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## Exchange rate determination and dynamics in China: A market microstructure analysis

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### ABSTRACT

This paper provides a market-microstructure analysis of exchange rate dynamics in the Chinese foreign exchange market using a vector autoregressive (VAR) modeling framework. An index of order flow is constructed in the Chinese context to reflect excess demand pressure in the foreign exchange market. The VAR model is then estimated to examine whether, and to what extent, order flow influences the long-term level and short-term fluctuations of the Chinese exchange rate. Focusing on the relationship between cumulative order flow and the exchange rate of the Chinese renminbi (RMB) against the US dollar, we find that order flow as a measure of excess demand pressure explains a significant part of the fluctuations in the RMB-dollar exchange rate. Specifically, the results show that there is a long-term cointegrating relationship among the order flow, macro factors and the exchange rate. Overall, these findings are important in understanding the role of order flow in exchange rate determination and bear important implications for practitioners and market regulators.

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### 1. Introduction

With increasing empirical evidence showing that macroeconomic models of exchange rate determination perform poorly in capturing foreign exchange rate movements (Frankel & Rose, 1995; Meese & Rogoff, 1983), the market microstructure approach to the exchange rate has emerged as a new avenue to explore the forces driving exchange rate movements. Focusing on the pivotal role of order flow in the transaction process, recent theoretical and empirical works based on this approach have demonstrated that this new methodology has promising explanatory power for exchange rate changes (Evans & Lyons, 2002a). However, prior studies in this field have been primarily concerned with key currency pairs of mature economies, and little research has been conducted on the potential influence of order flow on the emerging markets.<sup>1</sup> Given China's growing importance in the world economy in general and international currency relations in particular, there is a pressing need for applying the recent research methodology to further our understanding of the Chinese

exchange rate policy. The current research represents the latest attempt of such efforts.

This paper aims to shed some light on exchange rate determination in China using a VAR model, generated within the market microstructure framework, to estimate the relationship between order flow and the exchange rate in the Chinese foreign exchange market. Specifically, we seek to address the following questions:

- (1) Does the order flow help to capture the exchange rate movements of Chinese currency, the renminbi (RMB) against the US dollar as representative of China's exchange rate?
- (2) How do the long- and short-term factors influence the relative value of the Chinese currency in the foreign exchange market?

The results of our analyses are of direct interest to regulators and policy makers in evaluating the potential role of order flow in influencing the exchange rate movements and to practitioners who invest on the basis of market microstructure variables, treating them as principal indicators for future market movements.<sup>2</sup> Furthermore, this paper adds to the growing literature studying the determinants of foreign exchange rates in a number of ways. First, while the microstructure approach has been used to investigate exchange rate

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<sup>1</sup> A notable exception is the recent work of Duffuor et al. (2012) who, by adopting the microstructure approach, examine the explanatory power of order flow in Ghanaian foreign exchange market and find that order flow has a significant, positive effect on the official exchange rate in both stable and crisis periods. Gereben et al. (2006) and Wu (2010) are two other studies on emerging markets that adopt a microstructure framework.

<sup>2</sup> An increasing number of studies have found evidence of a relationship between microstructure variables such as order flow and exchange rates. This idea has drawn additional support from practitioners who believe that, aside from macroeconomic factors, such as interest rates and inflation, order flow is one of the most important forces behind major exchange rate movements.

dynamics for a range of major international currency pairs (Osler, 2006; Rime, Sarno, & Sojli, 2010), academic studies of Chinese foreign exchange markets using such an important framework are limited. This lack of research is, perhaps, surprising given the importance of the Chinese markets in terms of both the volume and the value of trade and the growing popularity of the market microstructure approach to exchange rate research. This study presents one of the very few attempts to fill the gap in the literature. The results obtained may be particularly relevant in providing a deeper understanding of foreign exchange market in such an important economy. Second, unlike many previous studies, this paper employs a measure of country risk premium as an exogenous variable to control for the potential sources of common shocks on the exchange rate fluctuations, which appears to be another novelty in the literature.<sup>3</sup> Indeed, this may be a reason why the portion of the exchange rate movements explained by order flow is lower than what has been documented in more developed markets, but unlike previous studies in emerging markets, order flow remains a significant factor in our results.<sup>4</sup> Finally, our study takes into account a unique feature of emerging markets, namely, the existence of a strong government intervention and its impact on the exchange rate dynamics.

Overall, this paper contributes to the microstructure approach to the exchange rates research by taking a closer look at the behavior of the exchange rate in China, focusing on the impact of order flow on the exchange rate dynamics. We first construct a measure of order flow that is based on high frequency transaction data from the Chinese market, from which the cumulative daily order flow is calculated. In addition, we also consider the trading system reform and incorporate the consequences of market evolution into our analysis. Our sample period begins with June 2010 to take into account a new “managed floating” exchange rate system re-launched in mid-2010. Furthermore, a control variable (i.e., the country risk premium) is included in our empirical model because prior studies have shown that this risk factor is an important influence of exchange rate dynamics in emerging markets.<sup>5</sup> Finally, using the VAR modeling framework, we investigate whether the cumulative order flow is cointegrated with the exchange rate in the Chinese foreign exchange market.

