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Exchange rate dynamics and US dollar-denominated sovereign bond prices in emerging markets☆

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ABSTRACT

Using data on Brazil, Colombia, Mexico, the Philippines, Russia and Turkey, our empirical results show that the exchange rates of their currencies have adequate explanatory power in explaining their US dollar-denominated sovereign bonds, particularly in the post-global financial crisis period. We develop a two-factor pricing model with closed-form solutions for the sovereign bonds in which the correlated factors are foreign exchange rates and US risk-free interest rates that follow a double square-root process relevant in the low interest rate environment. The numerical results and associated error analysis show that the model credit spreads can broadly track the market credit spreads.

1. Introduction

In the aftermath of the global financial crisis of 2008, capital inflows to emerging markets surged and have been volatile since then. This raises the issue of the relationship between sovereign risk and exchange rate stability in those markets, that has long been a subject of interest in international finance. At the same time, the US Fed lowered the policy interest rate to the zero lower bound. In view of such market development, this paper studies the dynamic linkage between US dollar-denominated sovereign bond prices and exchange rates in emerging markets by deriving a two-factor risky bond pricing model with closed-form solutions in which the exchange rate and US risk-free interest rate are the underlying factors. To incorporate forward looking market information into the model, the currency option-implied volatility is used as the associated model parameter of the exchange rate.

In the literature, Eichengreen, Rose, and Wyplosz (1996), Frankel and Rose (1996), Kaminsky and Lizondo (1998), Kumar, Moorthy, and Perraudin (2003), who use macro-economic indicators to estimate the probability of currency crashes versus the US dollar. On the empirical side, Reinhart (2002), finds that 84 percent of the defaults in her emerging markets sample are connected with currency crises and almost half of the currency crises in the sample are related to defaults. Herz and Tong (2008) analyze emerging markets and find that 32 percent of all debt crises are linked to currency crises, while 20 percent of currency crises are associated with debt crises. Dreher, Herz, and Karb (2006) study the empirical relationship between currency and sovereign debt

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crisis covering 80 countries over the period from 1975 to 2000 and find that currency crisis are more likely to occur with a contemporaneous debt crisis and vice versa. Empirically, twin debt and currency crises occur more frequently than twin banking and currency crises.

The dynamic linkage between sovereign credit risk and exchange rates has been studied for emerging markets. Carr and Wu (2007) investigate the connection between currency option-implied volatilities and sovereign creditworthiness for Mexico and Brazil from 2002 to 2005. They find that the level and skew of the option-implied volatility display significant co-movement with the sovereign credit default swap (CDS) spreads of the two countries. Pan and Singleton (2008) explore the term structure of CDS spreads for Mexico, Turkey, and Korea from 2001 to 2006 and consider the risk-neutral credit event intensities and loss rates that best describe the CDS data. Their results suggest that currency option volatilities may have served as a proxy for the fundamental macroeconomic and event risks embodied in VIX. Pavlova and de Boyrie (2015) find information flows between currency carry-trade returns of nine Asian-Pacific economies and changes in the Markit iTraxx SovX Asia Pacific index from 2008 to 2011, which are negatively correlated.[1] Della Corte, Sarno, Schmeling, and Wagner (2016) find that global shocks play a key role for the contemporaneous link between exchange rates and sovereign risk, while sovereign risk forecasts future currency excess returns.[2]

To price sovereign risky bonds based on exchange rate dynamics, Cathcart and El-Jahel (1998) propose a model in which default occurs when some signaling process hits a constant default barrier. The signal can be a factor affecting the probability of default, such as the GDP growth rate or an exchange rate.[3] A similar framework was also used by Claessens and Pennacchi (1996) to price Mexican Brady bonds. Hui and Lo (2002) develop a model in which the nominal exchange rate signals default to price US dollar-denominated Korean and Brazilian government bonds. Rocha and Garcia (2005) propose a similar model in which signaling for default depends on the real exchange rate and apply the model to price Brazilian, Mexican, Russian, and Turkish sovereign bonds. While all of these models allow for stochastic interest rates using mainly the Cox, Ingersoll, and Ross (1985) (CIR) model, the correlation between the signal and interest rates is assumed to be zero. The empirical studies of these models used the data in 1990's when the regional financial crises occurred.

