Journal of International Money and Finance 41 (2014) 46–64

Contents lists available at ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

Macroeconomic fundamentals and the exchange rate dynamics: A no-arbitrage macro-finance approach☆

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JEL classification:
F31
G12
E43
C32

Keywords:
Exchange rate dynamics
Macroeconomic fundamentals
Stochastic discount factor
Term structure of interest rates
Unscented Kalman filter

A B S T R A C T

In this paper, we propose an arbitrage-free international macro-finance model that links the exchange rate dynamics to macro-economic fundamentals. Jointly using data on exchange rates, yields of zero-coupon bonds, and macroeconomic variables of the US and the Euro area, we find a close link between macroeconomic fundamentals and the exchange rate dynamics. The model-implied monthly exchange rate changes can explain about 57% variation of the observed data. The macroeconomic innovations can help capture large variation of exchange rate changes. Robustness checks show that the results also hold for other major exchange rates.

1. Introduction

The nominal floating exchange rate has often been regarded as an asset price in exchange rate modeling. According to the standard asset pricing theory, its current price should reflect market's expectations concerning present and future economic conditions (Frenkel and Mussa, 1985; Obstfeld and Rogoff, 1996; Cochrane, 2005). However, a long-standing puzzle in international economics and finance is the disconnection between exchange rate movements and macroeconomic fundamentals.

☆ We would like to thank Carlo Favero, Francesco Giavazzi and M. Hashem Pesaran for very helpful advices and comments. Comments of Lucio Sarno, Donald Robertson, Claudo Tebaldi, Andrew Meldrum, and participants of Bocconi Economics workshop, ESSEC Business School Finance seminar, Bocconi Alesina seminar, Cambridge Macroeconomic workshop, and CES Annual Conference 2010 are also appreciated.

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http://dx.doi.org/10.1016/j.jimonfin.2013.10.004

Since 1970's, a variety of models have been proposed and tried to link the exchange rate dynamics to macroeconomic fundamentals. Monetary models (Frenkel, 1976, 1978; Mussa, 1976; Bilson, 1978; Dornbusch, 1976) state existence of a long-run equilibrium relationship among relative money supplies, relative income levels and the nominal exchange rates. New open economy macroeconomics models (Obstfeld and Rogoff, 2003) attempt to explain exchange rate movements by incorporating imperfect competition and nominal rigidities in a general equilibrium open economy. However, these models have not found empirical evidence on a close relationship between short-run exchange rate movements and macroeconomic fundamentals (Meese, 1990; Frankel and Rose, 1996; Engel and West, 2005). Furthermore, they fail to capture the volatile foreign exchange risk premium, implied by the well documented forward premium anomaly in foreign exchange markets (Fama, 1984; Hodrick, 1989; Backus et al., 1993; Bansal et al., 1995; Bekaert, 1996).

In this paper, we investigate interactions between the exchange rate dynamics and macroeconomic fundamentals by proposing an arbitrage-free stochastic discount factor model that jointly prices bond yields and exchange rates. Under a two-country world, the exchange rate of these two economies is governed by the ratio of their stochastic discount factors, which are modeled by a factor representation under the no-arbitrage condition. We take outputs, inflations and short-term interest rates as fundamental macroeconomic factors. Real output growth directly governs the aggregate consumption of an economy and should be a key element of the stochastic discount factor. Inflation can also enter into the stochastic discount factor via its dynamic interactions with the real production (Piazzesi and Schneider, 2006). The short-term interest rate is typically viewed as a macroeconomic variable reflecting monetary policy (Duffee, 2007). We extend macro-finance term structure models (Ang and Piazzesi, 2003; Diebold et al. 2006; Ang et al., 2007) to a two-country framework in order to improve identification of the time-varying market prices of risks. This is important since ignoring risk premia or assuming constant market prices of risks may mislead to a conclusion that exchange rates are not linked to macroeconomic fundamentals.

Under the above modeling set-ups, the exchange rate has a nonlinear relation with macroeconomic fundamentals. In contrast to uncovered interest parity (UIP), our model indicates that the expected exchange rate changes are determined by both the interest rate differential of two countries and the foreign exchange risk premium. Moreover, in our model, the unexpected exchange rate changes are also driven by the fundamental innovations, whose roles are amplified by the time-varying market prices of economic risks.

Using monthly data of the US and the Euro area (EA) ranging from January, 1999 to December, 2008, we find a close connection between macroeconomic fundamentals and the exchange rate dynamics. The model-implied monthly exchange rate changes can explain 57% variation of the observed data. We also find that both economies are highly interdependent. These findings are in stark contrast to previous studies using monetary and new open economy macroeconomics models and to a recent study of Dong (2006), which follows a similar modeling approach to this paper. The former finds that the models can only explain at most 10% variation of the data (Lubik and Schorfheide, 2005; Engel and West, 2005), and the latter, by using latent factors and assuming no impact of the foreign country on the home country, finds that his model can explain about 38% variation of exchange rate changes between the US dollar and the German Mark.

The time-varying foreign exchange risk premium plays an important role in explaining the forward premium anomaly and in remedying the failure of uncovered interest parity. For example, if we run a regression of exchange rate changes only on the interest rate differential, the estimated coefficient is far away from unity, and the R^2 is very tiny. However, if we introduce the risk premium term, as suggested by our model and Fama (1984), this estimate becomes closer to unity. The parameter estimate of the risk premium term is positive and highly significant. The R^2 is improved dramatically. Note that the risk premia generated by Brennan and Xia (2006) and Sarno et al. (2012) can fully explain the forward premium anomaly. However, given that our model is fairly simple and intuitive and we explicitly take into account macroeconomic variables, the results above are still remarkable.

Macroeconomic fundamentals enter into the exchange rate dynamics through the time-varying market prices of risks, and their shocks have time-varying effects on exchange rate movements. This is in contrast to the model with the constant market prices of risks, in which the exchange rate changes become time-homogeneous, and whose performance is dramatically deteriorated. For example, the