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Jumps in foreign exchange rates and stochastic unwinding of carry trades

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ABSTRACT

Tails in the distribution of JPY/USD exchange rate returns are well approximated by an exponentially dampened power-law. Distribution parameter estimates indicate that yen appreciation jumps belong to a Levy process with unbounded variation, suggesting that same mechanism may be responsible for fluctuations in normal times as well as rare crashes. In contrast, yen depreciation jumps have a well defined second moment suggesting a Gaussian regime. In addition, extreme episodes of yen appreciation are larger and more persistent than episodes of yen depreciation. The asymmetry is magnified and power-law tails are more elongated during times of higher interest rate differential between U.S. and Japan and higher level of VIX indicating that carry trade may be the driver. We propose a model of strategic carry trader behavior that in equilibrium generates exponentially dampened power-law distribution of jumps in foreign exchange along with "up by the stairs down by the elevator" dynamics arising from the assymetries between negative and positive jumps.

1. Introduction

Foreign exchange returns of high (low) yield currencies tend to exhibit negative (positive) skewness—long duration of runs interrupted by abrupt crashes. Understanding the processes behind rare events in foreign exchange markets is important for both risk management and policy making. Brunnermeier, Nagel, and Pedersen (2009) find that yen has exhibited the highest degree of skewness among developed countries' currencies and attribute it to large periodic yen appreciations caused by the unwinding of carry trade[1,2]. To account for skewness and kurtosis in financial returns they are normally modeled as a stochastic jump diffusion process intended to handle both "normal" and "rare" events simultaneously. Traditionally, it has been assumed that "rare" events augmenting the Brownian motion in returns follow Merton's compound Poisson normal jump process. However, recently Wu (2006) and Bakshi, Carr, and Wu (2008) put forth exponentially dampened power-law as an alternative to Merton's formulation because of its better ability to match stochastic skewness in financial returns. We find that jumps in the JPY/USD exchange rate are more likely to follow an exponentially dampened power-law rather than Merton's compound Poisson process and, given yen's role as a funding currency in carry trade, propose a model of strategic carry trader behavior that in equilibrium generates exponentially dampened power-law in the distribution of jumps.

Carry trade is the suspect because Japanese yen in particular has served as a funding currency for overseas investments because of prolonged "zero-interest rate" policy of the Bank of Japan. Fig. 1 shows the JPY/USD exchange rate (top) and the U.S.–Japan

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[1] Carry trade is a strategy in which an investor borrows in a low interest rate currency and takes a long position in a higher interest rate currency betting that the exchange rate will not change so as to offset the interest rate differential Burnside, Eichenbaum, and Rebelo (2007) and Hochradl and Wagner (2010) document excess returns to carry trade strategies.

[2] In addition, Gagnon and Chaboud (2007) find that prices of deep out-of-money foreign exchange options indicate an overall market hedge against large yen appreciation.

