Understanding Exchange Rates: A Micro-Based Perspective on the Importance of Fundamentals

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Abstract

This paper discusses how recent micro-based research on the foreign exchange market sheds new light on the link between macroeconomic fundamentals and spot exchange rates. I argue that micro-based models not only leave room for fundamentals as a driver of spot rates, but also provide a more detailed picture of how the dynamics of spot rates are linked to the evolution of the macroeconomy.

Introduction

The apparent disconnect between the dynamics of spot exchange rates and macroeconomic variables over short- and medium-term horizons has been a long-standing puzzle. Surveys of the empirical literature by Frankel and Rose (1995) and Cheung et al. (2005) conclude that changes in macroeconomic variables, so called exchange rate fundamentals, can account for very little of the observed variation in spot rates over months, quarters or a year. At the same time, there is a new but rapidly growing body of evidence showing that order flows - a measure of trading patterns in the foreign exchange (FX) market - can account for a very large proportion of the variation in spot rates over days, weeks and months (for a recent survey, see Evans 2008, Chap. 7). Many students of the FX market have interpreted these new micro-based findings as a confirmation that exchange rates are disconnected from

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fundamentals. Indeed, the prevalent view is that the trading patterns summarized in order flow are largely independent of macroeconomic activity, so the empirical success of micro-based models leaves little role for traditional fundamentals as a source of exchange rate dynamics.

This paper puts forward a different view. I shall argue that the micro-based evidence on the importance of order flows leaves plenty of room for macroeconomic fundamentals as a driver of exchange rates. In fact, micro-based models represent a new perspective, based on the microeconomics of FX trading, that allows us to investigate the link between exchange rates and the macroeconomy with much greater resolution. As a result, recent micro-based research points to the existence of a more nuanced link between macroeconomic fundamentals and spot exchange rates.

**Traditional and Micro-Based Exchange Rate Models**

To understand why the micro-based approach provides a new perspective on the role of fundamentals as a driver of exchange rate dynamics, it is useful to delineate how traditional exchange rate models differ from their micro-based counterparts. In particular, I want to focus on the key difference between the two modeling approaches that opens up new conceptual space for studying the connections between exchange rates and macroeconomic variables.

Traditional exchange rate models pay little attention to how trading in the FX market actually takes place. The implicit assumption is that the details of trading (i.e., who quotes currency prices and how trade takes place) are unimportant for the behavior of exchange rates over months, quarters or longer. This simplifying assumption carries little weight when all information relevant to the determination of the spot rate is common knowledge. In such a world, all market participants have the same information about the structure and state of the economy, and so have no difficulty in agreeing on the “appropriate price” at which trade in foreign currency could take place. The fact that trade takes place or follows a particular pattern in terms of who buys and sells foreign currency is irrelevant for the determination of spot rates.

Trading patterns may also be largely irrelevant for the determination of spot rates in the absence of common information. If market participants have different information but are able to quickly reach a consensus concerning the “appropriate price” for FX, most of the variations in spot rates we observe at macroeconomic frequencies will be unrelated to trading activity. Bacchetta and van Wincoop (2006) develop an exchange rate model in this genre. They study the dynamics of the spot rate in a standard monetary model where investors have different exchange rate exposures and private information concerning future macroeconomic fundamentals. As is standard in the literature, the rational expectations equilibrium (REE) spot exchange rate is identified as the rate that sets aggregate excess demand for foreign currency equal to zero. This rate is not the one at which market
participants would first agree to trade because it embodies information that is not yet known by any one investor. However, it is possible to identify conditions under which the REE rate is established after only one round of trading in a limit order market (see, for example, Evans 2008, Chap. 8). If these conditions hold true, the high pace of FX trading suggests that deviations of actual spot rates from the REE values should be very short-lived. As a result, these so-called microstructure effects should be dominated by the impact of new information concerning fundamentals when we consider the behavior of spot rates over months, quarters or years. In short, the presence of heterogeneous information may give rise to short-lived microstructure effects, but they may be safely ignored if we are interested in understanding the behavior of spot rates over macro-relevant horizons.

