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The skewness risk premium in currency markets☆

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ABSTRACT

This paper examines the relationship between currency option's implied skewness and its future realized skewness, where the difference is known as the skewness risk premium (SRP). The SRP indicates whether investors pay a premium to be insured against future crash risk. Past investigations about implied and realized skewness within currency markets showed that both measures are loosely connected or even exhibit a negative relationship that cannot be rationalized by no-arbitrage arguments. Therefore, this paper studies time-series of *future* and *option contract positions* data in order to explain the disconnection in terms of investor's position-induced demand pressure. While demand pressures on options do not sufficiently contribute to the disconnection, there is evidence that, surprisingly, demand pressure in currency future markets have the power to explain this market anomaly. Furthermore, currency momentum also plays an important role, which leads to a strong cyclical demand for OTM calls in rising or OTM puts in declining markets. In order to exploit the disconnection of skewness, a simple skew swap trading strategy proposed by Schneider (2012) has been set up. The resulting skew swap returns are relatively high, but the return distribution is extremely fat-tailed. To appropriately compare different skew swap strategy returns, this paper proposes a *Higher Moment Sharpe Ratio* that also takes higher moments into account.

1. Introduction

While it is quite common to use the second moment or variance as a measurement of risk, the focus of this paper lies on the third moment risk or skewness of a return distribution in the currency market. Strictly speaking, the investigation here concentrates on the relationship between future realized skewness ($Rskew_{t:t+1}$) and its ex ante known risk-neutral counterpart, the implied skewness ($Iskew_t$). The difference between the two variables is known as the skewness risk premium ($SRP_{t:t+1}$). While *Rskew* measures the physical asymmetry of a return distribution, *Iskew* is supposed to measure investors' future perception of an asymmetrical return distribution under the risk-neutral measure. Literature has used skewness to predict large and rare disasters and estimate crash risks in any desired setting. Hence, one can state that *Rskew* measures the future realized crash intensity and *Iskew* measures the option-implied crash risk and can be characterized as the current price for ensuring against future crashes. Taking these definitions as a basis, one can imagine that both variables are closely related to each other. It is also well-known that realized and implied moment risks are also used to design swap contracts to make the difference tradable. While the design of second-moment swap contracts or variance swaps are frequently used in practice, third-moment swaps or skew swaps have only been considered in academic literature.

However, empirical evidence for the currency market provided by Jurek (2009) and Brunnermeier et al. (2009) suggests that *Rskew* and *Iskew* are, on average, negatively related to each other. This is quite puzzling, since it means that, especially in times of fragile markets, the insurance price against crashes gets cheaper. In a study of skewness in the commodity market, Ruf (2012) found similar results that realized and implied skewness are somehow disconnected from each other. He found mounting evidence to suggest that this disconnectedness of skewness (DS) is primarily driven by option demand-based market pressures. Ruf (2012) showed that, especially in times where "arbitrageurs" faced large net long option positions,[1] they became restricted to offer more option contracts. Subsequently, the option prices started to rise, and, as a consequence, the implied skew degenerated from its realized counterpart. In a different study that focused on *Iskew* for the equity market, Garleanu et al. (2009) analysed the disconnection between the heavily negative *Iskew* of the S&P 500 Index compared to the much flatter *Iskew's* of its single stock constituents. They

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[1] "Net option positions" refer to the aggregate option positioning of an arbitrary number of market participants belonging to a special group of traders, e.g. end-users. If a trader group is exposed to a net long put position it means that the group of traders, as a whole, has a greater number of long put positions in contrast to short put positions.

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rationalized their findings by comparing with different net option positions of "end-users"[2] in their respective index or single stock markets. End-users are, on average, net long puts on the index side, which has led to a more negative *Iskew*. On the other hand, end-users have been, on average, more exposed to net short puts in the various single stock option markets, leaving the volatility smile more positively-skewed. Again, different positioning of market participants seems to play a big role in explaining some unusual market anomalies and, therefore, encourages an investigation of the DS in currency markets.

Therefore, the aim of this paper is (1) to study the existence of a skewness risk premium in currency markets and (2) to identify the source of the disconnectedness of realized and implied skewness (DS) in the time-series. While the first part gives an overview of the historical situation of about 30 different currency pairs against the US-dollar (USD), with investors paying an extra premium to be insured against crash risk, the second part more thoroughly investigates the dependency of skewness to market pressures. Here, using a subsample of up to 8 currencies, the study concentrates on future and option contract data provided by the *U.S. Commodity Futures and Trading Commission* (*CFTC*) in order to find a demand-based explanation of the DS in the currency market.

