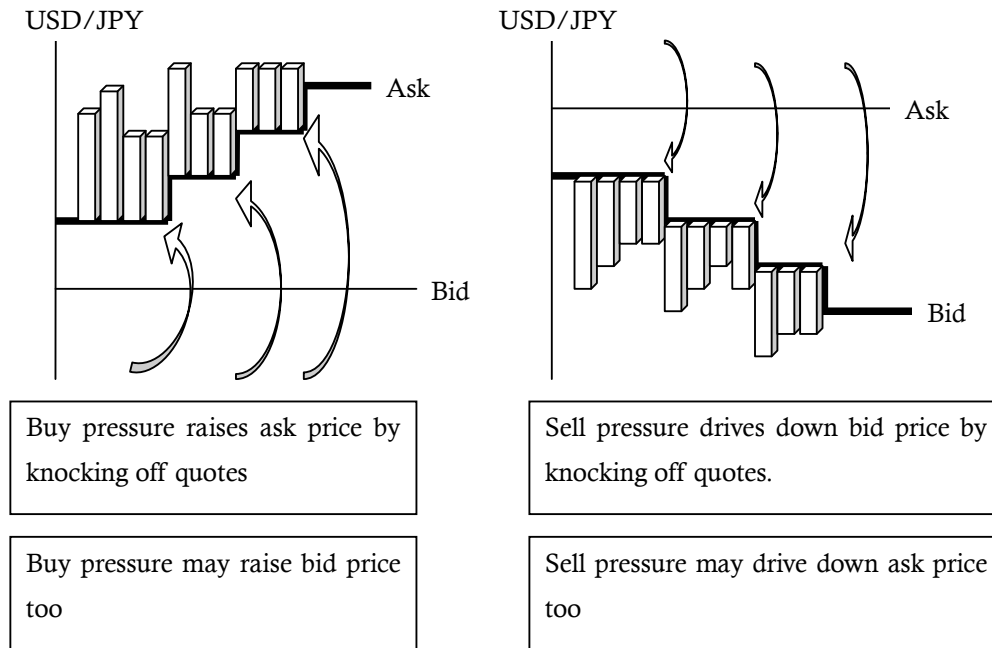
By counting the number of ask (bid) deals within a fixed time period (X minutes), we measure the order flows to buy (sell, respectively). If the number of the ask deals is larger (smaller) than the number of the bid deals in the time period, it is interpreted as that pressure to buy (sell, respectively) is stronger. When pressure to buy (sell) is stronger, the prices—here the price of the dollar in terms of the yen—tend to rise (drop, respectively). There are two ways that pressure is materialized into quote/price changes. First, when buy orders may hit all volumes at the best ask quotes, then the second best ask quotes becomes the best, so the best ask moves up. Second, by watching that deals are done on the ask side, dealers may withdraw the best ask quote and re-quote at a higher price. Either way, the ask quote tends to move up when buyers start to hit the best ask quote. If the process continues, then the ask deal prices continue to move up in the subsequent time period. The reverse is true, namely, if selling pressure is strong, then bid deal prices may decline. When the ask quote is rising, the bid quote is likely to rise with it, as dealers revise the equilibrium value of the currency.

The above inference leads to a hypothesis that the return of (or, changes in) the ask deal price, as well as ask quote price, will be influenced by the buy pressure, that is the positive net deals, while the return of the bid deal price, as well as bid quote price, will

⁸ The buyer-initiated trades (the seller-initiated trades) used in Berger et al. (2005) corresponds to the number of deals on ask side (the number of deals on bid side) in our paper, respectively. The order flow, the net excess of buyer-initiated trades in Berger et al. corresponds to the *netdeal* in our paper. Berger et al. had access to the data of actual transaction volumes---proprietary data of EBS---while we use the number of seconds in which at least one deals was done. The number of deals, rather than the signed (actual) volume, is good enough proxy for the volume of transaction. In fact, the actual transaction volume is not revealed to participants other than parties involved, so that they would not be able to be used in prediction of price movement in real time.

be influenced by the sell pressure, that is the negative net deals.

As we differentiate ask-side deals (buy pressure) and bid-side deals (sell pressure), we can identify the direction of order flows from deal data. So, our variables, the difference between the ask-side and bid-side deals is regarded to represent order flows.



3. Prediction window estimation

In this section, we examine whether order flows in period t will have a predictive power of price movement from period t to $t+1$. More precisely, whether a relative number of deals on the bid and ask side will drive the price lower/higher X -minute later. For the proxy of order flows in the EBS data, we use “net deals” that is defined as the difference between the number of ask deals and that of bid deals during a specified frequency. For testing the predictability of this framework, we use three frequencies, 1-minute, 5-minute, 15-minute and 30-minute windows. The sample period covers from January 4, 1998 to October 31, 2003 for USD/JPY and from January 3, 1999 to October 31, 2003 for EUR/USD pair.

We will examine *netdeals* at period t help predict the price movements in period $t+1$. A similar attempt was made by Berger, et al (2005). They regarded a net excess of buyer-initiated trades as order flow. The “net excess of buyer-initiated trades” is the difference between the volume of the buyer-initiated trades, that is, deals done on the ask side, and the seller-initiated trades, that is, deals done on the bid side. They note that a dealer tends to break up a large customer’s order into small lots and execute them in a staggered manner, in order to avoid large impacts on prices.

One difference of our approach from Berger, et al. (2005) and Evans and Lyons (2004) is that we do not include contemporaneous effect in this inference, in order to avoid an endogeneity problem, and to test predictability directly.

A variable *netdeal* corresponds to “net excess buyer-initiated trades”, as a proxy for order flow. We also use a *netdeal ratio* (*ndr*), the *netdeal* over the total number of deals (both bid and ask sides) during the period, instead of *netdeal*. Since the overall market activity varies from time to time, the share is able to scale *netdeal* by the degree of market activeness; for example, # deal ask=700 and # deal bid =690 when market is active and # deal ask=80 and # deal bid=70 when market is calm, then, *netdeal* is 10 for both cases but *netdeal ratio*, *ndr* is 0.0072 and 0.067, respectively. Therefore, two definition of order flows is written as follows.

$$netdeal = \#askdeal - \#biddeal$$

$$ndr = \frac{\#askdeal - \#biddeal}{\#askdeal + \#biddeal}$$

To reiterate, a conjecture of deal and price movements is as follows: When *netdeal* (or *ndr*) is positive, that represents buying pressure, and when *netdeal* (or *ndr*) is negative, that represents selling pressure. We expect that buying pressure will raise the ask quote, as explained earlier, and selling pressure will lower the bid quote. Therefore, we construct a variable that would represent buying pressure and selling pressure separately in order to associate with ask and bid quote movements separately.

Let us define the buying pressure as,

$$nd_t^{plus} = \max(netdeal_t, 0),$$

and selling pressure as,

$$nd_t^{minus} = \min(netdeal_t, 0).$$

The regression model is specified as follows. We examine whether deals done at period $t-1$ at either side help predict the price movement for the next period, t , using information that is contained in the data up to period t .

$$\Delta s_t = \beta_0 + \beta_1 nd_{t-1}^{plus} + \beta_2 nd_{t-1}^{minus} + \sum_j \delta \Delta s_{t-j} + \varepsilon_t \quad (1)$$

where Δs denotes the exchange rate return from period $t-1$ to t . Here, nd^{plus} means that the number of deals done at the ask side is larger than the number of deals done on the bid side during period t , and nd^{minus} vice versa.

The estimation methodology is similar to that of Berger et al. (2005), in which they estimated the contemporaneous regression with time horizon of 1-minute, 5-minute, 10-minute, 1-hour, 1-day and 1-month. They went on to estimate another regression with lagged Δs and order flows up to five periods. In this paper, we estimate equation (1) with various definitions of returns and explanatory variables.

In the estimation, six different definitions of returns are used for this variable: for deal price returns, we consider the following three patterns; the midpoint of the deal ask and deal bid prices, the ask-side deal price, and the bid-side deal price. For quote returns, we again consider the three types of returns; the midpoint of the quote prices, the ask price and the bid price. Berger et al. (2005) use the midpoint of the ask and bid deal prices, which is a standard practice in the literature. However, the mid point may not represent a true state of the market, if the last ask side deal was done several minutes prior to the last bid deal. In other words, when the market is thin, or the market is one-sided (strong buy pressure or sell pressure) then the mid-point may not be representative. Therefore, we also use the bid-bid return and ask-ask returns, in addition to the midpoint price returns.

Therefore, the regression models to be estimated are the followings;

$$\Delta s(\text{Askdeal})_t = \alpha_0 + \alpha_1 nd_{t-1}^{plus} + \alpha_2 nd_{t-1}^{minus} + \sum_j \delta \Delta s_{t-j} + \varepsilon_t \quad (2)$$

$$\Delta s(\text{Biddeal})_t = \beta_0 + \beta_1 nd_{t-1}^{plus} + \beta_2 nd_{t-1}^{minus} + \sum_j \delta \Delta s_{t-j} + \varepsilon_t \quad (3)$$

$$\Delta s(\text{Midpoint})_t = \gamma_0 + \gamma_1 nd_{t-1}^{plus} + \gamma_2 nd_{t-1}^{minus} + \sum_j \delta \Delta s_{t-j} + \varepsilon_t \quad (4)$$

In equation (2), the parameters α_1 captures the direct price impact of ask-side transaction (buy pressures) on the ask deal price (sell quote) movement. The continuum of ask deals will drive up the price in the following period (dollar appreciation) after eating up orders at the best ask price and re-quoting of ask side dealers. The expected sign is unambiguously positive. The parameter α_2 shows the effect of bid-side deal on the ask quotes in the following period. The expected sign is positive, since the negative movement (selling pressure) will drive down the prices. But the effect may not be as significant as α_1 since the causal effect of deals on quotes is not as direct as the ask side deals. If the value of α_1 equals that of α_2 then the effect is symmetric and there is no reason that we differentiate nd^{plus} and nd^{minus} , but to use *netdeal* suffices.