Micro-based exchange rate models differ from their traditional counterparts in that they examine the determination and behavior of spot exchange rates in an environment that replicates the key features of trading in the FX market. In particular, they focus on how information relevant to the pricing of foreign currency becomes reflected in the spot exchange rate via the trading process. According to this approach, trading is not an ancillary market activity that can be ignored when considering exchange rate behavior. Rather, it is an integral part of the process through which spot rates are determined and evolve.

The focus on trading necessitates the specification of a rich informational environment. Micro-based exchange-rate models start from the premise that much of the information about the current and future state of the economy is dispersed across agents (i.e., individuals, firms, and financial institutions). Agents use this information in making their every-day decisions, including decisions to trade in the FX market at the prices quoted by dealers. Dealers quote prices (e.g. dollars per unit of foreign currency) at which they stand ready to buy or sell foreign currency; they will purchase foreign currency at their bid quote, and sell foreign currency at their ask quote. Agents that choose to trade with an individual dealer are termed the dealer’s customers. The difference between the value of purchase and sale orders initiated by customers during any trading period is termed customer order flow. Importantly, order flow is different from trading volume because it conveys information. Positive (negative) order flow indicates to a dealer that, on balance, their customers value foreign currency more (less) than his asking (bid) price. Interdealer order flow is similarly defined for transactions between dealers. By tracking who initiates each trade, order flow provides a measure of the information exchanged between counterparties in a series of financial transactions.

At their heart, micro-based models describe the process by which the dispersed macroeconomic information on fundamentals contained in the customer order flows becomes known across the market, and hence embedded into FX quotes. As part of this process,

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2 Interdealer trading can take place directly (i.e. when one dealer asks another for a bid and ask quote, and then decides whether he wishes to trade) or indirectly via a limit order book run by a broker. In the latter case, order flow is defined as the different between the value of market orders to purchase and sell foreign currency. In recent years electronic brokerages have come to dominate interdealer trading.
dealers extract information from their trades with customers and other dealers by solving a series of inference problems. Under some circumstances, these problems are sufficiently simple for every dealer to learn all there is to know about fundamentals in a few rounds of interdealer trading. In this case, the pace of information aggregation is very fast, so that new information concerning fundamentals is quickly reflected in dealer quotes whether the news is initially dispersed or common knowledge. The resulting dynamics for exchange rates over weeks, months or quarters will be indistinguishable from the predictions of traditional models. Here micro-based models provide the theoretical justification for the prevalent assumption that microstructure effects may be safely ignored when our concern is the behavior of spot rates over macro-relevant horizons.

The real potential of the micro-based approach comes to the fore when the inference problem facing individual dealers is sufficiently complex to slow down the pace of information aggregation. Under these circumstances, it takes many rounds of interdealer trading before the dispersed information concerning fundamentals becomes known across the market. This scenario is much more likely from a theoretical perspective because the conditions needed for fast information are quite stringent (Evans and Lyons, 2004). When these conditions are not met, variations in spot rates over macro-relevant horizons primarily reflect the process through which existing (dispersed) information concerning fundamentals becomes embedded into FX quotes rather than changes in actual fundamentals. It is this process of information aggregation that constitutes the new conceptual space for studying the connections between exchange rates and macroeconomic variables.

The Role of Fundamentals
How do micro-based models provide a new perspective on the role played by fundamentals in the determination and evolution of spot exchange rates? To address this question, let us consider the determination of the equilibrium exchange rate in a micro-based model.

Evans and Lyons (2007) develop a model of foreign exchange trading embedded within an otherwise standard two country dynamic general equilibrium model. The model contains two key features: First, the equilibrium spot exchange rate is identified from the optimally determined price of foreign currency quoted by dealers at a point in time. This means that information about the current and future state of the economy (i.e. fundamentals) will only impact on exchange rates when, and if, it affects dealers’ quotes. The second feature concerns dealers’ information. Each dealer receives information from two sources: (i) macro data releases and (ii) the foreign currency orders from customers (i.e. households and firms) and other dealers. Taken together, these sources provide incomplete information about current and future fundamentals.

The structure of trading in the foreign exchange market is far too complex to be modeled in great detail. Instead, micro-based models describe a trading environment that captures key facets of actual trading in an analytically tractable setting. In practice this means that trading is assumed to follow a simple sequence of events. In Evans and Lyons
(2007), dealers quote FX prices to customers at the start of each period. Each dealer then receives orders from a subset of firms and households that comprise his customers. Dealers next quote prices in the interdealer market. These prices, too, are good for any quantity and are publicly observed. Dealers then have the opportunity to trade among themselves. Interdealer trading is simultaneous and trading with multiple partners is feasible.