In our proposed model, a currency's exchange rate, i.e., the US dollar price of the local currency, is analogous to the stock price by using an analogy between corporate valuation and budget constraints for an economy proposed by Sims (1999) and Cochrane (2005). Such analogy assumes that the exchange rate adequately reflects country fundamentals anticipated in the market, similar to a firm's value measured by its stock price.[4] On the balance sheet of an economy, foreign and domestic debt sum to the present value of the future budget surplus. Foreign debt of the economy is the "actual" debt while domestic debt and fiat money act like equity in a firm. Given that the government promises only to pay the domestic debt in local currency in the future, the function of domestic debt is to absorb fiscal risk by adjustment of its foreign currency (e.g., US dollar) equivalent value. In other words, solvency can be restored through devaluation of nominal debt, created by currency depreciation. As long as there is some probability that the government will run a primary surplus in the future and/or will engage in the repurchase of domestic currency debt then such debt has value. Furthermore, the currency price, e.g., the US dollar price of the local currency, is analogous to the stock price. Similar to a firm facing risk of insolvency as its equity value declines substantially, when instability is anticipated in the economy, the currency devalues with rising volatility and the credit quality of the economy deteriorates. As in the framework developed by Duffie and Lando (2001), if the dynamics of the exchange rate are treated as a hazard rate process, which governs an inaccessible default stopping time, the proposed model can be recast as a special case of "reduced-form models".

Our model incorporates two features different from the previous models. First, the correlation between the exchange rate and risk-free interest rate is explicitly incorporated into the model and its closed-form solutions. Therefore, their dynamic linkage which is absence in the previous models is fully reflected in the proposed model. Secondly, the stochastic risk-free interest rate in the proposed model is assumed to follow the double square-root (DSR) process proposed by Longstaff (1989). One important characteristic of the DSR model is that it has a nonlinear restoring force in its drift term such that the interest rate is sticky downward. It is therefore particularly relevant to the low interest rate environment since the global financial crisis in 2008 when the short-term interest rate has tended to persist near the zero lower bound instead of moving back towards higher levels in a short time as implied by the CIR model and Vasicek (1977) models which are conventionally used in risky bond pricing models.[5]

The empirical results in Longstaff (1989) suggest that by estimating the model parameters the DSR model is more successful in capturing the level and variation of 6- to 12-month Treasury bill yields during the 1964–1986 period compared with the CIR model. The results also suggest that yields are nonlinearly related to the risk-free interest rate as the model implies. Similarly, the estimations of the DSR model parameters presented in Section 4.1 below show that the data of the Treasury bill and notes during the January

[1] Carry trades are speculative investment strategies in the foreign exchange market, where investors borrow low yielding (funding) currencies and invest in high yielding (investment) currencies.

[2] While sovereign risk and exchange rate stability have been studied in the context of sovereign debt crises, the literature on the empirical determinants of sovereign bond yield spreads usually focuses on other macroeconomic and financial variables instead of exchange rates. See Edwards (1986), Min (1998), Eichengreen and Mody (2000), Beck (2001), Ferrucci (2003), Duffie, Pedersen, and Singleton (2003), Hilscher and Nosbusch (2010), and Longstaff, Pan, Pedersen, and Singleton (2011).

[3] Moraux (2004) solves the model of Cathcart and El-Jahel (1998) in closed-form.

[4] This is also consistent with the basic log linear model of the exchange rate on which most of the target-zone literature [such as Krugman's (1991)] is based for a small open economy. In the model, the exchange rate is equal to fundamentals plus a term proportional to the expected change in the log exchange rate.

[5] Following the bankruptcy of Lehman Brothers in mid-September 2008, developments took a dramatic turn and spilled over to other economies. During 2008, the US Fed lowered the policy interest rate from the 4% level to 0–0.25% to provide monetary support for the economy. Subsequently, it has taken unprecedented measures including quantitative easing policies that have lowered long-term borrowing costs and fostered economic activity. As the interest-rate term structure was affected by the Federal Reserve's ultra-accommodative monetary policy, the 3-month US Treasury-bill yield has fallen to near zero for an extended period. The 10-year Treasury yield fell and hit the historical low of 1.32% in July 2016, even after the Feb raised the policy rate by 0.25% in December 2015.

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