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Variance risk premiums in foreign exchange markets ☆

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ABSTRACT

Based on the theory of static replication of variance swaps we assess the sign and magnitude of variance risk premiums in foreign exchange markets. We find significantly negative risk premiums when realized variance is computed from intraday data with low frequency. As a likely consequence of microstructure effects however, the evidence is ambiguous when realized variance is based on high-frequency data. Common to all estimates, variance risk premiums are highly time-varying and inversely related to the risk-neutral expectation of future variance.
When we test whether variance risk premiums can be attributed to classic risk factors or fear of jump risk, we find that conditional premiums remain significantly negative. However, we observe a strong relationship between the size of log variance risk premiums and the VIX, the TED spread and the general shape of the implied volatility function of the corresponding currency pair. Overall, we conclude that there is a separately priced variance risk factor which commands a highly time-varying premium.

1. Introduction

The increase of traded volumes in foreign exchange derivative markets over the past decades suggests that it becomes ever more important to understand risk factors and their potential premiums in currency markets. The aim of this paper is a careful examination of the variance risk premiums in foreign exchange markets. Specifically, we investigate the sign, size and evolution of variance risk premiums along the lines of Carr and Wu (2009). Based on the theoretical work from Carr and Madan (1998), Demeterfi et al. (1999) and Britten-Jones and Neuberger (2000), we synthesize zero cost variance swaps, which are equivalent to constructing risk-neutral forecasts of future variance. Using a model-free variance estimator has the advantage that we can be agnostic about the volatility process of the underlying exchange rate. More precisely, our estimator produces robust forecasts under an arbitrary volatility process and thus avoids an important source of potential error. When variance swaps are compared with a measure of ex-postrealized variance, the sign and magnitude of the average variance risk premiums can be directly inferred.

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To the best of our knowledge, we are the first to apply the model-free approach of Britten-Jones and Neuberger (2000) to study variance risk premiums in foreign exchange markets. Our analysis is based on OTC options, for which only a handful of standard quotes in the strike domain is available. For this reason, we compute variance risk premiums for different interpolation methods and settings. We also propose a novel interpolation technique that extends the information set to all option quotes in the strike domain. Finally, we contribute to the literature by carefully examining the relationship between variance risk premiums and the sampling frequency of the spot rate on which realized variance estimates are based.

A number of studies on currency markets document biases for option-implied volatility in predicting future realized volatility. Early work on the subject includes Scott (1992), who introduces the notion of a volatility risk premium, Jorion (1995) and Bates (1996a). Covrig and Low (2003), Christoffersen and Mazzotta (2005) and Charoenwong et al. (2009) use OTC options to study the accuracy of implied volatility forecasts. While their evidence is ambiguous as to whether or not implied volatility is a biased predictor of future realized volatility, they agree that implied volatility subsumes the information contained in competing time-series models. Martens and Zein (2004) and Pong et al. (2004) compare implied volatility with forecasts from high-frequency historical data. They conclude that the latter provide accurate forecasts of future realized volatility. Contrary to this body of research, we do not benchmark implied against historical volatility forecasts. Instead, our attention is devoted to a thorough analysis of the variance risk premiums in currency markets.

Variance risk premiums in equity markets are relatively well studied. For example, Coval and Shumway (2001) and Bakshi and Kapadia (2003) conduct analyses with a focus on the performance of hedged option positions. The former construct so-called zero-beta index straddles, while the latter examine returns to delta-neutral call option strategies. Both report significant negative returns and attribute these to negatively priced variance risk. Carr and Wu (2009) quantify variance risk premiums for both index options and individual stocks. Although they report some cross-sectional differences for the latter, the overall evidence is strongly indicative of negative variance risk premiums. Currency markets in contrast have so far received little attention, in spite of their very distinct nature compared to equities. Guo (1998) investigates variance risk premiums in the context of the Heston (1993) stochastic volatility model, whereas we assess them in a model-free manner. Low and Zhang (2005) adapt the approach of Bakshi and Kapadia (2003). Compared to their analysis, our approach has two distinct advantages: First, we can directly quantify the magnitude of variance risk premiums. Second, we account for the information in the cross-section of option prices, whereas their evidence rests entirely on the at-the-money quotes.

Currency markets are fundamentally different from equities in that one of the key explanations for negative variance risk premiums does not necessarily apply. The classical argument goes as follows: Since equity investors are primarily concerned with a decrease in share prices, and since negative returns tend to coincide with an increase in volatility, instruments with a positive exposure to volatility pay out in bad states of the economy. As such, risk-averse investors should be willing to pay a premium for holding such instruments. In foreign exchange, the relationship between the level of volatility and the direction of the underlying currency pair is not as clear-cut. Evidently, the so-called leverage effect first pointed out by Black (1976) is absent. More importantly, there are likewise domestic and foreign investors and firms with opposite interest in the valuation of one currency against another. As a result, a currency depreciation need not be a bad thing. Thinking in the context of the mean-variance framework, an increase in volatility is however likely to adversely affect the opportunity set of an international investor. Furthermore, it impedes the budgeting and planning process of an internationally operating firm. Provided market participants are risk-averse, this reasoning suggests that potentially negative variance risk premiums can be attributed to a separately priced variance risk factor.

In line with the economic argument, we find significantly negative variance risk premiums when realized variance is computed from intraday data with low frequencies. However, we report a considerable difference in average variance risk premiums when spot data with daily sampling frequency as opposed to high-frequency data is used. Our results suggest that the observed discrepancies are owed to microstructure effects that come into play as the sampling frequency is increased. We can further assert that variance risk premiums are highly time-varying and inversely related to the risk-neutral expectation of future variance. Finally, our results are robust to whether or not we include data covering the financial crisis of 2008.

In an attempt to better comprehend the nature of variance risk premiums, we interpret our results in the context of classic risk factors. Specifically, we regress log variance risk premiums on excess returns in the S&P 500, returns on the VIX and first differences in the TED spread. While the latter two share a significant relationship with the magnitude of log variance risk premiums, the conditional premiums remain significantly negative. We also examine whether variance risk premiums subsume fear of jump risk. Assuming that jump risk is well proxied by the prices for risk reversal and butterfly strategies, we can conclude that jump risk aversion cannot account for the observed variance risk premiums in currency markets. Overall, our results point towards an independent variance risk factor which commands a time-varying premium.

The remainder of the paper is organized as follows. Section 2 provides an outline of the general estimation methodology applied in this paper. In Section 3, we present the data set and elaborate on the details of replicating variance swaps in foreign exchange markets. Section 4 provides evidence on average variance risk premiums as well as their time series characteristics. Section 5 investigates variance risk premiums during the financial crisis of 2008. In Section 6, we assess the variance risk premiums within the framework of classical factor models. Section 7 concludes.

2. Static hedging and model-free variance forecasting

Throughout this paper, we work with the risk-neutral variance forecast developed in Carr and Madan (1998), Demeterfi et al. (1999) and Britten-Jones and Neuberger (2000). We follow the common foreign exchange quotation convention and assume that