In this trading environment, optimal quote decisions take a simple form; all dealers quote the same FX price to both customers and other dealers. We can represent the period- \( t \) quote as

\[
s_t = (1-b) \sum_{i=0}^{\infty} b^i E[f_{t+i} | \Omega^D_t],
\]

where \( 0 < b < 1 \). \( s_t \) is the log price of foreign currency quoted by all dealers, and \( f_t \) denotes exchange rate fundamentals. The form for fundamentals differs according to the macroeconomic structure of the model. In Evans and Lyons (2007), \( f_t \) includes home and foreign money supplies and household consumption. In models where central banks conduct monetary policy via the control of short-term interest rates, \( f_t \) will include variables used to set policy. More generally, \( f_t \) will also include a term that compensates dealers for providing liquidity to customers wanting to trade foreign currency. This is the source of the micro-based foreign exchange risk premium.

While equation (1) takes the present value form familiar from standard international macro models, it is crucial to recognize that it represents how dealers quote the price for foreign currency in equilibrium. All dealers choose to quote the same price in this trading environment because doing otherwise opens them up to arbitrage, a costly proposition. Consequently, the period- \( t \) quote must be a function of information known to all dealers. Equation (1) incorporates this requirement with the use of the expectations operator, \( E[\cdot | \Omega^D_t] \), that denotes expectations conditioned on information common to all dealers at the start of period \( t \), \( \Omega^D_t \). This is not to say that all dealers have the same information. On the contrary, the customer order flows received by individual dealers represent an important source of private information so there may be a good deal information heterogeneity across dealers at any one time. Dealers use their private information in initiating trade with other dealers, and, in so doing, contribute to the process through which all dealers acquire information.

We can now use equation (1) to examine the role of fundamentals as a driver of exchange rate dynamics. Iterating (1) forward one period and rearranging gives

\[
\Delta s_{t+1} = \frac{1-b}{b} (s_t - E[f_t | \Omega^D_t]) + \varepsilon_{t+1},
\]

where \( \Delta s_{t+1} = s_{t+1} - s_t \) and

\[
\varepsilon_{t+1} = \frac{1-b}{b} \sum_{i=1}^{\infty} b^i (E[f_{t+i} | \Omega^D_{t+i}] - E[f_{t+i} | \Omega^D_t]).
\]
Equation (2) provides us with a very useful decomposition for thinking about the channels through which fundamentals contribute to the dynamics of the spot rate. It says that the change in the log spot rate (i.e., the depreciation rate for the home currency) comprises two components: the expected depreciation rate, $E[\Delta s_{t+1} | \Omega^0_t]$, identified by the first term; and the unexpected change, $e_{t+1} = s_{t+1} - E[s_{t+1} | \Omega^0_t]$, shown in equation (3). The expected depreciation rate is proportional to the difference between the current spot rate and dealers’ expectations concerning the current level of fundamentals. Equation (1) implies that this difference equals the present value of future changes in fundamentals:

$$s_t - E[f_t | \Omega^0_t] = \sum_{i=1}^{\infty} b^i E[\Delta f_{t+i} | \Omega^0_t],$$

where $\Delta f_{t+i} = f_{t+i} - f_t$. Thus, if dealers expect fundamentals to grow in the future, they also anticipate quoting a higher future price for foreign currency, which in turn contributes to the realized depreciation rate, $\Delta s_{t+1}$. The second term in (2), $e_{t+1} = s_{t+1} - E[s_{t+1} | \Omega^0_t]$, identifies the impact of new information received by all dealers between the start of periods $t$ and $t+1$. Equation (3) shows that new information impacts on the FX price quoted in period $t+1$ to the extent it revises forecasts of the present value of fundamentals based on dealers’ common information.