The main findings of our investigation can be summarized as follows. First, our results indicate that unidirectional causality exists from order flow to exchange rate movements. Moreover, we find that a long-term cointegrating relationship exists between the USD/RMB exchange rate and its main determinants, i.e., the order flow, the proxy for macro influences and the country risk premium. More specifically, the estimated results show that order flow not only Granger causes exchange rate movements but also is a significant determinant of the exchange rate in the short run. In our sample, order flow explains approximately 19% of exchange rate movements for every \$0.1m USD/RMB purchase. Overall, our findings are consistent with the view that in the Chinese market, order flow as a ‘signed’ measure of trading volume is able to explain a significant proportion of fluctuations in the exchange rate of the RMB against the US dollar.

The remainder of this paper is organized as follows. The next section briefly reviews previous literature on the microstructure approach to exchange rate dynamics. In Section 3, we outline China’s exchange rate policy to establish the background for the ensuing analysis. Data and methodological issues relating to our empirical investigation are discussed in Section 4. Section 5 presents the estimation results and discusses their main implications. Finally, Section 6 provides a summary and concluding remarks.

<sup>3</sup> Wu (2010) argues that macroeconomic variables such as the interest rates, the exchange rates, and the country risk premiums may affect the order flow. Thus, careful attention needs to be paid to these potential sources of common shocks when studying the relationship between order flow and exchange rate movement.

<sup>4</sup> The authors are grateful to an anonymous referee for pointing this out.

<sup>5</sup> See, for instance, De Medeiros (2004) who find that the country risk premium is a significant factor in influencing the Brazilian foreign exchange market.

## 2. Related literature

The microstructure approach underscores the central role of the trading process in the price formation in the foreign exchange market (Lyons, 1995). This process can be broadly grouped into three phases (Evans, 2011). First, the customers trade with their personal dealers. Then, these dealers carry their own customer orders to trade with other dealers through the electronic interdealer market; the transactions in this market are known as interdealer trades. In the last round, dealers trade with customers again to balance their net inventory position. In this process, the trading size and transaction position are the most important factors for these transactions. These critical parameters of the market are summarized by order flow, which is the net balance of buyer-initiated and seller-initiated foreign exchange market transactions (Lyons, 2001). Measured as the sum of the signed seller-initiated and buyer-initiated orders in the empirical specification, order flow is considered an important information transmission mechanism linking price changes and dispersed information. Indeed, the explanatory role of order flow in exchange rate models has been the focal point of empirical studies in the market microstructure literature, which can be generally cataloged in terms of those using data of customer order flow and those using interdealer order flow. However, the majority of empirical research focuses primarily on the customer order flow as it conveys private information about not only fundamentals but also monetary policy (Bjonnes & Rime, 2005; Evans & Lyons, 2006; Rime, 2000).

Nevertheless, because of the availability of data, many studies have focused on the data of interdealer order flow from the electronic transaction market. For example, Danielsson, Payne, and Luo (forthcoming) investigate 10-month order flow data from the Reuters D2000-2 data platform and find that order flow Granger causes the changes in exchange rate returns. Influential research by Evans and Lyons (2002a) uses the interdealer order flow based on the 4-month data of the exchange rates between the deutchmark and the Japanese yen against the US dollar from Reuters D2000-1. In a radical departure from the conventional macro models, the authors develop a hybrid model that contains both a macro variable (interest differential) and a micro variable (order flow). They find that over 60% of the USD/DEM daily changes and 40% of the USD/JPY daily changes can be explained by order flow. In another study, Evans and Lyons (2002b) extend their dataset to seven currency pairs: the US dollar against the pound sterling, Belgian, French and Swiss francs, Swedish krona, Italian lira and Dutch guilder. They find that order flow may generate an  $R^2$  up to 78% on a daily frequency. However, Fisher and Hillman (2003) extend the research of Evans and Lyons (2002b) but get much lower  $R^2$  statistics results. Berger, Chaboud, Chernenko, Howorka, and Wright (2008) show that interdealer order flow has a 0.65 correlation with the exchange rate of the EUR/USD.

Osler (2006) summarizes three explanations of order flow driving exchange rate movements: the inventory effect, information effect, and downward-sloping demand and liquidity effects. The inventory effect refers to the situation whereby any deviation from the desired inventory level will expose dealers to risk. To avoid undesired risk, dealers will decrease (increase) their prices to attract more buying (selling) orders when their inventory positions are higher (lower) than desired levels. Inventory-based models can successfully explain the temporary changes in the exchange rate but fail to capture permanent exchange rate movements. Information-based models imply that order flow should permanently affect market prices. Hence, exchange rates should be cointegrated with cumulative order flow. Recent research has uncovered evidence for such a stable long-term relationship for several currency pairs (Bjonnes & Rime, 2005; Killeen, Lyons, & Moore, 2006). However, Boyer and Van Norden (2006) point out that these results are selective and, in some cases, the results are statistically weak and suffer from a small sample bias. They conduct cointegration tests on the dataset of Evans and Lyons (2002a), which

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