In equation (3), the parameter β_2 shows the price impact of bid-side transaction (sell pressures) on bid-price (buy price) returns. The enough bid deals will drive down bid quotes in the following period, with knocking off orders at the best bid price and causing revising quotes on the bid side. The β_2 is expected to be unambiguously positive. The parameter β_1 captures the effect of ask-side transaction (buy pressures) on bid-deal returns (buy quote prices) and the expected sign is positive. We will call the estimated parameters α_1 and β_2 to represent knocking off effects, and α_2 and β_1 catch-up effects. For the explanatory variables of *nd*, we attempt two versions: one with the difference in numbers, *netdeal* and another with the ratio, *ndr*.

$$\Delta s(\text{bestOffer})_t = \alpha_0 + \alpha_1 nd_{t-1}^{plus} + \alpha_2 nd_{t-1}^{minus} + \sum_j \delta \Delta s_{t-j} + \varepsilon_t \quad (5)$$

$$\Delta s(\text{bestBid})_t = \beta_0 + \beta_1 nd_{t-1}^{plus} + \beta_2 nd_{t-1}^{minus} + \sum_j \delta \Delta s_{t-j} + \varepsilon_t \quad (6)$$

$$\Delta s(\text{quoteMidpoint})_t = \gamma_0 + \gamma_1 nd_{t-1}^{plus} + \gamma_2 nd_{t-1}^{minus} + \sum_j \delta \Delta s_{t-j} + \varepsilon_t \quad (7)$$

We apply the same regression methodology to estimate the price impact of quote price

returns. Interpretations are similar to the above. Equations (5)-(7) show the best offer returns, best bid returns and the midpoint of quote prices, respectively.

Other explanatory variables included in the regression are 1-10 lags of dependent variable. We also control for the time of the day (hour) effect for the regressions.⁹

Results

The regression results are summarized in Tables 1-1-1-4 (USD/JPY, deal returns), Tables 2-1-2-4 (USD/JPY, quote returns), and Tables 3-1-3-4 (EUR/USD, deal returns), and Tables 4-1-4-4 (EUR/USD, quote returns).

Overall, the t-statistics of variables becomes insignificant as the chosen frequency becomes lower regardless of currency pairs and the choice of return definition. For example, the estimated coefficients of explanatory variables (*nd*) are positive and statistically significant in most cases at the 1-minute window, but they turned insignificant at the 30-minute window.

The regression results of USD/JPY deal price returns are shown in Tables 1-1-1-4. In each table, left panel reports the results estimated with *netdeal* and the right panel reports the results with *netdeal ratio* (*ndr*). As you see from Tables 1-1 and 1-2, price impact is highly significant at 1-minute and 5-minute frequencies. For deal returns, both the eat-up effect and catch-up effect are statistically significant and positive.

The result for five minutes are is still quite clean and robust. In the five minute window, the net buy (sell) pressure represented by order flows have predictive power on the deal price movements in the following five minutes. The result is robust with respect to the choice of the ask deal price, bid deal price, or mid-point. The result is also robust with respect to the choice of buy (sell) pressure, either in the difference in the number of net (buy) deals or the ratio of net (buy) deals. The result is confirmed in each year in the sample.

Tables 1-1-1-4

⁹ It is well known that foreign exchange markets have intra-day seasonality, see Ito and Hashimoto (2004) and Ito, Lyons, and Melvin (1998) for such a phenomenon for the yen market, and more generally, Andersen and Bollerslev (1997, 1998) and Baillie and Bollerslev (1990).

Tables 2-1-2-4 reports the price impact of USD/JPY quote returns. Price impact is significant at 1-minute and 5-minute frequencies, but we do not see a significant price impact at 30-minute frequency. The transaction at $t-1$ significantly moves quote prices from $t-1$ to t up to 5-minute window, but the price impact disappears at 30-minute frequency.

In the case of returns measured in bid and ask quotes, the results are clean in the time windows of both 1 minute and 5 minutes. In other words, predictability of changes in bid and ask quotes in response to order flows, i.e., buy or sell pressure, of preceding time window is clearly established for the 1 minute and 5 minute windows.

Tables 2-1-2-4

Regression results of EUR/USD deal price returns are summarized in Tables 3-1-3-4. As clearly seen in these tables, price impact is significant at 1-minute frequency. This is quite Looking at the price impact at 5-minute frequency, some of the price impact in 1999 and 2000 are not significantly estimated. For example, estimated parameter $nd^{negative}$ for midpoint return and bid-side deal return in 1999 and 2000, parameter nd^{plus} for midpoint return in 1999, and parameters nd^{plus} and $nd^{negative}$ for ask-side deal return in 1999 (all estimated with *netdeal*) are not significant at 10%. However, since 2001 deal price returns, both in ask and bid, have been significant at 1 % in the 5 minute window (Figure 3-2), just like in the case of USD/JPY (Figure 1-2). At 15-minute and 30-minute frequencies, most of the price impact are not significantly estimated.

Tables 3-1-3-4

Tables 4-1-4-4 reports the price impact of EUR/USD quote returns. Again, we find a significant price impact at 1-minute frequency, but some of the parameters in early years are not significant at 5-minute frequency. Parameter nd^{plus} for midpoint return in 1999, 2000 (*netdeal*), 1999 (*ndr*), bid-side deal return in 1999 (*netdeal*, *ndr*), ask-side deal return in 1999 (*netdeal*), and parameter nd^{plus} for mid point return from 1999-2001, bid-side deal return in 1999 and 2000 (*netdeal* and *ndr*) and ask-side deal return 1999 and 2000 (*netdeal* and *ndr*) are not significant at 10%. However, the significance price impact disappears at 15-minute and 30-minute frequency.

Tables 4-1-4-4

Overall, our tests turned out to be successful in finding some predictive power of exchange rate changes based on order flows for both USD/JPY and EUR/USD, at least up to 5 minutes. The dispersed information or private information affecting the fundamental value of currencies is transmitted through order flow. However, the predictability (and information) is short-lived. We fail to detect any predictability even at the 30-minute frequency. Our results are consistent with the view that the exchange rate movement is near random walk—hard to predict. What is new here is that there exists a time window, albeit a short period, that the movement is predictable if right information is available in real time.

4. Distributed Lag

We can summarize the findings from the preceding section as follows. Order flows, resulting in buy pressure or sell pressure, do move the exchange rate, and the effect is strong up to, at least, the following 5 minutes. The predictability is already very weak in 15 minutes, and predictability definitely disappears in 30 minutes. The preceding section did not test exactly how long the predictable power may persist. In this section, the lagged effects are measured cumulatively so that how long effects may persist can be estimated more precisely. In other words, the estimation will answer a question, how long the order flow information will remain valuable.

In order to examine the cumulative effect of order flows on the exchange rate changes, the following specification with the 1 minute frequency is adopted.

$$\Delta s_t = \alpha + \sum_{i=0}^{30} \beta_i ndr_{t-i} + v_t \quad (8)$$

In this specification, the contemporaneous effect, β_0 , is also included, based on the presumption that order flows Granger-cause the price movement. The past 1 minute effect of transaction on the current price movement is captured by $\beta_0 + \beta_1$, and the past 14-minute effect is expressed as $\beta_0 + \beta_1 + \beta_2 + \beta_3 + \dots + \beta_{14}$. We calculate the price impact up to 30 minutes.

In estimating equation (8), again, we use three deal returns (midpoint of the deal ask and the deal bid price, deal ask price, and deal bid price) for Δs , where “*ndr*” denotes the

netdeal ratio.¹⁰ Lagged independent variables (up to 30 lags) are also included in the estimation. The calculated price impact defined as $\sum_{i=0}^p \beta_i$ (p equals up to 30) and associated standard errors are estimated for each of the three candidate return variables and a currency pair. The estimated cumulative price impact with one standard deviation will be examined below.

The price impact, the sum of β_i , is expected to be positive. For example, if the number of deals done on the ask-side exceeds the number of deals done on the bid-side for USDJPY, the USD will appreciate vis-à-vis the Japanese yen due to more buyer initiated trades occurred. Therefore, the *netdeal ratio*, *ndr*, is positively associated with the returns.

Results

Results are summarized in Figures 1 through 6. Figures 1-3 show the price impact of USDJPY and figures 4-6 show the result of EURUSD. In each figure, the horizontal axis shows the duration from 0 minute to 30 minutes and the vertical axis shows the price impact with bars of one standard errors. The price impact is not significantly different from zero when vertical bars of s.e. cross the horizontal axis of zero. Overall, the contemporaneous effects are significantly positive regardless of currencies, definition of returns (midpoint returns, bid-side deal returns, or ask-side deal returns), or sample years.

Figures 1-3 summarize the price impact of order flows on various measures of returns of USDJPY. Figure 1 shows the price impact on midpoint returns. Overall, the contemporaneous price impact (0 min) is small but positive. The past one minute impact (1min) is the largest and then the cumulative price impact gradually decreases, although it remains significantly positive even after 30 minutes. There is not a large difference in the price impact patterns over the years.

Estimation with bid-side deal returns and ask-side deal returns are shown in Figures 2 and 3, respectively. The size of the contemporaneous price impact (0 min) varies across years, but they are all positive and significant. The past one minute impact (1 min) is the largest, as is the case for midpoint returns, and then the price impact

¹⁰ Since we do not see a large difference in estimation results of equations through (2) to (7), the estimation in this section was conducted with explanatory variable of *netdeal ratio* only.

gradually decreases. In some years, price impact remains significantly positive after 30 minutes, and in other years, it becomes insignificant at around 25-30 minutes. For bid-side deal returns, price impact becomes insignificant at around 25-30 minutes in 2000, 2001, 2002 and 2003, as shown in Figure 2. For ask-side deal returns, price impact becomes insignificant around 28-30 minutes only in 2003 as shown in Figure 3.