While fundamentals can contribute to the dynamics of spot rates in a micro-based model via two channels, they need not be equally important. Indeed, the relative importance of each channel depends on the behavior of fundamentals and the quality of dealers’ information. Let us consider these factors in turn. If there is little serial correlation in the change in fundamentals, dealers’ forecasts of future changes in fundamentals will be small even if they have complete information about current fundamentals. Under these circumstances, dealers will not anticipate any significant change in the prices they will quote for foreign currency in the future. And, as a result, fundamentals exert little influence on $\Delta s_{t+1}$ via the expected depreciation rate. Similarly, if dealers have very incomplete information about the current state of the fundamentals, their forecasts for future changes in fundamentals may be small even though the changes appear to be serially correlated. In this case, fundamentals exert little influence on spot rate dynamics via the expected depreciation rate because the information available to dealers was insufficient to exploit the time series properties of fundamentals that become apparent ex post.

These observations provide a simple explanation for the well-known fact that depreciation rates are very hard to forecast. As Engel and West (2005) and others have noted, the variables that comprise fundamentals in many traditional exchange rate models appear to follow non-stationary I(1) processes with little serial correlation in their first difference. It would therefore be rather surprising to find that dealers’ forecasts of future changes in fundamentals were significant even if they had complete information about the current state of the economy. Add to this a more realistic view about how incomplete dealers’
information actually is, and it is little wonder that under most circumstance dealers quote FX prices which imply an expected depreciation rate that is close to zero.  

The fact that depreciation rates are very hard to forecast does not imply that exchange rates are disconnected from fundamentals. It simply means that the dynamics of spot rates must be largely attributable to the effects of news. Here micro-based models have a big advantage over their traditional counterparts because their trade-based foundations provide detail on how news affects spot rates. In particular, as equation (3) indicates, micro-based models focus on how new information about fundamentals reaches dealers and induces them to revise their FX quotes. It is here that micro-based models provide the new conceptual space for studying the connections between exchange rates and macroeconomic variables.

News concerning fundamentals can reach dealers either directly or indirectly. Common knowledge (CK) news operates via the direct channel. CK news contains unambiguous information about current and/or future fundamentals that is simultaneously observed by all dealers and immediately incorporated into the FX price they quote. In principle, macroeconomic data releases on say GDP, industrial production or unemployment could be a source for CK news, but in practice they rarely contain much unambiguous new information. In fact, CK news events appear rather rare.

The indirect channel operates via order flow and conveys dispersed information about fundamentals to dealers. Dispersed information comprises micro-level information on economic activity that is correlated with fundamentals. Examples include the sales and orders for the products of individual firms, market research on consumer spending, and private research on the economy conducted by financial institutions. Dispersed information first reaches the FX market via the customer order flows received by individual dealers. These order flows have no immediate impact on dealer quotes because they represent private information to the recipient dealer. The information in each customer flow will only impact on quotes once it is known to all dealers. Interdealer order flow is central to this process. Individual dealers use their private information to trade in the interdealer market. In so doing, information on their customer orders is aggregated and spread across the market. Dispersed information is incorporated into dealer quotes once this information aggregation process is complete.

To summarize, the micro-based approach to exchange rate modeling opens up new conceptual space for understanding the link between fundamentals and spot rates because it provides the analytical framework for studying how new information about fundamentals becomes embedded in dealers’ quotes via trading. This is an important theoretical step forward for two reasons. First, the near-legendary difficulty of forecasting future changes in

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3 One likely exception to this observation occurs during financial crises. If dealers view the current state of the economy as unsustainable, they will forecast future changes in fundamentals even though they lack complete information about the current state of the economy. Under these circumstances, anticipated future changes in their FX quotes will become an important driver of the spot rate.
the spot rate (i.e. beating the “random walk”) provides compelling empirical evidence that the assimilation of new information accounts for most of the variations in spot rates. Second, micro-based models make novel empirical predictions about how the assimilation process takes place and so offer the foundation for new empirical research on the link between spot rates and fundamentals.

Empirical Evidence
Two strands of recent research provide empirical support for the idea that information concerning fundamentals is assimilated by dealers as a result of trading activity. The first strand considers the impact of macroeconomic data releases; the second provides direct evidence that order flows carry information about the macroeconomic variables that comprise exchange rate fundamentals. Let me review these strands in turn.

