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A heterogeneous agent exchange rate model with speculators and non-speculators

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ABSTRACT

This paper constructs a heterogeneous agent exchange rate model of speculators and non-speculators from a simple monetary framework. The model replaces rational expectations with an adaptive learning rule that forecasts future exchange rates with an econometric model, and assumes two types of market participants, speculators and non-speculators, that differ by their forecasting model. Speculators employ a correctly specified forecasting model, are relatively short-term oriented, and are subject to momentum and herding effects via an expectation shock; non-speculators utilize a simple forecasting model, have no incentive to be short-term oriented, and are not subject to herding effects. Parameters are calibrated and estimated using the method of simulated moments, and simulation results show that the model is able to replicate foreign exchange market stylized facts better than a model of representative agent rational expectations. Furthermore, the dynamics of the model are shown to derive from both agent heterogeneity and the expectation shock.

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1. Introduction

In 2013, trading in the foreign exchange (FX) market averaged about $5.3 trillion a day, while the total value of exports and imports amounted to around $92 billion per day.[1] These data, consistent with the earlier findings of Mark (2001), suggest that much more currency trading is taking place than is necessary for global commerce. In general, any currency trade can be categorized into one of two types: (1) A trade that has an expectation of profit from anticipated one-way currency fluctuations, and (2) one that does not have any such expectation. The former can be referred to as speculative, and the latter as non-speculative. Put Another way, speculative activities are those that are designed to be subject to FX market risk, while non-speculative activities are not. Examples of speculative activity are going long (or short) a currency with no hedge in place, and arbitrage, while examples of non-speculative activity are trades made for commerce, hedging,

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[1] The FX trading data come from the Bank for International Settlements 2013 Triennial Central Bank Survey, while the global trade data come from the World Bank.

tourism, etc.[2] With this in mind, the goal of this paper is to construct a heterogeneous agent exchange rate model that incorporates the concepts of speculation and non-speculation into a simple monetary framework, and to examine how well the model explains salient facts of the FX market.

In the model developed in this paper, the relatively strong assumption of rational expectations is replaced with the more realistic notion of adaptive learning, an expectations modeling technique that assumes agents behave like econometricians who make forecasts using econometric methods.[3] Agent heterogeneity results from agents utilizing different forecasting models. The dynamics of the exchange rate result completely from the forecasts of the agent-types; No actual trading takes place. However, the forecasting models employed by the different agent-types reflect their particular trading goals, time horizon, level of knowledge, etc.

Specifically, speculators forecast with a "correctly" specified model in the sense that it is of the same form as the rational expectations equilibrium solution. Non-speculators, however, employ a parsimonious model. The intuition is that speculators are attempting to make profits from one-way currency movements and therefore have a profit incentive to be sophisticated market participants. For this reason, they employ fundamental analysis (i.e., conducting research into the FX market, employing computer algorithms to determine discrepancies in exchange rates, studying activities of central banks, etc.) and technical analysis (studying historical price movements to ascertain future price movements). This effort to understand the FX market results in a correctly specified forecasting model. Meanwhile, since non-speculators are unconcerned with making a profit on one-way currency movements, they have no incentive to be sophisticated market participants and are therefore not conducting rigorous analysis of the FX market in the form of fundamental and technical analysis. The result is that they employ a relatively simple forecasting model. This setup is consistent with survey evidence in Cheung and Chinn (2011) that large institutions in the FX market tend to have an informational advantage over other market participants, and in King et al. (2013) who find that non-speculators tend to make no attempt to forecast exchange rates.

The two agent-types are also differentiated by their time horizon. Speculators are assumed to be short-term oriented, while non-speculators are assumed to have no specific time-horizon preference. The intuition is that most institutions engaging in speculative activities (banks, hedge funds, proprietary trading firms, etc.) tend to be focused on quarterly trading performance, as measured by profits or investment returns, and can potentially lose assets under management if their quarterly performance significantly lags behind competitor institutions. On the other hand, institutions conducting trades for commerce, hedging, tourism, or other non-speculative activities have no clear incentive to favor any specific time horizon. This time horizon differentiation is captured by the degree to which the two-agent types utilize historical data when estimating the parameters of their forecasting model.

In addition to fundamental analysis, survey evidence in Allen and Taylor (1990) and Taylor (1992) suggests that sophisticated FX traders also tend to employ technical analysis, a concept which rests on the idea that historical price action can predict future price movements. These tools measure an exchange rate's momentum and trend, which practitioners use to make trading decisions.[4] One of the results of traders employing these tools is that exchange rate movements can exhibit "herding effects" in that rates that exhibit strong directional movements will attract momentum buyers. To model this idea, I incorporate an expectation shock into the forecasting equation of speculators, which is a relatively simple way of capturing exogenous influences (waves of optimism and pessimism, herding effects, animal spirits, etc.) on agent forecasts. Non-speculators, however, are not subject to expectation shocks because they, due to their lack of incentive towards sophistication, are not conducting technical analysis. Expectation shocks have been employed in a similar manner in Evans and Honkapohja (2003); Milani (2011), and Elias (2016), and are related to the idea of judgemental adjustments to forecasts used in Bullard et al. (2008) and Bullard et al. (2010). The primary contribution of the current paper is the incorporation and estimation of an expectation shock process in a model of flexible exchange rates.

The work in this paper is most similar to Kim (2009) and Markiewicz and Lewis (2009), with the main difference from those authors being the inclusion of agent heterogeneity in the adaptive learning mechanism. Agent heterogeneity is a natural extension to the model and empirical evidence in the FX market exists justifying its inclusion. Pesaran and Weale (2006) examine survey evidence at the individual and macro level and find significant evidence of heterogeneity in expectations formation. Ito (1990) looks at panel data of biweekly surveys of the yen/dollar exchange rate and determines that heterogeneity exists in market participant's expectation formation. Allen and Taylor (1990) find that a significant number of FX dealers use non-fundamental analysis when making trading decisions, suggesting that the market consists of both fundamentalists and non-fundamentalists (i.e., technical analysts). Furthermore, several studies in the heterogenous agent exchange rate literature depict exchange rate markets as the dueling interaction of chartists and fundamentalists, both of which are trading styles that can be categorized as speculative.[5] A secondary contribution of the current paper is the broadening of the agent heterogeneity to include both speculative and non-speculative activity. This is consistent with survey evidence of the FX market in King and Rime (2010) who find that a significant amount trading activity can be attributed to algorithmic trading styles, like high frequency trading, which are speculative in nature, and in Bodnar and Hayt (1998) who

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[2] Hedging would be considered non-speculative in the sense that a hedge is intended to eliminate market risk. In other words, there is no intention to make a profit from a one-way currency movement with a hedge.

[3] See Evans and Honkapohja (2001) for more background information on adaptive learning.

[4] Examples of momentum-based technical trading tools are moving average convergence divergence and the directional movement indicator.

[5] Examples are Frankel and Froot (1987) and Frankel and Froot (1990).