For USDJPY deals, estimation results show that most of the price impact remains significantly positive after 30 minutes.

Figures 1-3

Figures 4-6 show the price impact of order flows on various measures of returns on EURUSD. Results are mostly the same as the USDJPY with a slight difference--in some years, price impact appears significantly negative at higher lags at around 26-30 minutes. For the midpoint returns, in Figure 4, the contemporaneous impact is small but positive, again, and the past one minute impact (1 min) is the largest. Then price impact gradually decreases but it remains significant even at 30 minutes in 1999 and in 2000. Price impact becomes insignificant at 26 minutes in 2001 and significantly negative at around 28 minutes in 2002 and 2003.

Figures 5 and 6 show the price impact for bid-side deal returns and ask-side deal returns. For bid-side deal returns, price impact remains significant at 30 minutes in 1999 and 2000, whereas it becomes significantly negative around 26 minutes in 2001 and after. For ask-side deal returns, price impact is significant for 30 minutes in 1999, it becomes insignificant at 28 minutes in 2000, and it becomes significantly negative after 2001.

In summary, the duration of positively significant returns following order flows is getting shorter recently. This may be due to advances in technical trading that exploits profit opportunities very quickly. For USDJPY, the impact remains significant around 25minutes (bid-side deal) and 28 minutes (ask-side deal). For EURUSD, the price impact becomes significantly negative in recent years.

Figures 4-6

5. Conclusion

We examine the price impact of order flows using the transaction data recorded in the electronic broking system of the both USD/JPY and EUR/USD spot foreign exchange

markets. At the 1-minute and 5-minute frequencies, our results show a strong predictive power of order flow for future exchange rate movement, whereas we fail to find any predictability at the half-hour window. The results confirm that the private information may be contained in prices via order flows, but such information is very short-lived.

These findings suggest some profit opportunities if one has detailed information of the second-to-second deal counts/volumes in real time. This may explain why the private institutions spend millions of dollars to gather real time information and develop a model to extract buy and sell signals.

Although we found some evidence that price movements are predictable given trades information a minute earlier. However, this does not necessarily mean there was a profitable opportunity. First, the estimation was done for a whole sample, and predictability is tested as an in-sample exercise. For the profitable opportunity, the exercise has to be done as out-of-sample simulations. A task of more sophisticated out-of-sample simulations is left for future research.

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Table 1-3: Prediction; USDJPY 15-minute Deal return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1998	3.16E-05	8.61E-05	8.07E-05	1.14E-04	23149
1999	-1.81E-04	7.13E-05 ***	-1.47E-04	9.58E-05 *	22821
2000	6.53E-05	6.79E-05	-1.93E-05	7.93E-05	22292
2001	1.15E-04	6.32E-05 **	3.49E-05	7.94E-05	22354
2002	-3.46E-05	5.79E-05	1.73E-04	7.00E-05 ***	22569
2003	2.79E-05	5.92E-05	-7.10E-06	6.98E-05	19113

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Ask Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1998	4.25E-05	8.52E-05	1.14E-04	1.12E-04	23654
1999	-1.84E-04	7.09E-05 ***	-1.08E-04	9.49E-05	23272
2000	9.12E-05	6.70E-05 *	1.81E-05	7.82E-05	23057
2001	1.15E-04	6.22E-05 **	8.00E-05	7.83E-05	23260
2002	-1.96E-05	5.71E-05	2.26E-04	6.91E-05 ***	23445
2003	5.39E-05	5.86E-05	1.24E-05	6.93E-05	19680

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Bid Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1998	9.71E-05	8.66E-05	1.26E-04	1.15E-04	23370
1999	-1.23E-04	7.09E-05 *	-1.12E-04	9.55E-05	23266
2000	1.14E-04	6.71E-05 **	2.91E-07	7.87E-05	23009
2001	1.52E-04	6.27E-05 ***	6.69E-05	7.89E-05	22926
2002	4.93E-06	5.74E-05	1.81E-04	6.97E-05 ***	23058
2003	5.84E-05	5.90E-05	2.62E-05	6.97E-05	19421

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1998	5.84E-03	6.53E-03	6.74E-03	7.35E-03	23149
1999	2.42E-03	5.09E-03	3.76E-03	5.91E-03	22821
2000	5.76E-03	3.97E-03 *	2.41E-03	4.15E-03	22292
2001	4.77E-03	3.73E-03	4.79E-03	4.25E-03	22354
2002	5.97E-03	3.55E-03 **	3.58E-03	4.05E-03	22569
2003	7.87E-03	3.60E-03 **	-4.45E-04	4.04E-03	19113

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Ask Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1998	5.17E-03	5.98E-03	8.87E-03	7.11E-03	23654
1999	4.33E-03	4.73E-03	5.56E-03	5.79E-03	23272
2000	8.10E-03	3.55E-03 **	2.57E-03	4.01E-03	23057
2001	4.76E-03	3.30E-03 *	7.02E-03	4.07E-03 **	23260
2002	5.57E-03	3.11E-03 **	5.80E-03	3.90E-03 *	23445
2003	8.30E-03	3.25E-03 ***	1.29E-03	3.90E-03	19680

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Bid Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1998	1.02E-02	6.52E-03	9.71E-03	1.71E-03	23370
1999	7.01E-03	5.00E-03 *	1.90E-03	5.33E-03	23266
2000	8.82E-03	3.84E-03 ***	2.28E-03	3.66E-03	23009
2001	9.46E-03	3.63E-03 ***	4.41E-03	3.83E-03	22926
2002	8.61E-03	3.47E-03 ***	2.01E-03	3.67E-03	23058
2003	1.03E-02	3.54E-03 ***	-1.35E-03	3.78E-03	19421

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Table 1-4: Prediction; USDJPY 30-minute Deal return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1998	-1.88E-04	1.10E-04 *	-5.97E-05	1.66E-04	11805
1999	-1.86E-04	9.21E-05 **	-2.87E-05	1.38E-04	11720
2000	2.28E-04	8.94E-05 **	-2.65E-05	1.12E-04	11824
2001	1.09E-04	8.28E-05	-5.41E-05	1.14E-04	11777
2002	-3.43E-05	7.68E-05	1.34E-04	9.98E-05	11823
2003	-7.96E-05	7.97E-05	5.56E-06	9.98E-05	9890

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Ask Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1998	-2.07E-04	1.10E-04 *	-6.34E-05	1.65E-04	11870
1999	-1.70E-04	9.19E-05 *	-1.69E-05	1.38E-04	11828
2000	2.17E-04	8.88E-05 **	6.35E-07	1.11E-04	11946
2001	1.08E-04	8.27E-05	-3.50E-05	1.14E-04	11894
2002	-3.39E-05	7.67E-05	1.63E-04	9.96E-05	11955
2003	-5.62E-05	7.95E-05	1.70E-05	9.97E-05	9980

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Bid Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1998	-1.48E-04	1.11E-04	-1.88E-05	1.67E-04	11839
1999	-1.73E-04	9.21E-05 *	-1.02E-05	1.38E-04	11763
2000	2.67E-04	8.96E-05 ***	-2.63E-05	1.12E-04	11904
2001	1.36E-04	8.27E-05	-2.95E-05	1.14E-04	11852
2002	-9.49E-06	7.67E-05	1.39E-04	9.97E-05	11905
2003	-7.84E-05	7.98E-05	1.32E-05	1.00E-04	9925

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1998	-2.31E-02	1.58E-02	7.52E-04	1.87E-02	11805
1999	-6.08E-03	1.26E-02	6.20E-03	1.53E-02	11720
2000	3.39E-03	9.50E-03	9.21E-03	1.02E-02	11824
2001	4.02E-03	8.75E-03	-8.36E-04	1.03E-02	11777
2002	-3.12E-04	8.45E-03	7.33E-03	9.93E-03	11823
2003	-4.03E-03	8.99E-03	-6.58E-03	1.03E-02	9890

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Ask Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1998	-1.92E-02	1.52E-02	-2.23E-03	1.85E-02	11870
1999	-5.13E-03	1.21E-02	7.00E-03	1.51E-02	11828
2000	1.40E-03	8.87E-03	1.13E-02	1.01E-02	11946
2001	3.96E-03	8.28E-03	-6.01E-04	1.02E-02	11894
2002	-2.26E-03	7.95E-03	1.03E-02	9.75E-03	11955
2003	-1.36E-03	8.43E-03	-6.56E-03	1.02E-02	9980

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Bid Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1998	-2.15E-02	1.59E-02	1.76E-02	1.82E-02	11839
1999	-2.04E-03	1.25E-02	4.11E-03	1.48E-02	11763
2000	5.20E-03	9.43E-03	1.05E-02	9.70E-03	11904
2001	7.94E-03	8.69E-03	-1.80E-03	9.92E-03	11852
2002	4.70E-03	8.36E-03	4.99E-03	9.50E-03	11905
2003	-3.76E-03	8.96E-03	-5.26E-03	1.01E-02	9925

*note: ***, ** and * indicate the significance at 1.5,10%, respectively.*

Table 2-3: Prediction; USDJPY 15-minute Quote return

Log middle price					
	<i>ndplus</i> (<i>netdeal</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>netdeal</i>)	<i>s.e.</i>	NOB
1998	1.05E-04	8.48E-05	1.32E-04	1.12E-04	24118
1999	-1.96E-04	6.91E-05 ***	-2.17E-04	9.29E-05 **	24141
2000	1.57E-05	6.42E-05	-8.59E-05	7.52E-05	24337
2001	5.95E-05	5.98E-05	-2.35E-05	7.56E-05	24386
2002	-7.39E-05	5.51E-05	1.58E-04	6.68E-05 **	24477
2003	-1.32E-05	5.72E-05	-1.44E-05	6.76E-05	20306

