Economic Modelling xxx (2017) 1–10

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.journals.elsevier.com/economic-modelling

On the persistence of the forward premium in the joint presence of nonlinearity, asymmetry, and structural changes

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ARTICLE INFO

JEL classification:
C22
F31
G01
G15

Keywords:
Nonlinearity
Asymmetry
Structural changes
Smoothly changing parameters
Forward premium

ABSTRACT

This paper investigates the degree of the persistence of the forward premium by simultaneously taking into account nonlinearity, asymmetry, and possible structural changes in the process. The analysis uses the multiple regime smooth transition autoregressive model, which is embedded within a nonlinear and asymmetric process, with time as the transition variable. In the model, parameters are allowed to change smoothly over time. The estimated structural change dates appear to be closely related to important economic events caused by macroeconomic shocks or changes in monetary policy. The results reveal that the persistence of the forward premium declines when nonlinearity, asymmetry, and structural changes are jointly allowed in the process. In addition, ignoring nonlinearity and asymmetry in the process tends to induce downward amplification in the persistence of the forward premium. This suggests that it is necessary to take into account all of the statistical properties of the forward premium when one measures persistence.

1. Introduction

The theory of uncovered interest rate parity (UIP) indicates that the expected change in spot exchange rates is equal to the interest rate differential between two countries, or equivalently the forward premium. This implies that while currencies with high interest rates should depreciate, currencies with low interest rates should appreciate. The theory of UIP has been extensively tested by regressing the change in spot exchange rates on the lagged forward premium. If the theory of UIP holds, the estimated slope coefficient yields a value of unity. An important puzzle in international finance is that the forward premium is not an unbiased estimate or predictor of the future change in spot exchange rates. More specifically, the estimated slope parameter in the standard forward premium regression tends to yield a value that is statistically significantly different from unity and even a negative figure as in Fama (1984). The negative slope coefficient estimate, which has been broadly reported in the previous literature, implies that currencies with high (low) interest rates tend to appreciate (depreciate) which is obviously against the theory of UIP.[1]

This empirically well-documented phenomenon is referred to as the forward premium anomaly or the failure of the theory of UIP. The forward premium anomaly also implies the apparent predictability of excess returns over the theory of UIP. It is closely related to the carry trade, which is the popular currency investing strategy of investing in currencies with high interest currencies (or target currencies) by borrowing in currencies with low interest rates (or funding currencies).[2] A vast body of the previous literature has attempted to account for the forward premium anomaly by concentrating primarily on the following issues: the presence of a time dependent risk premium, irrational agents in segmented markets, peso problems, limited market participation, and econometric issues with the testing of the slope parameter estimate in the standard forward premium regression.[3]

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[1] Baillie and Cho (2014a) find that the global financial crisis of 2008–2009 has apparently led to a reversal of the forward premium anomaly for many currencies, which means that the slope coefficient estimate has turned into a positive value exceeding unity.

[2] The carry trade strategy exploits the forward premium anomaly or the empirical failure of UIP. If UIP holds, there should be no excess return on the carry trade. However, many previous studies have shown that on average, the carry trade appears to make profits even though it is subject to crash risk, which is measured by a negative skewness (Brunnermeier et al., 2008).

[3] Engel (1996) provides excellent and extensive surveys pertaining to the forward premium anomaly and possible resolutions. More recently, Bacchetta (2012) provides some explanations for deviations from UIP or the forward premium anomaly based on risk premium, limited market participation, and deviations from rational expectations.

https://doi.org/10.1016/j.econmod.2017.11.013
Received 18 May 2017; Received in revised form 9 October 2017; Accepted 13 November 2017
Available online XXX

This paper is concerned with the econometric issue for testing the theory of UIP. As pointed out by Baillie and Bollerslev (2000) and Maynard and Phillips (2001), the forward premium anomaly may be viewed as a statistical phenomenon based on the fact that the forward premium exhibits a highly persistent autocorrelation. Thus, the appropriate modeling of the forward premium by taking into account its various statistical properties appears to be important in accounting for the anomaly. In this effort, more recently, many other studies have focused on the statistical properties of the forward premium to explain the forward premium anomaly which denotes the aforementioned empirical regularity. The statistical properties of the forward premium have been widely discussed by Crowder (1994), Baillie and Bollerslev (1994, 2000), Hai et al. (1997), Maynard and Phillips (2001), Choi and Zivot (2007), and Sakoulis et al. (2010), among others. Many previous articles have found the forward premium to be a fractionally integrated or long memory process and the spot return to be a stationary process. That is, while the forward premium is highly persistent, the spot return is not. The implication of this finding is that the standard forward premium regression is unbalanced; this has been analyzed by both Baillie and Bollerslev (2000) and Maynard and Phillips (2001). That is, the statistical properties give rise to the obvious problem of regressing the remarkably volatile and uncorrelated spot returns on the very persistent, highly autocorrelated forward premium. This econometric issue with the testing of the slope parameter estimate in the standard forward premium regression has been associated with further attempts to account for the forward premium anomaly throughout the investigation of the persistence of the forward premium. This paper mainly focuses on examining the persistence of the forward premium using six major currencies.