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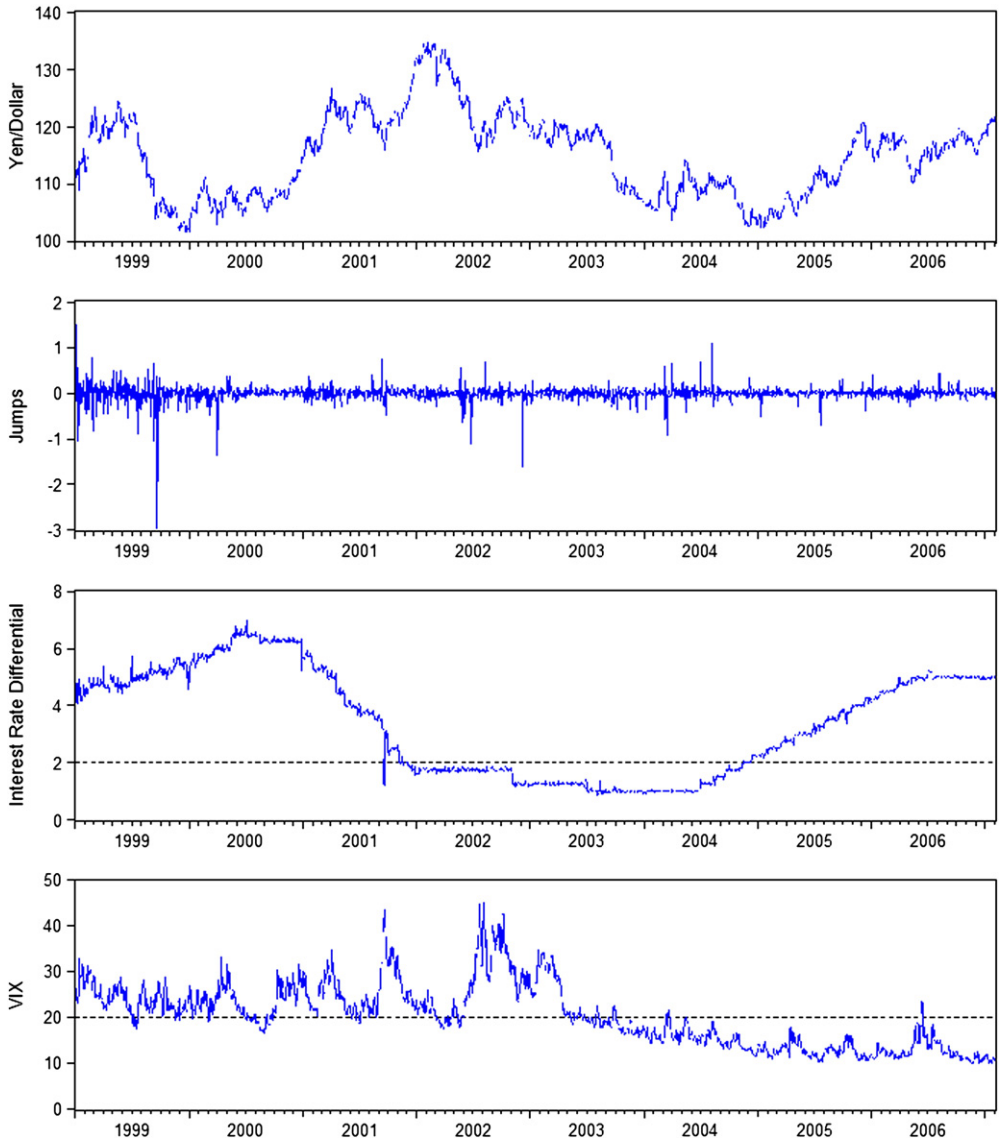

Fig. 1. Daily time–series of JPY/USD exchange rate, realized volatility jumps, U.S.–Japan interest rate differential, and CBOE VIX; 01/01/1999 through 02/01/2007 sample period.

interest rate differential (2nd from the bottom). In strong violation of the uncovered interest parity (UIP)[3] an increase in the interest rate spread corresponded with dollar appreciation against the yen in late 1999 through 2000 and again from 2004 through 2007[4]. For instance, Ichiue and Koyama (2008) estimate the UIP regression coefficient as low as −2.79 for the yen. Farhi, Fraiberger, Gabaix, Ranciere, and Verdelhan (2009) interpret UIP violations as a compensation to carry traders for the risk of periodic currency crashes, such as a sharp yen appreciation in 2008 following the sub-prime crisis.

We focus on time period from Jan 1, 1999 through Feb 1, 2007, thus the 1998 and 2008 crashes are just outside of our sample. We examine daily jumps in JPY/USD exchange rate extracted using a non-parametric method allowing us to test hypothesis regarding the underlying distribution. We find that a compound Poisson normal jump process is strongly rejected in favor of a process that generates power-law tails in the distribution of jumps. Specifically, the data favors exponentially dampened power-law. We also find that positive and negative jumps in JPY/USD exchange rate exhibit asymmetries indicating higher likelihood of large discrete yen appreciations. The asymmetries are more pronounced when the interest rate differential is high. Splitting the sample by the option-implied volatility index VIX, which Brunnermeier et al. (2009) consider an important measure of risk for

[3] UIP is an ex-ante no-arbitrage condition predicting that excess returns from holding high interest rate currency must be eliminated through an expected depreciation of that currency. Under rational expectations a regression of exchange rate returns on in interest rate differential should yield a coefficient of 1.

[4] An appreciation of the high yield currency is an example of the forward premium puzzle and the violation of the uncovered interest parity (UIP) well documented by Hansen and Hodrick (1980) and Engel (1996).