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Ask Return					
	<i>ndplus</i> (<i>netdeal</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>netdeal</i>)	<i>s.e.</i>	NOB
1998	3.93E-04	8.72E-05 ***	4.21E-04	1.16E-04 ***	24118
1999	-1.66E-04	6.93E-05 **	-1.97E-04	9.31E-05 **	24141
2000	4.52E-05	6.44E-05	-6.02E-05	7.54E-05	24337
2001	9.45E-05	6.01E-05	5.84E-07	7.59E-05	24386
2002	-2.80E-05	5.54E-05	1.95E-04	6.71E-05 ***	24477
2003	1.04E-05	5.74E-05	-4.06E-07	6.78E-05	20306

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Bid Return					
	<i>ndplus</i> (<i>netdeal</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>netdeal</i>)	<i>s.e.</i>	NOB
1998	4.38E-05	8.49E-05	1.22E-04	1.12E-04	24118
1999	-1.80E-04	6.94E-05 ***	-1.81E-04	9.34E-05 *	24141
2000	4.10E-05	6.46E-05	-4.99E-05	7.56E-05	24337
2001	8.25E-05	6.01E-05	2.03E-05	7.61E-05	24386
2002	-7.44E-05	5.53E-05	1.71E-04	6.70E-05 **	24477
2003	4.79E-06	5.76E-05	1.10E-05	6.81E-05	20306

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Log middle price					
	<i>ndplus</i> (<i>ndr</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>ndr</i>)	<i>s.e.</i>	NOB
1998	5.62E-03	5.78E-03	8.13E-03	6.68E-03	24108
1999	1.89E-03	4.37E-03	-2.10E-03	4.91E-03	24124
2000	2.43E-03	3.18E-03	-1.22E-03	3.30E-03	24314
2001	1.38E-03	2.97E-03	2.13E-04	3.39E-03	24355
2002	3.56E-03	2.79E-03	-9.54E-04	3.25E-03	24454
2003	4.10E-03	3.02E-03	-2.39E-03	3.44E-03	20293

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Ask Return					
	<i>ndplus</i> (<i>ndr</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>ndr</i>)	<i>s.e.</i>	NOB
1998	1.69E-02	5.99E-03 ***	1.53E-02	6.95E-03 **	24108
1999	2.55E-03	4.39E-03	-1.75E-03	4.93E-03	24124
2000	2.18E-03	3.19E-03	-1.34E-04	3.32E-03	24314
2001	1.91E-03	2.99E-03	6.04E-04	3.41E-03	24355
2002	4.62E-03	2.81E-03	6.99E-04	3.27E-03	24454
2003	3.81E-03	3.03E-03	-1.26E-03	3.46E-03	20293

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Bid Return					
	<i>ndplus</i> (<i>ndr</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>ndr</i>)	<i>s.e.</i>	NOB
1998	4.09E-03	5.78E-03	8.99E-03	6.67E-03	24108
1999	2.86E-03	4.40E-03	-1.17E-03	4.94E-03	24124
2000	4.15E-03	3.20E-03	-1.05E-03	3.32E-03	24314
2001	2.50E-03	3.00E-03	1.29E-03	3.41E-03	24355
2002	3.78E-03	2.80E-03	-1.37E-03	3.26E-03	24454
2003	0.0056029	3.05E-03 *	-2.38E-03	3.47E-03	20293

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Table 2-4: Prediction; USDJPY 30-minute Quote return

Log middle price					
	<i>ndplus</i> (<i>netdeal</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>netdeal</i>)	<i>s.e.</i>	NOB
1998	-1.27E-04	1.10E-04	-9.05E-06	1.67E-04	11919
1999	-2.06E-04	9.07E-05 **	-7.29E-05	1.36E-04	11952
2000	2.03E-04	8.77E-05 **	-7.16E-05	1.10E-04	12066
2001	8.23E-05	8.14E-05	-4.34E-05	1.12E-04	12075
2002	-6.70E-05	7.54E-05	1.18E-04	9.78E-05	12103
2003	-9.75E-05	7.88E-05	-4.16E-05	9.88E-05	10033

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Ask Return					
	<i>ndplus</i> (<i>netdeal</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>netdeal</i>)	<i>s.e.</i>	NOB
1998	3.62E-05	1.13E-04	1.93E-04	1.71E-04	11919
1999	-1.92E-04	9.08E-05 **	-7.11E-05	1.36E-04	11952
2000	2.36E-04	8.78E-05 ***	-6.09E-05	1.10E-04	12066
2001	8.56E-05	8.16E-05	-6.78E-05	1.13E-04	12075
2002	-5.43E-05	7.56E-05	1.39E-04	9.80E-05	12103
2003	-8.16E-05	7.89E-05	-4.23E-05	9.89E-05	10033

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Bid Return					
	<i>ndplus</i> (<i>netdeal</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>netdeal</i>)	<i>s.e.</i>	NOB
1998	-1.52E-04	1.11E-04	5.03E-06	1.67E-04	11919
1999	-2.00E-04	9.09E-05 **	-4.88E-05	1.37E-04	11952
2000	1.93E-04	8.81E-05 **	-5.72E-05	1.10E-04	12066
2001	1.06E-04	8.18E-05	1.28E-05	1.13E-04	12075
2002	-5.60E-05	7.57E-05	1.22E-04	9.82E-05	12103
2003	-8.85E-05	7.92E-05	-1.96E-05	9.95E-05	10033

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Log middle price					
	<i>ndplus</i> (<i>ndr</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>ndr</i>)	<i>s.e.</i>	NOB
1998	-1.43E-02	1.52E-02	9.74E-03	1.80E-02	11918
1999	-7.84E-03	1.13E-02	-3.08E-03	1.38E-02	11946
2000	-7.72E-04	8.55E-03	5.78E-03	9.22E-03	12064
2001	2.72E-03	7.93E-03	-6.13E-03	9.34E-03	12066
2002	-2.37E-03	7.56E-03	7.05E-04	9.00E-03	12097
2003	-5.81E-03	8.29E-03	-1.27E-02	9.69E-03	10032

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Ask Return					
	<i>ndplus</i> (<i>ndr</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>ndr</i>)	<i>s.e.</i>	NOB
1998	-9.26E-04	1.57E-02	2.11E-02	1.86E-02	11918
1999	-7.92E-03	1.14E-02	3.66E-04	1.38E-02	11946
2000	6.00E-05	8.57E-03	6.84E-03	9.25E-03	12064
2001	9.45E-04	7.94E-03	-6.21E-03	9.36E-03	12066
2002	-3.15E-03	7.58E-03	2.53E-03	9.02E-03	12097
2003	-6.17E-03	8.30E-03	-1.09E-02	9.70E-03	10032

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Bid Return					
	<i>ndplus</i> (<i>ndr</i>)	<i>s.e.</i>	<i>ndminus</i> (<i>ndr</i>)	<i>s.e.</i>	NOB
1998	-1.32E-02	1.53E-02	9.54E-03	1.81E-02	11918
1999	-6.04E-03	1.14E-02	-5.22E-03	1.38E-02	11946
2000	-2.00E-04	8.59E-03	5.86E-03	9.26E-03	12064
2001	6.32E-03	7.98E-03	-4.59E-03	9.39E-03	12066
2002	-1.02E-04	7.59E-03	2.04E-04	9.04E-03	12097
2003	-3.91E-03	8.34E-03	-1.31E-02	9.76E-03	10032

note: ***, ** and * indicate the significance at 1.5, 10%, respectively.

Table 3-1: Prediction; EURUSD 1-minute Deal return

Log middle price					NOB
<i>ndplus</i> (<i>netdeal</i>)	s.e.	<i>ndminus</i> (<i>netdeal</i>)	s.e.		
1999	3.12E-04	2.88E-05 ***	3.09E-04	3.01E-05 ***	94682
2000	4.12E-04	3.43E-05 ***	3.94E-04	3.56E-05 ***	115301
2001	2.95E-04	3.33E-05 ***	3.85E-04	3.41E-05 ***	106335
2002	2.22E-04	2.93E-05 ***	2.38E-04	3.05E-05 ***	90761
2003	3.09E-04	2.79E-05 ***	2.48E-04	2.87E-05 ***	107231

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					NOB
<i>ndplus</i> (<i>netdeal</i>)	s.e.	<i>ndminus</i> (<i>netdeal</i>)	s.e.		
1999	3.35E-04	2.52E-05 ***	5.59E-04	2.65E-05 ***	124575
2000	3.99E-04	3.07E-05 ***	6.59E-04	3.21E-05 ***	143585
2001	2.86E-04	2.97E-05 ***	6.31E-04	3.06E-05 ***	134865
2002	2.28E-04	2.52E-05 ***	4.26E-04	2.65E-05 ***	121033
2003	3.02E-04	2.51E-05 ***	4.15E-04	2.61E-05 ***	132283

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					NOB
<i>ndplus</i> (<i>netdeal</i>)	s.e.	<i>ndminus</i> (<i>netdeal</i>)	s.e.		
1999	5.33E-04	2.61E-05 ***	3.23E-04	2.69E-05 ***	118122
2000	6.68E-04	3.15E-05 ***	4.20E-04	3.24E-05 ***	138445
2001	4.99E-04	3.05E-05 ***	3.88E-04	3.10E-05 ***	128689
2002	3.99E-04	2.63E-05 ***	2.46E-04	2.70E-05 ***	114936
2003	4.74E-04	2.56E-05 ***	2.46E-04	2.63E-05 ***	128043

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Log middle price					NOB
<i>ndplus</i> (<i>ndr</i>)	s.e.	<i>ndminus</i> (<i>ndr</i>)	s.e.		
1999	5.20E-03	4.50E-04 ***	5.54E-03	4.73E-04 ***	94682
2000	6.60E-03	5.59E-04 ***	7.29E-03	5.84E-04 ***	115301
2001	5.32E-03	5.20E-04 ***	6.43E-03	5.44E-04 ***	106335
2002	4.07E-03	4.53E-04 ***	4.59E-03	4.78E-04 ***	90761
2003	4.46E-03	4.55E-04 ***	4.98E-03	4.74E-04 ***	107231