Some other studies have also provided evidence that considering more statistical properties of the forward premium is beneficial since it gives rise to more accurate modeling, which in turn may be useful for explaining the anomaly.[4] For instance, Choi and Zivot (2007) provide evidence that ignoring structural changes in the mean of the forward premium may generate spurious long memory properties of the forward premium. Baillie and Kapetanios (2008) show that the nonlinearity and persistence of the forward premium can be captured well using the nonlinear autoregressive model with long memory and smooth transition. Thus, it appears that taking into account the various statistical properties of the forward premium is important in modeling the forward premium.

This paper is closely related to Baillie and Bollerslev (2000) and Sakoulis et al. (2010). Baillie and Bollerslev (2000) provide evidence that the forward premium anomaly is not as bad as previously supposed in the literature, in part because of the statistical properties of the forward premium.[5] In addition, Sakoulis et al. (2010) investigate the persistence of the forward premium by modeling the forward premium as an autoregressive of order 1 (AR(1)) process and conclude that the persistence increases because of the presence of structural changes in the process. Using the multiple break model developed by Bai and Perron (1998, 2003), they show that the persistence of the forward premium substantially drops when multiple structural breaks are allowed in the mean of the process. However, Ho and Mo (2016) argue that, as long as the dynamic lag structure is specified, the forward premium still exhibits high persistence even after structural breaks are accounted for. Li (2014) shows that the ability of structural breaks to account for the persistence of the forward premium weakens markedly when daily data is used. Hence, it appears that previous studies have focused primarily on how taking into account just structural breaks in the process affects the persistence of the forward premium.

This paper contributes to the existing literature in the following ways. First, in addition to structural changes, some additional and important properties of the forward premium such as nonlinearity and asymmetry are incorporated within a flexible econometric framework, which is a multiple regime smooth transition autoregressive (STAR) model proposed by Chan and Tong (1986), and further developed by Luukkonen et al. (1988) and Teräsvirta (1994). Second, distinct from previous studies, this paper uses time as the transition variable in the multiple regime STAR model. In doing so, the model allows parameters to change smoothly over time. Third, this paper explores whether neglecting nonlinearity and asymmetry in the process yields downward amplification in the persistence of the forward premium. Taken together, based on the smoothly changing parameters, this paper investigates how the persistence, as measured by the AR(1) coefficient estimate, changes when the properties of the forward premium—nonlinearity, asymmetry, and structural changes—are simultaneously taken into account in the process within one flexible econometric model. The results reveal that the degree of the persistence of the forward premium declines when nonlinearity, asymmetry, and structural changes are jointly allowed in the process. In addition, the AR(1) coefficient estimates obtained from the model are then compared with those from the partial structural break model which considers just structural breaks in the mean. The analysis suggests that neglecting nonlinearity and asymmetry in the process may induce downward amplification in the persistence of the forward premium. This in turn implies that it is necessary to take into account all of the statistical properties of the forward premium when one measures persistence.

The remainder of this paper is organized as follows. Section 2 presents the model and describes the estimation procedure. Section 3 provides a description of the data set and presents a preliminary analysis and the empirical results. Section 4 provides concluding remarks.

2. The model

2.1. Model specification and estimation

Following such previous studies as Hai et al. (1997) and Zivot (2000), the forward premium is modeled as an AR(1) process. To investigate the dynamic properties of the forward premium, this paper employs a multiple regime STAR model, embedded within a nonlinear and asymmetric process.[6] The model with $M+1$ limiting regimes is given as follows:

$$(f_t - s_t) = [\mu_0 + \phi_0 (f_{t-1} - s_{t-1})] + \sum_{m=1}^{M} [\mu_m + \phi_m (f_{t-1} - s_{t-1})] \times G(z_t; \gamma_m, c_m) + \varepsilon_t, \quad (1)$$

where s_t is the log of the spot exchange rate and is measured as the foreign currency price of one unit of the domestic currency, f_t is the log of the forward exchange rate for a one-period ahead transaction, ε_t

[4] There have been some studies that examine the forward premium anomaly from a different perspective. Grossmann et al. (2014) explore the forward premium anomaly of the British pound and the euro for the subsample periods. Cho (2015) analyzes the dynamic properties of the forward premium anomaly depending on deviations from covered interest rate parity using a nonlinear panel model. Narayan and Sharma (2015) find that data frequencies matter for the forward premium anomaly. In addition, Cho and Chun (2017) show that accounting for the shifts in trend for the forward premium results in the significant predictability of currency excess returns irrespective of the sample period.

[5] In related work, Baillie and Kiliç (2006) analyze the asymmetric and nonlinear adjustments of the forward premium anomaly using the logistic smooth transition regression model. Amri (2008) employs the model of Baillie and Kiliç (2006) using data with different maturities such as 3 months and 6 months.

[6] Some previous studies have employed smooth transition regression models to consider the nonlinearity or asymmetry of the time series. Villavicencio (2008) shows that the degree of nonlinearity in the real exchange rates decreases when outliers are taken into account. Beckmann et al. (2015) provide evidence that gold may be regarded as a hedge or safe haven pertaining to stocks by accounting for asymmetries of positive and negative extreme shocks.