Exchange rate expectations: controlled experiments with artificial traders

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Abstract

The purpose of this paper is to investigate the plausibility of standard exchange rate expectations mechanisms, which are favored over rational expectations in survey data for longer horizons, in an artificial economy with heterogeneous traders. Adaptive expectations markets, bandwagon expectations markets and distributed lag expectations markets exhibit more serial correlation than found in empirical quarterly data. Extrapolative expectations markets often do not, but generate too many extreme returns to be empirically plausible. Regressive expectations markets are able to reproduce the stylized facts of empirical quarterly exchange rates, confirming the importance of fundamentals, in particular in dampening the frequency of extreme exchange rate returns.
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1. Introduction

Survey data studies indicate that long term exchange rate expectations are heterogeneous (Ito, 1990; Taylor and Allen, 1992) and are not adequately described by rational expectations (Dominguez, 1986; Frankel and Froot, 1987a; Froot and Frankel, 1989; Ito, 1990; Cavaglia et al., 1993). The survey evidence favors extrapolative, adaptive and regressive expectations, while static expectations are usually rejected (Frankel and Froot, 1987a, 1987b; Bank of Japan, 1989; Froot and Frankel, 1990; Cavaglia et al., 1993).

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The objective of this paper is to investigate the plausibility of these standard exchange rate expectations mechanisms in an artificial economy with traders which are heterogeneous in initial endowments, risk aversion and use of information. We will focus on three month exchange rate expectations, as survey evidence is most elaborate for this horizon. The standard expectations schemes (extrapolative, adaptive and regressive expectations) can be summarized (Frankel and Froot, 1987a) as:

$$E_{t,i}(s_{t+1}) = (1 - \alpha_{t,i})s_t + \alpha_{t,i}z_{t,i} \qquad (1)$$

where s_t is the natural logarithm of the spot exchange rate S_t in period t and $E_{t,i}(.)$ denotes the (not necessarily mathematical) expectation of trader i in period t with respect to the variable between brackets. Extrapolative expectations are represented by $z_{t,i} = s_{t-1}$. We can distinguish between three cases: $\alpha_{t,i} < 0$ (bandwagon expectations), $\alpha_{t,i} = 0$ (static expectations) and $\alpha_{t,i} > 0$ (distributed lag expectations). Another scheme that is technical or chartist in nature is adaptive expectations: $z_{t,i} = E_{t-1,i}(s_t)$. It is straightforward to show that such traders use the entire history of the exchange rate and that the forecast follows from a geometric series. Regressive expectations are represented by $z_{t,i} = q_{t,i}$, the natural logarithm of some fundamental or long run equilibrium exchange rate $Q_{t,i}$. Combinations of standard schemes are also easily represented in this framework, for example a hybrid expectations mechanism reflecting both regressive and extrapolative expectations: $z_{t,i} = (1 - \beta_{t,i})q_{t,i} + \beta_{t,i}s_{t-1}$. Notice that specification (1) yields two sources of heterogeneity of expectations: the type of information contained in $z_{t,i}$ represented by the variables s_{t-1}, $E_{t-1,i}(s_t)$, $q_{t,i}$ and the use of that information indicated by the parameters $\alpha_{t,i}$ and $\beta_{t,i}$.

The main finding of this paper is that fundamentals play an important role in foreign exchange markets, especially in limiting the number of extreme exchange rate returns. Regressive expectations markets or hybrid markets with both regressive and extrapolative expectations are able to reproduce the stylized facts of empirical quarterly exchange rates, while adaptive expectations markets, extrapolative expectations markets, bandwagon expectations markets and distributed lag expectations markets are not. Adaptive expectations markets, bandwagon expectations markets and distributed lag expectations markets generate too much serial correlation in exchange rate returns. Extrapolative expectations markets, consisting of both bandwagon and distributed lag expectations traders, are often able to replicate the serial correlation properties of empirical quarterly exchange rates, but exhibit too many extreme exchange rate returns.

The paper is organized as follows. In Section 2 we describe how the artificial foreign exchange market will be used to perform controlled experiments with exchange rate expectations. In Section 3 we develop a microeconomic model of foreign exchange between heterogeneous traders with extrapolative, adaptive and regressive expectations. In Section 4 we assign empirically plausible parameter and initial values to the theoretical model, which is thus transformed into an artificial economy. In Section 5 we establish which statistical regularities can be considered