Information Assimilation from Macroeconomic Announcements
There is a large literature studying the impact of macroeconomic data releases (so called macroeconomic announcements) on exchange rates and other asset prices. A common finding in this literature is that macroeconomic announcements account for a small fraction of the total variation in spot rates. For example, Klein (1991) finds that announcements concerning the US trade-balance can account for approximately 40 percent of the variance of the USD/DM and YEN/USD spot rates measured at a daily frequency. This is an impressive result, but it only applies to the days when the announcements were made. If we include all other days, the announcements account for less than 3 percent of the daily changes in spot rates. This finding extends beyond the trade-balance. Andersen et al. (2003) find that spot rates respond immediately to a number of different macroeconomic announcements, but taken together they account for a small fraction of the total variation in spot exchange rates at macro-relevant frequencies.

One interpretation of these findings is that spot rates are primarily driven by factors that are unrelated to the new information contained in macroeconomic announcements. Quite what these factors are remains a mystery; but they do not appear to be related to the fundamentals identified in traditional exchange rate models. From this perspective, the announcements’ literature appears to confirm that spot rates are largely disconnected from fundamentals. Micro-based models provide an alternative interpretation: Macroeconomic announcements do contain new information about fundamentals, but most of this information is transmitted indirectly to spot rates via order flow - a mechanism that is overlooked by existing research on announcement effects. The reason for this is most easily understood with the aid of an example.

Suppose a scheduled announcement on US GDP growth is greater than the expectations of FX market participants. Furthermore, let us assume that everyone agrees that unexpectedly high US GDP growth represents good news for the international value of
the dollar. If everyone agrees that GDP growth is \(x\) percent higher than expected, and as a result, the dollar is \(y\) percent more valuable in terms of Japanese Yen, dealers will immediately quote a YEN/USD rate that is \(y\) percent higher. This is the standard mechanism through which news directly impacts on currency prices – a mechanism that does not appear to be very empirically important.

Now suppose that everyone agrees that the GDP announcement represents good news for the dollar, but that there are diverse opinions as to how large the appreciation should be. Under these circumstances, the initial rise in the YEN/USD spot rate may be viewed as too large by some market participants and too small by others. Those who view the rise as too small will place orders to purchase the dollar, while those who view the rise as too large will place orders to sell. In aggregate, the balance of these trades represents the order flow that dealers use to further revise their spot rate quotes. In particular, positive (negative) order flow signals that the initial YEN/USD spot rate was below (above) the balance of opinion among market participants concerning the implications of the GDP announcement for the value of dollar. Importantly, there is no theoretical limit to the duration of this price adjustment process. It may take a matter of minutes when market participants can easily infer each others’ views from their trading actions, or much longer when incomplete information concerning order flow across the market make inferences less precise. In the latter case, it will be impossible to estimate the full impact of announcements on currency prices without data on order flows – data that was not utilized in the existing announcements literature. Consequently, the results from the existing literature do not rule out the possibility that macroeconomic announcements contain significant new information about fundamentals that is transmitted indirectly to spot rates via order flow.

Recent results in Evans and Lyons (2008) provide strong empirical support for this view. This study examined how the joint behavior of spot rates and order flow is affected by the arrival of macroeconomic news at intraday and daily frequencies. In particular, the paper estimates models where diverse views about the implications of a news item creates volatility in order flow, which in turn feeds through to changes in currency prices. Estimates based on intraday data show that order flow contributes more to changing FX prices in the period immediately following the arrival of news than at other times. This evidence points to the importance of the indirect channel. Estimates based on daily data imply that approximately two-thirds of the effect of macroeconomic news on spot rates is transmitted via order flow, the remainder being the direct effect. With both the direct and indirect channels operating, the estimates imply that macroeconomic news accounts for 36 percent of the total daily variation in spot rates. This is a far higher figure than suggested by the earlier announcements literature and provides some direct evidence connecting the behavior of spot rates to the macroeconomy.
Information Assimilation from Order Flows

The second strand of recent research focuses on the source of the strong contemporaneous relationship between depreciation rates and order flows documented by Evans and Lyons (2002a & 2002b), Payne (2003), Froot and Ramadorai (2005) and others. These papers show that order flows can account for as much as 80 percent of the variation in daily depreciation rates, but they do not provide evidence on why order flows have this high level of explanatory power.