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					NOB
<i>ndplus</i> (<i>ndr</i>)	s.e.	<i>ndminus</i> (<i>ndr</i>)	s.e.		
1999	4.22E-03	2.91E-04 ***	8.09E-03	3.89E-04 ***	124575
2000	4.69E-03	3.79E-04 ***	1.05E-02	4.92E-04 ***	143585
2001	3.84E-03	3.43E-04 ***	9.07E-03	4.56E-04 ***	134865
2002	2.72E-03	2.79E-04 ***	6.70E-03	3.82E-04 ***	121033
2003	3.53E-03	3.02E-04 ***	6.80E-03	4.01E-04 ***	132283

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					NOB
<i>ndplus</i> (<i>ndr</i>)	s.e.	<i>ndminus</i> (<i>ndr</i>)	s.e.		
1999	7.77E-03	3.86E-04 ***	4.34E-03	3.24E-04 ***	118122
2000	9.97E-03	4.87E-04 ***	5.45E-03	4.12E-04 ***	138445
2001	8.10E-03	4.49E-04 ***	4.29E-03	3.78E-04 ***	128689
2002	6.38E-03	3.82E-04 ***	3.16E-03	3.09E-04 ***	114936
2003	6.53E-03	3.94E-04 ***	3.72E-03	3.28E-04 ***	128043

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Table 3-2: Prediction; EURUSD 5-minute Deal return

Log middle price					NOB
<i>ndplus</i> (<i>netdeal</i>)	s.e.	<i>ndminus</i> (<i>netdeal</i>)	s.e.		
1999	5.71E-05	3.63E-05	-4.29E-05	3.95E-05	49697
2000	1.40E-04	4.67E-05 **	6.12E-05	5.07E-05	51451
2001	1.43E-04	4.39E-05 **	1.53E-04	4.69E-05 ***	51035
2002	1.22E-04	3.46E-05 ***	1.45E-04	3.80E-05 ***	51551
2003	1.21E-04	3.80E-05 **	1.43E-04	4.12E-05 ***	48206

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					NOB
<i>ndplus</i> (<i>netdeal</i>)	s.e.	<i>ndminus</i> (<i>netdeal</i>)	s.e.		
1999	5.58E-05	3.47E-05	5.14E-05	3.76E-05	54902
2000	1.49E-04	4.46E-05 **	1.59E-04	4.84E-05 ***	56457
2001	1.53E-04	4.19E-05 ***	2.19E-04	4.47E-05 ***	56446
2002	1.32E-04	3.31E-05 ***	1.98E-04	3.63E-05 ***	56928
2003	1.28E-04	3.63E-05 ***	1.87E-04	3.94E-05 ***	52520

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					NOB
<i>ndplus</i> (<i>netdeal</i>)	s.e.	<i>ndminus</i> (<i>netdeal</i>)	s.e.		
1999	1.42E-04	3.51E-05 ***	-8.16E-06	3.84E-05	53563
2000	2.03E-04	4.51E-05 ***	7.58E-05	4.92E-05	55121
2001	2.09E-04	4.24E-05 ***	1.65E-04	4.54E-05 ***	55093
2002	1.73E-04	3.34E-05 ***	1.50E-04	3.68E-05 ***	55772
2003	1.65E-04	3.70E-05 ***	1.55E-04	4.02E-05 ***	51031

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Log middle price					NOB
<i>ndplus</i> (<i>ndr</i>)	s.e.	<i>ndminus</i> (<i>ndr</i>)	s.e.		
1999	4.07E-03	1.41E-03 **	2.77E-03	1.52E-03 *	49697
2000	8.26E-03	1.96E-03 ***	4.22E-03	2.13E-03 **	51451
2001	1.01E-02	1.66E-03 ***	4.25E-03	1.84E-03 **	51035
2002	6.11E-03	1.28E-03 ***	4.52E-03	1.38E-03 ***	51551
2003	5.78E-03	1.48E-03 ***	7.86E-03	1.63E-03 ***	48206

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					NOB
<i>ndplus</i> (<i>ndr</i>)	s.e.	<i>ndminus</i> (<i>ndr</i>)	s.e.		
1999	4.27E-03	1.05E-03 ***	4.35E-03	1.35E-03 ***	54902
2000	6.00E-03	1.44E-03 ***	7.47E-03	1.88E-03 ***	56457
2001	7.68E-03	1.22E-03 ***	6.59E-03	1.62E-03 ***	56446
2002	3.77E-03	9.48E-04 ***	5.98E-03	1.22E-03 ***	56928
2003	4.72E-03	1.12E-03 ***	9.21E-03	1.44E-03 ***	52520

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					NOB
<i>ndplus</i> (<i>ndr</i>)	s.e.	<i>ndminus</i> (<i>ndr</i>)	s.e.		
1999	6.77E-03	1.30E-03 ***	2.67E-03	1.20E-03 **	53563
2000	1.04E-02	1.79E-03 ***	3.63E-03	1.65E-03 **	55121
2001	1.18E-02	1.51E-03 ***	3.58E-03	1.40E-03 **	55093
2002	7.49E-03	1.16E-03 ***	3.78E-03	1.05E-03 ***	55772
2003	7.54E-03	1.38E-03 ***	6.90E-03	1.33E-03 ***	51031

note: ***, ** and * indicate the significance at 1.5,10%, respectively.

Table 3-3: Prediction; EURUSD 15-minute Deal return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-9.27E-05	5.24E-05 *	-3.54E-05	6.25E-05	21290
2000	1.27E-05	6.53E-05	-1.67E-04	7.75E-05 **	22128
2001	-6.66E-05	6.18E-05	1.77E-04	7.04E-05 **	22439
2002	6.21E-05	4.80E-05	-1.29E-04	5.76E-05 **	22724
2003	7.73E-05	5.58E-05	-1.99E-05	6.38E-05	19881

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-8.45E-05	5.11E-05 *	-1.78E-05	6.07E-05	22545
2000	1.72E-05	6.39E-05	-1.45E-04	7.59E-05 *	23110
2001	-5.06E-05	6.06E-05	1.89E-04	6.92E-05 ***	23347
2002	6.41E-05	4.74E-05	-1.15E-04	5.70E-05 **	23388
2003	7.58E-05	5.54E-05	-1.78E-05	6.35E-05	20132

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-6.71E-05	5.15E-05	-3.07E-05	6.15E-05	22090
2000	4.08E-05	6.44E-05	-1.53E-04	7.64E-05 **	22874
2001	-4.50E-05	6.12E-05	1.86E-04	6.98E-05 ***	23002
2002	8.42E-05	4.75E-05 *	-1.18E-04	5.70E-05 **	23337
2003	9.56E-05	5.57E-05 *	-8.44E-06	6.38E-05	20054

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	1.42E-03	4.05E-03	6.72E-04	4.53E-03	21290
2000	2.88E-03	5.26E-03	-1.64E-03	5.95E-03	22128
2001	5.52E-03	4.43E-03	2.26E-03	4.99E-03	22439
2002	-1.38E-03	3.57E-03	2.31E-03	3.90E-03	22724
2003	2.99E-03	4.63E-03	1.36E-02	5.26E-03 **	19881

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	1.04E-03	3.26E-03	6.75E-04	4.19E-03	22545
2000	2.80E-03	4.45E-03	8.25E-04	5.56E-03	23110
2001	4.35E-03	3.82E-03	3.53E-03	4.71E-03	23347
2002	-1.86E-03	3.18E-03	4.43E-03	3.74E-03	23388
2003	2.73E-03	4.40E-03	1.43E-02	5.14E-03 ***	20132

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	4.30E-03	3.86E-03	1.13E-03	3.80E-03	22090
2000	5.53E-03	5.01E-03	-1.27E-03	5.09E-03	22874
2001	7.40E-03	4.28E-03 *	3.12E-03	4.46E-03	23002
2002	9.49E-04	3.45E-03	2.20E-03	3.44E-03	23337
2003	5.09E-03	4.59E-03	1.26E-02	5.02E-03 **	20054

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Table 3-4: Prediction; EURUSD 30-minute Deal return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-6.76E-05	6.90E-05	-9.24E-05	8.72E-05	11473
2000	-1.80E-04	8.50E-05 **	-3.64E-04	1.08E-04 ***	11840
2001	-7.01E-05	8.04E-05	1.13E-04	9.66E-05	11865
2002	-9.72E-05	6.31E-05	-3.08E-05	8.19E-05	11914
2003	9.64E-06	7.52E-05	-4.65E-05	9.30E-05	10025

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-6.60E-05	6.83E-05	-7.14E-05	8.59E-05	11706
2000	-1.80E-04	8.47E-05 **	-3.63E-04	1.08E-04 ***	11948
2001	-6.36E-05	8.02E-05	1.22E-04	9.64E-05	11957
2002	-9.18E-05	6.30E-05	-3.43E-05	8.18E-05	11995
2003	1.01E-05	7.52E-05	-3.39E-05	9.29E-05	10044

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-5.19E-05	6.86E-05	-9.24E-05	8.68E-05	11615
2000	-1.63E-04	8.50E-05 *	-3.48E-04	1.08E-04 ***	11906
2001	-6.09E-05	8.04E-05	1.14E-04	9.67E-05	11946
2002	-8.87E-05	6.31E-05	-2.73E-05	8.19E-05	11974
2003	1.35E-05	7.54E-05	-5.17E-05	9.32E-05	10030

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	4.24E-03	9.01E-03	-1.23E-02	1.05E-02	11473
2000	-1.22E-03	1.19E-02	-2.44E-02	1.37E-02 *	11840
2001	-4.70E-03	1.05E-02	-5.23E-03	1.22E-02	11865
2002	-1.10E-02	8.59E-03	3.96E-04	9.38E-03	11914
2003	-1.84E-02	1.22E-02	1.64E-02	1.42E-02	10025

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Ask Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	3.69E-03	8.10E-03	-1.04E-02	1.02E-02	11706
2000	5.82E-04	1.12E-02	-2.25E-02	1.35E-02 *	11948
2001	-2.48E-03	9.91E-03	-4.07E-03	1.20E-02	11957
2002	-9.95E-03	8.24E-03	1.14E-03	9.28E-03	11995
2003	-1.73E-02	1.19E-02	1.72E-02	1.40E-02	10044

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Bid Deal Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	5.16E-03	8.90E-03	-7.83E-03	9.67E-03	11615
2000	-1.55E-03	1.18E-02	-1.88E-02	1.33E-02	11906
2001	-3.28E-03	1.04E-02	-2.11E-03	1.17E-02	11946
2002	-9.24E-03	8.54E-03	1.27E-03	9.03E-03	11974
2003	-1.64E-02	1.22E-02	1.58E-02	1.42E-02	10030

note; ***, ** and * indicate the significance at 1.5,10%, respectively.

