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Gradual learning about shocks and the forward premium puzzle ☆

Kevin Moran *, Simplice Aimé Nono

Université Laval, Canada

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ABSTRACT

When interest rates are higher in one's home country than they are abroad, standard arbitrage arguments suggest this signals that the home currency will depreciate in the future. However, empirical evidence has regularly been found to be strongly at odds with this intuition. This is the "forward premium puzzle". This paper proposes a learning-based explanation for this puzzle. Specifically, we assume economic agents cannot ascertain whether the monetary policy or technology shocks affecting the economy are persistent or transitory but only gradually infer this persistence using Kalman filtering. We embed this information problem in a two-country open-economy DSGE model with nominal rigidities and simulate the model with and without this informational friction. We find that our incomplete information with learning framework, combined with data generating processes dominated by the persistent monetary policy shifts or by slightly distorted beliefs as in Gourinchas and Tornell (2004), lead our artificial data to replicate features of the forward premium puzzle.

1. Introduction

Empirical research in international finance has documented the presence of empirical regularities that pose significant challenges to standard open-economy models. These regularities, often described as "anomalies" or "puzzles", are the subject of much active research. One important such anomaly is the forward premium puzzle. This puzzle arises because simple theories of international finance predict that observing a premium between the domestic interest rate and its foreign counterpart signals that the home currency will depreciate in the future. However, data on interest rates and realized exchange rate depreciations have consistently refuted these predictions.[1]

An important literature has assessed the extent to which the existence of risk premia between currencies could explain the puzzle. Originating with Fama (1984), this literature has notably studied incomplete markets, non-standard preferences and long-term risk. A second approach used to analyze the puzzle argues that it arises from systematic expectation errors on the part of investors. Starting with Froot and Frankel (1989), this approach notably includes Lewis (1988, 1989), Gourinchas and Tornell (2004) or Mark and Wu (1998) and cites informational heterogeneity between traders, or expectation errors due to learning or *peso problems*, as possible sources of the puzzle.

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* Corresponding author at: Department of Economics, Université Laval, 1026 avenue des sciences humaines, Quebec, QC G1V 0A6, Canada
E-mail address: kevin.moran@ecn.ulaval.ca (K. Moran).

[1] The existence of this puzzle was documented in early contributions such as Hansen and Hodrick (1980) and Fama (1984) and confirmed by several subsequent studies (Froot and Thaler, 1990; Gourinchas and Tornell, 2004; Engel et al., 2014).

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The present paper contributes to this second approach. To do so, we first embed an information friction in a quantitative general-equilibrium open-economy model with complete markets and local-currency pricing. The model belongs to the *New-Open Economy Macroeconomics* framework, which originates from Obstfeld and Rogoff (1995) and has become the workhorse general equilibrium model for international finance modeling.[2] Specifically, our benchmark model assumes that monetary policy shocks can arise from either a persistent or a transitory component, but that economic agents do not observe these components separately and must instead infer their nature using a filtering mechanism. We then simulate the model repeatedly, with and without this informational friction, and assess the generated artificial data to see if they exhibit the signs of the forward premium puzzle. Our robustness analysis then adds productivity shocks that also have transitory and persistent components not observable separately and therefore identified via filtering.[3]

Our findings are as follows: our incomplete information framework with learning, combined with data generating processes dominated by the persistent monetary policy shifts or by slightly distorted beliefs as in Gourinchas and Tornell (2004), lead our artificial data to replicate the key features of the forward premium puzzle. These include slope estimates substantially lower than 1 in regressions testing the uncovered interest parity (UIP) relation and frequent rejection of the UIP hypothesis. Our sensitivity analysis shows that these results are largely robust to parameter changes or to adding technology shocks to the model.

The rest of this paper is organized as follows. Section 2 is a literature review that discusses the forward premium puzzle and how we contribute to the literature analyzing it. Section 3 presents our model economy. Section 4 describe the information friction that we embed in our open-economy model and the filtering mechanism used to distinguish between persistent and transitory shocks. Section 5 presents our simulation results and discusses them, while Section 6 concludes.

2. Review of literature

The efficient-market hypothesis implies that prices integrate all information available to market participants and that no excess returns are possible. One implication of this hypothesis is that in foreign exchange markets, *covered* interest rate parity (CIP) holds:

$$f_t - e_t = i_t - i_t^*, \tag{1}$$

where i_t and i_t^* are the returns on comparable domestic and foreign assets between time t and $t+1$, f_t denotes the logarithm of the forward exchange rate (the rate for foreign exchange delivered next period) and e_t is the spot exchange rate (the price of foreign currency in units of domestic currency). The CIP condition (1) is a no-arbitrage condition, since all variables are known at time t, and has been assessed by a large empirical literature, with the plurality of contributions confirming its validity.[4]

Empirical evidence is not as supportive of the *uncovered* interest parity condition, however. This condition arises by taking (1), assuming further that agents are risk neutral and have rational expectations, with forward rates equal to expected future rates, so that

$$E_t(e_{t+1} - e_t) \approx i_t - i_t^*, \tag{2}$$

where $E_t(e_{t+1})$ is the rational expectation of the future spot exchange rate e_{t+1}. Since by definition $e_{t+1} = E_t(e_{t+1}) + \xi_{t+1}$ with $\xi_{t+1} \sim i.i.d\ N(0, \sigma)$, (2) can be rewritten as

$$e_{t+1} - e_t = i_t - i_t^* + \xi_{t+1}. \tag{3}$$

The empirical validity of this condition is usually assessed by running the following regressions, labelled in nominal terms:

$$e_{t+1} - e_t = \alpha_0 + \alpha_1 (i_t - i_t^*) + \xi_{t+1}, \tag{4}$$

or in real terms, with the real exchange rate denoted $s_t \equiv e_t P_t / P_t^*$:

$$s_{t+1} - s_t = \alpha_0 + \alpha_1 (r_t - r_t^*) + \xi_{t+1}, \tag{5}$$

and testing the unbiasedness hypothesis $H_0: \alpha_0 = 0,\ \alpha_1 = 1$. Under H_0, realized depreciations in exchange rates should have a one-to-one correlation with the interest rate differential. However, H_0 is rejected decisively in most empirical assessments, with estimates $\widehat{\alpha}_0 \neq 0, \widehat{\alpha}_1 \ll 1$ and many instances of *negative* estimates for α_1 (Froot and Thaler, 1990; Lewis, 1995; Bansal and Dahlquist, 2000; Moore and Roche, 2002, 2008; Gourinchas and Tornell, 2004; Engel et al., 2014). Froot and Thaler (1990), for example, survey more than 70 empirical contributions and report an average estimate of −0.88 for α_1. These frequent rejections of H_0 constitute the most-analyzed manifestation of the forward premium puzzle.

[2] See Corsetti (2008) for a survey of this class of models.

[3] The view that economic agents must learn about the persistence of shocks affecting the economy was first pursued in a quantitative model by Brunner et al. (1980). It has since been used in several contributions (Erceg and Levin, 2003; Schorfheide, 2005; Andolfatto et al., 2008; Saijo, 2017).

[4] Recent evidence by Pinnington and Shamloo (2016) and Du et al. (2017) suggests that the validity of CIP has declined recently, possibly because new regulatory capital requirements limit arbitrage possibilities.