Recent research by Evans and Lyons (2007) sheds light on this issue. They develop a model in which order flows drive depreciation rates because they convey information about fundamentals. Although order flows are determined endogenously, their impact on spot rates can be easily understood using equations (2) and (3) [repeated here for convenience]:

\[
\Delta y_{t+1} = \frac{1-\beta}{\beta} (y_t - E[f_t | \Omega^D_t]) + \varepsilon_{t+1}, \tag{2}
\]

\[
\varepsilon_{t+1} = \frac{1-\beta}{\beta} \sum_{i=1}^{\infty} b^i (E[f_{t+i} | \Omega^D_{t+i}] - E[f_{t+i} | \Omega^D_t]). \tag{3}
\]

In the Evans and Lyons model, the FX orders placed by households and firms at the start of day \(t\) are correlated with information concerning the fundamentals that is not currently known to FX dealers. (This correlation arises because the microeconomic conditions driving the trading decisions of individual agents represent a change in aggregate economic activity that is not CK.) As a result, the customer order flows received by individual dealers contain new information about fundamentals, information that is spread across the whole market via interdealer trade. Hence, the aggregate interdealer order flow observed on day \(t\) provides a measure of the market-wide information flow that dealers use to revise their quotes between the start of days \(t\) and \(t+1\). In other words, interdealer order flows carry much of the new information identified by \(\varepsilon_{t+1}\) in equation (3).

This mechanism not only provides a theoretical rationale for the strong empirical link between spot rate changes and order flows, it also delivers two new testable implications: First, transaction flows should have superior forecasting power for future fundamentals than current spot rates. Second, insofar as the transactions flows received by individual dealers predict what "the market" will learn about fundamentals in the future, those flows should have forecasting power for future exchange rate returns. Let us consider each of these predictions in more detail.

In the Evans and Lyons model, dealers are forward-looking when quoting FX prices, so spot rates embody their forecasts for fundamentals based on common information, \(\Omega^D_t\), as in equation (1). One empirical implication of this observation is that spot exchange rates should have forecasting power for fundamentals. While there is some evidence that this is true for variables that comprise fundamentals in many models (Engel and West 2005), the forecasting power is rather limited. The forecasting implication of the Evans and Lyons model is more exacting. If order flows convey information about fundamentals that is not yet
CK to all dealers (i.e., not in $\Omega^D_t$), then they should have incremental forecasting power for fundamentals, beyond the forecasting ability any variable in $\Omega^D_t$. This is a strong prediction: it says that order flow should add to the forecasting power of all other variables in $\Omega^D_t$, including the history of spot rates and the fundamental variable itself. Nevertheless, Evans and Lyons (2007) find ample support for this prediction using customer order flows and candidate fundamental variables such as output, inflation and money supplies. These findings provide direct evidence on the information content of customer order flows, and provide a new perspective on the link between exchange rates and fundamentals.

Evans and Lyons (2005) showed that customer order flows had significant forecasting power for future depreciation rates, both in- and out-of-sample. For example, at the four week horizon the out-of-sample forecasts accounted for a highly significant 15.7 percent of the variation in excess returns. This forecasting result is surprising in its own right. However, it is even more interesting if we consider its implications for the flow of information concerning fundamentals. More specifically, if it takes some time for all the dealers in the market to assimilate the information about fundamentals that was originally carried by a subset of customer orders; those orders should have forecasting power for spot rates because they predict what “the market” will learn about fundamentals in the future. Again, Evans and Lyons (2007) find ample empirical support for this prediction.

Taken together, these results represent the first findings that link macro fundamentals, transaction flows and exchange rate dynamics. They provide strong support for the idea that exchange rates vary as “the market” assimilates dispersed information regarding macro fundamentals from transaction flows.

Conclusion

Micro-based models provide a new perspective on the links between macroeconomic fundamentals and spot exchange rates by focusing on the process through which participants in the FX market assimilate information. The power of this approach lies in its ability to relate the transmission of macroeconomic information to trading activity, thereby generating testable empirical implications that are absent in traditional exchange rate models. Although research in this area is still in its early stages, the results to date look promising. At this point it seems safe to say that spot rates are not completely disconnected from fundamentals. Instead, they appear to evolve, in part, as information concerning fundamentals is assimilated by “the market” via trading. Understanding this process is an important goal of micro-based research, and will have far-reaching implications for a variety of issues in international finance.
References