Table 4-1: Prediction; EURUSD 1-minute Quote return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	1.59E-04	1.97E-05 ***	1.66E-04	2.05E-05 ***	195862
2000	2.01E-04	2.47E-05 ***	2.68E-04	2.57E-05 ***	208196
2001	1.52E-04	2.46E-05 ***	2.54E-04	2.53E-05 ***	188917
2002	1.17E-04	2.20E-05 ***	1.51E-04	2.31E-05 ***	156517
2003	1.69E-04	2.09E-05 ***	1.31E-04	2.16E-05 ***	180919

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Ask Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	2.66E-04	2.04E-05 ***	3.20E-04	2.12E-05 ***	195862
2000	2.82E-04	2.54E-05 ***	4.06E-04	2.64E-05 ***	208196
2001	2.26E-04	2.53E-05 ***	3.70E-04	2.60E-05 ***	188917
2002	1.75E-04	2.27E-05 ***	2.39E-04	2.36E-05 ***	156517
2003	2.27E-04	2.14E-05 ***	2.05E-04	2.21E-05 ***	180919

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Bid Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	2.68E-04	2.01E-05 ***	2.37E-04	2.11E-05 ***	195862
2000	3.55E-04	2.53E-05 ***	3.74E-04	2.64E-05 ***	208196
2001	2.70E-04	2.51E-05 ***	3.45E-04	2.59E-05 ***	188917
2002	2.02E-04	2.25E-05 ***	2.09E-04	2.36E-05 ***	156517
2003	2.44E-04	2.12E-05 ***	1.92E-04	2.20E-05 ***	180919

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	1.25E-03	1.73E-04 ***	1.25E-03	1.80E-04 ***	191535
2000	1.81E-03	2.33E-04 ***	1.71E-03	2.43E-04 ***	204498
2001	1.79E-03	2.20E-04 ***	1.50E-03	2.30E-04 ***	185282
2002	1.45E-03	1.98E-04 ***	1.39E-03	2.07E-04 ***	153833
2003	1.20E-03	1.96E-04 ***	1.48E-03	2.03E-04 ***	178101

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Ask Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	2.03E-03	1.79E-04 ***	1.66E-03	1.86E-04 ***	191535
2000	2.57E-03	2.40E-04 ***	2.11E-03	2.50E-04 ***	204498
2001	2.42E-03	2.27E-04 ***	1.74E-03	2.37E-04 ***	185282
2002	1.96E-03	2.03E-04 ***	1.60E-03	2.13E-04 ***	153833
2003	1.68E-03	2.00E-04 ***	1.78E-03	2.08E-04 ***	178101

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Bid Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	1.61E-03	1.78E-04 ***	1.91E-03	1.84E-04 ***	191535
2000	2.36E-03	2.40E-04 ***	2.59E-03	2.49E-04 ***	204498
2001	2.24E-03	2.26E-04 ***	2.31E-03	2.35E-04 ***	185282
2002	1.78E-03	2.02E-04 ***	1.97E-03	2.11E-04 ***	153833
2003	1.50E-03	2.00E-04 ***	1.96E-03	2.07E-04 ***	178101

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Table 4-2: Prediction; EURUSD 5-minute Quote return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-1.97E-05	3.02E-05	-8.48E-05	3.31E-05 **	67676
2000	5.43E-05	3.93E-05	2.84E-05	4.29E-05	68196
2001	9.74E-05	3.71E-05 **	8.46E-05	3.98E-05 **	68079
2002	9.04E-05	2.98E-05 **	9.70E-05	3.29E-05 ***	67116
2003	1.04E-04	3.34E-05 **	9.89E-05	3.63E-05 ***	59787

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Ask Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	3.45E-05	3.06E-05	-1.96E-05	3.35E-05	67676
2000	8.48E-05	3.96E-05 *	6.74E-05	4.32E-05	68196
2001	1.24E-04	3.74E-05 **	1.27E-04	4.01E-05 ***	68079
2002	1.13E-04	3.01E-05 ***	1.22E-04	3.32E-05 ***	67116
2003	1.30E-04	3.37E-05 ***	1.19E-04	3.66E-05 ***	59787

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Bid Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	1.23E-05	3.04E-05	-5.49E-05	3.34E-05	67676
2000	9.25E-05	3.95E-05 *	6.49E-05	4.31E-05	68196
2001	1.39E-04	3.74E-05 ***	1.15E-04	4.02E-05 ***	68079
2002	1.13E-04	3.00E-05 ***	1.19E-04	3.31E-05 ***	67116
2003	1.15E-04	3.36E-05 **	1.17E-04	3.65E-05 ***	59787

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	9.63E-04	7.16E-04	-3.63E-04	7.66E-04	67050
2000	3.17E-03	1.00E-03 **	5.70E-04	1.08E-03	67641
2001	3.33E-03	8.68E-04 ***	1.38E-03	9.30E-04	67585
2002	1.28E-03	6.98E-04 *	1.94E-03	7.43E-04 ***	66771
2003	2.12E-03	8.80E-04 *	4.55E-03	9.62E-04 ***	59587

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Ask Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	1.70E-03	7.26E-04 *	2.54E-05	7.77E-04	67050
2000	3.43E-03	1.01E-03 ***	7.84E-04	1.09E-03	67641
2001	3.64E-03	8.76E-04 ***	1.63E-03	9.40E-04 *	67585
2002	1.55E-03	7.05E-04 *	1.99E-03	7.50E-04 ***	66771
2003	2.27E-03	8.87E-04 *	4.86E-03	9.70E-04 ***	59587

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Bid Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	1.14E-03	7.22E-04	1.19E-04	7.72E-04	67050
2000	3.71E-03	1.01E-03 ***	1.14E-03	1.09E-03	67641
2001	3.83E-03	8.75E-04 ***	1.87E-03	9.38E-04 **	67585
2002	1.60E-03	7.04E-04 *	2.44E-03	7.49E-04 ***	66771
2003	2.50E-03	8.84E-04 **	4.80E-03	9.67E-04 ***	59587

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Table 4-3: Prediction; EURUSD 15-minute Quote return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-9.99E-05	4.87E-05 **	-8.02E-05	5.80E-05	24089
2000	-3.20E-06	6.18E-05	-1.73E-04	7.34E-05 **	24325
2001	-7.52E-05	5.86E-05	1.60E-04	6.70E-05 **	24338
2002	6.25E-05	4.59E-05	-1.32E-04	5.52E-05 **	24372
2003	5.70E-05	5.47E-05	-2.21E-05	6.27E-05	20389

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Ask Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-8.51E-05	4.89E-05 *	-6.27E-05	5.82E-05	24089
2000	1.08E-05	6.19E-05	-1.61E-04	7.35E-05 **	24325
2001	-6.51E-05	5.88E-05	1.58E-04	6.72E-05 **	24338
2002	7.25E-05	4.61E-05	-1.24E-04	5.53E-05 **	24372
2003	6.57E-05	5.48E-05	-2.25E-05	6.29E-05	20389

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Bid Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-9.12E-05	4.89E-05 *	-7.06E-05	5.82E-05	24089
2000	2.12E-06	6.20E-05	-1.63E-04	7.36E-05 **	24325
2001	-6.47E-05	5.88E-05	1.83E-04	6.72E-05 **	24338
2002	6.53E-05	4.60E-05	-1.27E-04	5.53E-05 **	24372
2003	5.70E-05	5.48E-05	-1.31E-05	6.28E-05	20389

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	-1.41E-04	2.85E-03	-2.48E-03	3.24E-03	24058
2000	8.77E-04	4.01E-03	-1.12E-03	4.48E-03	24305
2001	1.85E-03	3.46E-03	7.08E-04	3.93E-03	24317
2002	-1.20E-03	2.89E-03	1.08E-03	3.08E-03	24352
2003	5.92E-04	4.24E-03	9.12E-03	4.75E-03 *	20385

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Ask Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	-3.26E-04	2.86E-03	-2.22E-03	3.26E-03	24058
2000	1.07E-03	4.02E-03	-2.71E-04	4.49E-03	24305
2001	2.30E-03	3.47E-03	6.07E-04	3.94E-03	24317
2002	-1.05E-03	2.90E-03	1.22E-03	3.09E-03	24352
2003	4.68E-04	4.25E-03	9.55E-03	4.76E-03 **	20385

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Bid Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	6.97E-04	2.86E-03	-2.11E-03	3.25E-03	24058
2000	1.35E-03	4.02E-03	-1.35E-03	4.49E-03	24305
2001	2.14E-03	3.48E-03	1.49E-03	3.95E-03	24317
2002	-8.30E-04	2.90E-03	1.39E-03	3.09E-03	24352
2003	1.17E-03	4.25E-03	9.16E-03	4.76E-03 *	20385

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Table 4-4: Prediction; EURUSD 30minute Quote return

Log middle price					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-8.87E-05	6.69E-05	-1.09E-04	8.44E-05	11938
2000	-1.89E-04	8.39E-05 **	-3.66E-04	1.07E-04 ***	12063
2001	-7.34E-05	7.94E-05	1.03E-04	9.56E-05	12077
2002	-1.09E-04	6.22E-05 *	-4.30E-05	8.07E-05	12123
2003	3.71E-06	7.49E-05	-5.32E-05	9.26E-05	10058

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Ask Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-7.93E-05	6.70E-05	-1.00E-04	8.44E-05	11938
2000	-1.74E-04	8.40E-05 **	-3.52E-04	1.07E-04 ***	12063
2001	-6.56E-05	7.97E-05	9.71E-05	9.59E-05	12077
2002	-1.03E-04	6.24E-05 *	-3.87E-05	8.09E-05	12123
2003	6.55E-06	7.49E-05	-5.59E-05	9.27E-05	10058

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Bid Return					
	ndplus (netdeal)	s.e.	ndminus (netdeal)	s.e.	NOB
1999	-8.69E-05	6.71E-05	-1.05E-04	8.46E-05	11938
2000	-1.94E-04	8.41E-05 **	-3.67E-04	1.07E-04 ***	12063
2001	-7.22E-05	7.96E-05	1.18E-04	9.59E-05	12077
2002	-1.09E-04	6.23E-05 *	-4.23E-05	8.08E-05	12123
2003	5.51E-06	7.50E-05	-4.61E-05	9.28E-05	10058

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

Log middle price					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	-6.29E-04	7.69E-03	-1.22E-02	9.04E-03	11934
2000	-1.23E-03	1.08E-02	-2.20E-02	1.28E-02 *	12061
2001	-5.29E-03	9.62E-03	-2.48E-03	1.12E-02	12076
2002	-1.32E-02	7.95E-03 *	-3.92E-03	8.67E-03	12118
2003	-1.95E-02	1.18E-02	1.42E-02	1.38E-02	10058

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

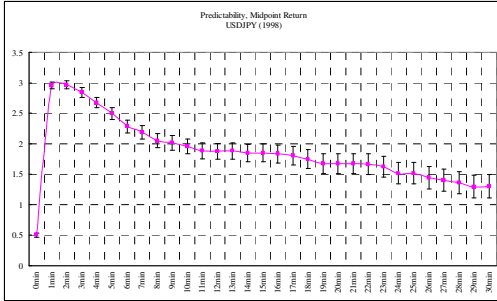
Ask Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	-5.23E-04	7.70E-03	-1.01E-02	9.05E-03	11934
2000	-7.42E-04	1.08E-02	-2.11E-02	1.28E-02	12061
2001	-3.44E-03	9.64E-03	-3.44E-03	1.13E-02	12076
2002	-1.27E-02	7.96E-03	-3.59E-03	8.69E-03	12118
2003	-2.03E-02	1.18E-02 *	1.38E-02	1.38E-02	10058

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

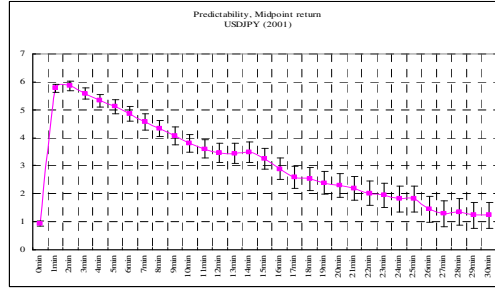
Bid Return					
	ndplus (ndr)	s.e.	ndminus (ndr)	s.e.	NOB
1999	-5.25E-05	7.71E-03	-1.38E-02	9.07E-03	11934
2000	-1.00E-03	1.08E-02	-2.23E-02	1.28E-02 *	12061
2001	-6.30E-03	9.65E-03	-7.85E-04	1.13E-02	12076
2002	-1.32E-02	7.96E-03 *	-3.82E-03	8.68E-03	12118
2003	-1.81E-02	1.19E-02	1.52E-02	1.39E-02	10058

*note: ***, ** and * indicate the significance at 1,5,10%, respectively.*

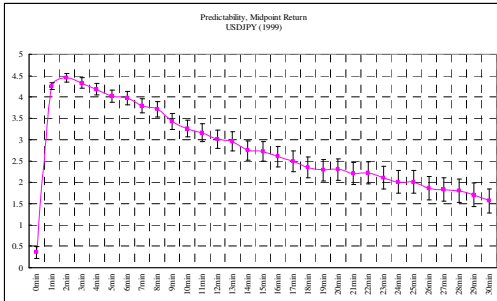
Figure 1:
USDJPY, Midpoint Deal Return
1998



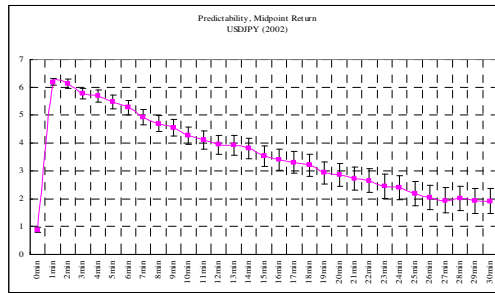
2001



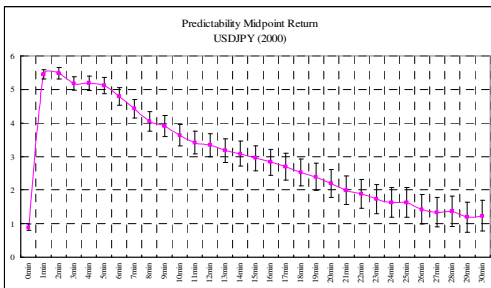
1999



2002



2000



2003

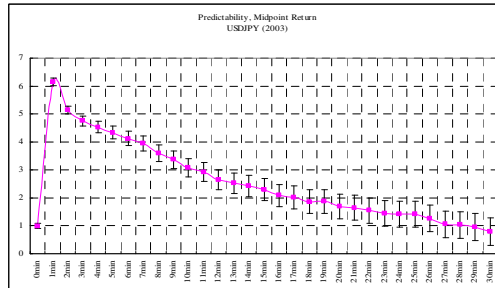
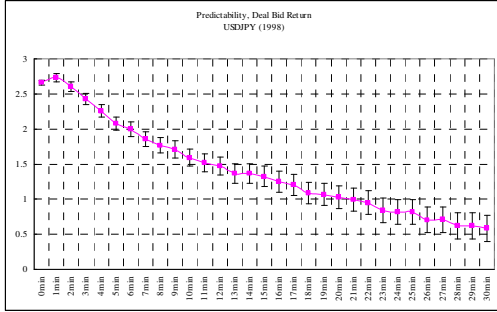
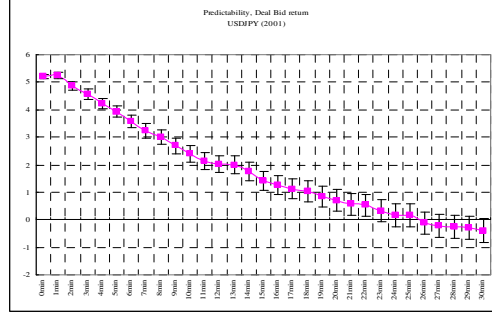


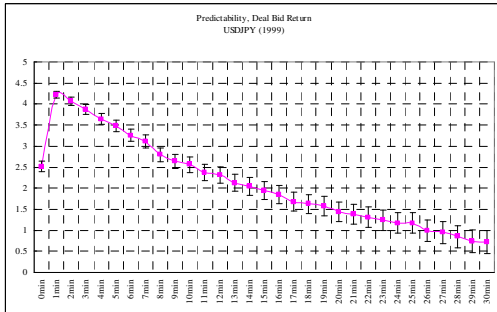
Figure 2:
USDJPY: Deal Bid return
1998



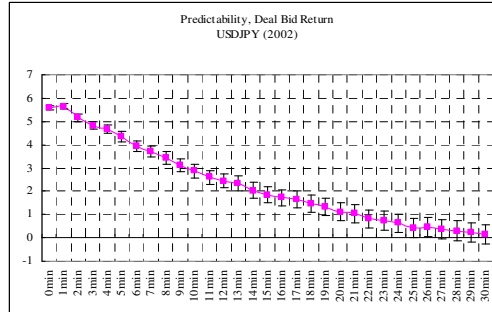
2001



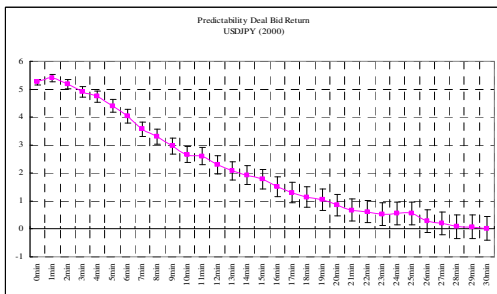
1999



2002



2000



2003

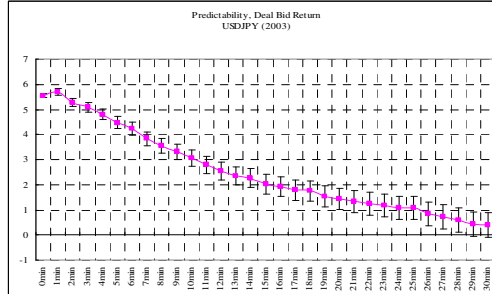
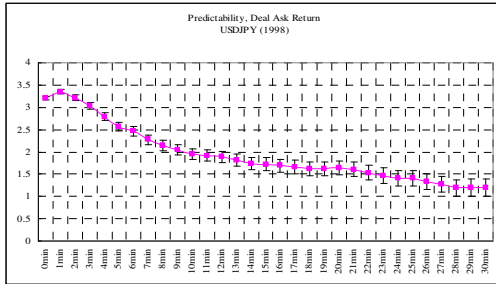
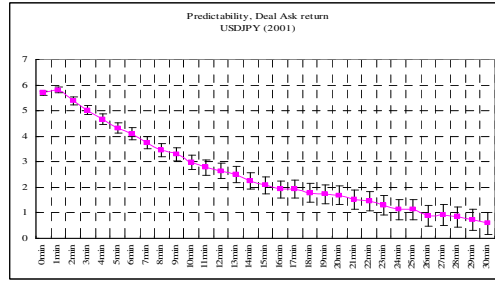


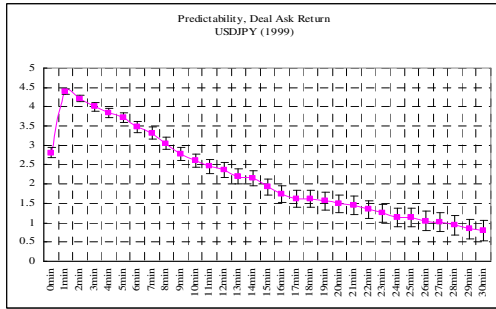
Figure 3:
USDJPY: Deal ASK return
1998



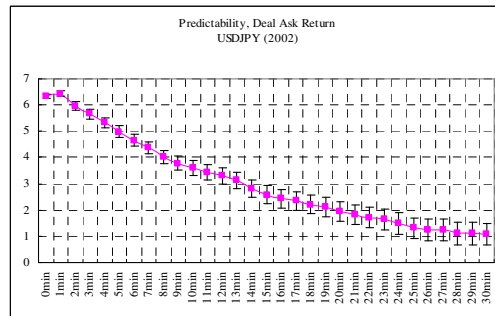
2001



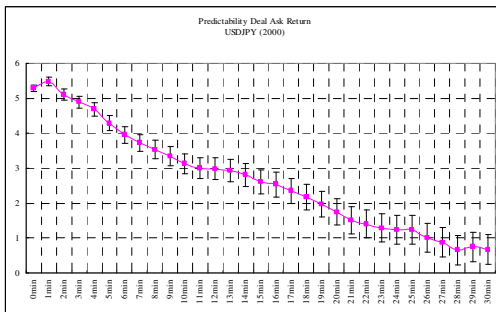
1999



2002



2000



2003

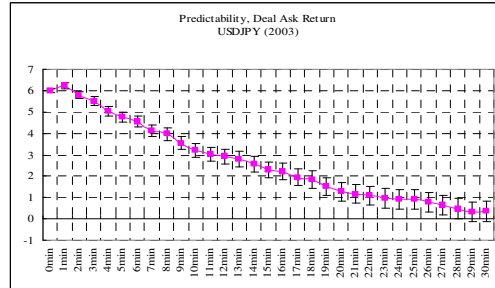
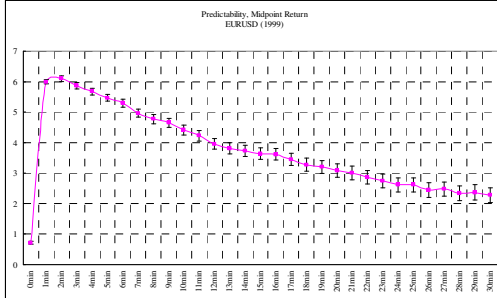


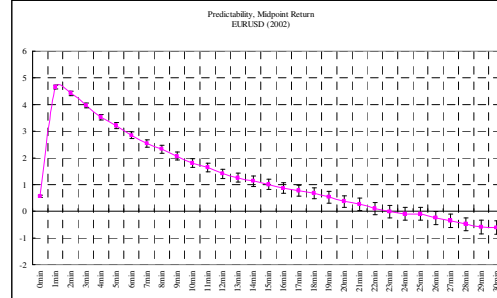
Figure 4

EURUSD: Midpoint Deal Return

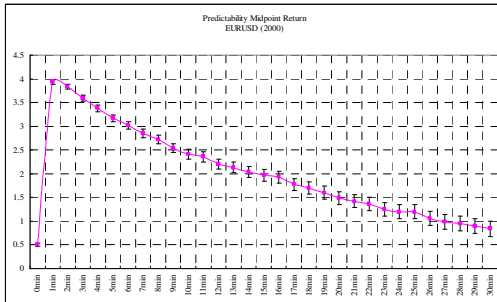
1999



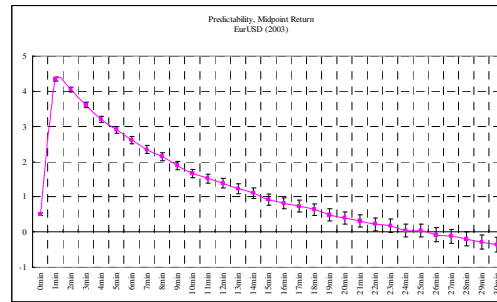
2002



2000



2003



2001

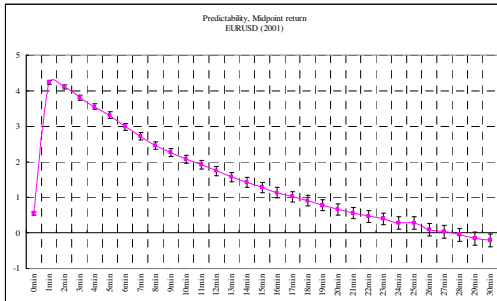
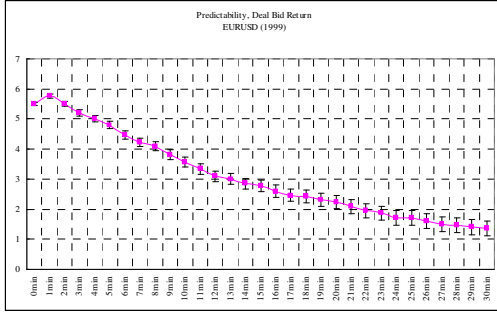
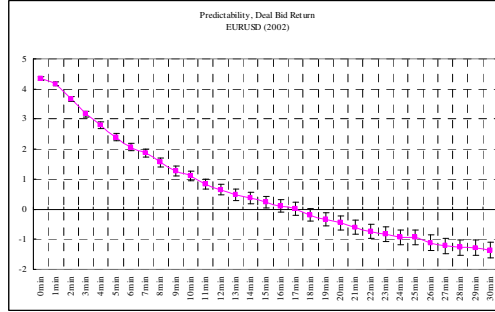


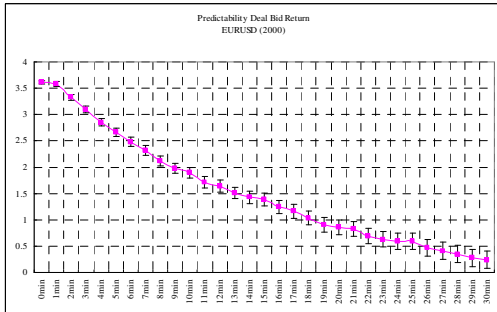
Figure 5
 EURUSD: Deal Bid return
 1999



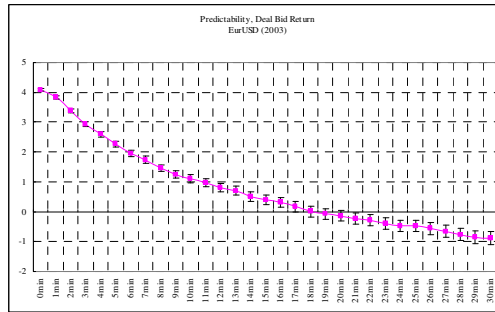
2002



2000



2003



2001

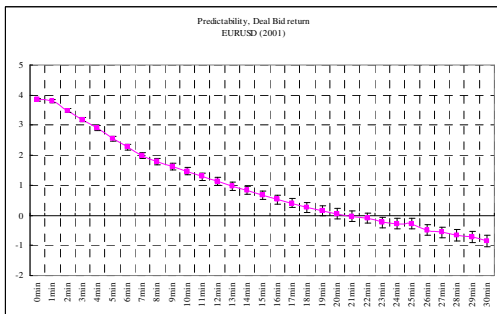
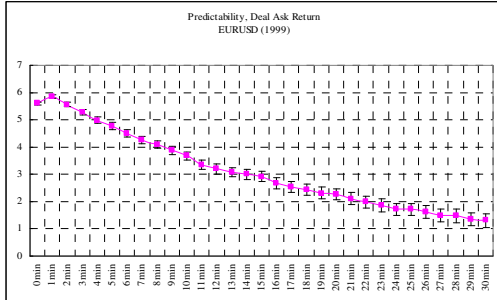
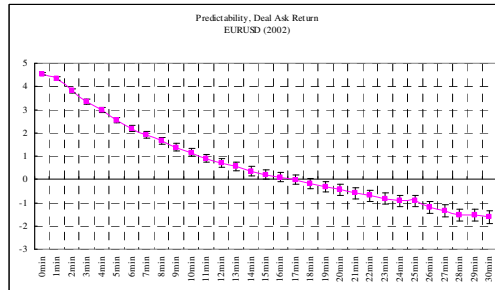


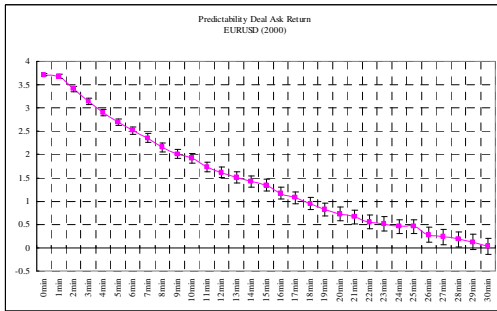
Figure 6
 EURUSD: Deal Ask return
 1999



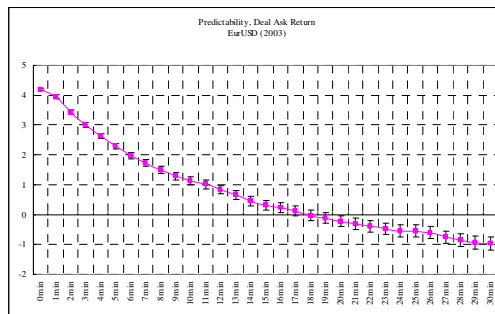
2002



2000



2003



2001