Why is the DS relevant for an economic investigation? And, how can skew risk be defined? The DS is not consistent with no-arbitrage arguments of financial markets and can therefore be characterized as a kind of market anomaly. This becomes clear when one starts to exploit the DS through the use of a skew swap. This paper will use the methodology of a synthetic skew swap, recently developed by Kozhan et al. (2013) (KNS) to describe the skewness risk premium. The advantage of KNS is that realized and implied skew perfectly aggregate to each other. This has been achieved by Neuberger (2012), which accurately derived a measure of realized skew that perfectly aggregates to its implied skew counterpart. KNS used this evidence to investigate the relationship between second and third-moment risk for the S&P 500 Index market.

This paper's empirical framework is broadly identical to Ruf's (2012). In a panel regression framework, it will be shown that the DS in currency markets are primarily driven by market pressures from the future market. Beside market pressures, the role of past currency momentum also exhibits a strong relation to the DS. Also market factors like illiquidity risk, macroeconomic risk, equity risk, and market volatility risk will be taken into account within the forthcoming analysis. At the end of this paper a more practical version of a skew swap in terms of cost efficiency (see Schneider (2012)) will be applied as a trading strategy, using the panel regression results to exploit the DS.

All implied variance or skewness measures are primarily based on the existence of a volatility smile of the respective currency pair and option maturity. Therefore, the option-implied volatility smile will be rebuilt, using 25-delta out-of-the-money (OTM) butterfly, 25-delta OTM risk reversal, and at-the-money (ATM) volatility quotes provided by Bloomberg. In order to calibrate such a volatility smile and translate it into option prices, the *simplified parabolic interpolation model* developed by Reiswich and Wystup (2012) has been chosen. This volatility smile model has proven to be robust against other well-known smile procedure approaches (see Reiswich (2011)) that are used in practice, e.g. the Vanna–Volga method by Castagna and Mercurio (2007).

The remainder of this paper is organized as follows: Section 2 gives an introduction to how second- and, especially, third-moment swaps are designed; Section 3 describes the variables used in the empirical analysis; Section 4 presents empirical evidence for why realized and implied skewness are disconnected in currency markets, a fact exploited in Section 5. Finally, Section 6 concludes the paper and sums up the argument.

[2] "End-users" are a group of traders who do not offer option contracts to the public and, therefore, only trade long positions in call or put contracts.

2. Moment swaps

Neuberger (2012) developed a trading strategy that is completely attributed to the third-moment risk, which works like a swap contract. The buyer of a contract pays the option-implied level at inception time t of the corresponding moment risk, also known as the fixed leg. Then, she will subsequently receive the realized moment risk, known as the floating leg, until expiration date T. The fixed leg is usually characterized as a contingent claim and therefore priced with using the spanning approach from Bakshi and Madan (2000).

An integrated part of Neuberger's (2012) derivations of second or third moment swaps is that they conform to the Aggregation Property (AP). To get a first impression of the meaning of the AP and how one can link it to the fixed and floating leg of a swap contract, take a look at the following equation:

$$\mathbb{E}_0[g(X_T - X_0)] = \mathbb{E}_0\left[\sum_{t=1}^{T} g(X_t - X_{t-1})\right] \quad (1)$$

On the left hand side (LHS), one can see the expected value of a function g that is dependent on a price change of a variable X over the period [0,T]. On the right hand side (RHS), there is the expected value of g-function's sum of price changes over more frequent observations of X. Suppose that the function g is composed of a moment risk and X is a stochastic price process that follows a martingale. Then, the LHS describes the expected value of that moment risk using the price change over the entire period, for example — a month. This should be equal to the expected value of the summation term of this moment risk, subsequently computed on a daily frequency over the same period. Interpreting this result in terms of a swap contract, one can state that the RHS, priced under a physical measure $\mathbb{P}$, represents the fair price of that moment risk and is equal in expectation to the contingent claim price evaluated under the implied (or risk-neutral) measure $\mathbb{Q}$.[3] The challenging question was to define a g-function that perfectly aggregates to the contingent claim price or implied measure of the third-moment risk. Neuberger (2012) introduced a g-function that perfectly matches the third-moment risk of log returns that has the AP and therefore can be priced at any desired frequency and is also robust to jump processes.

Under the following circumstances, it is assumed that the market is arbitrage-free and without frictions, and that calls and puts are available for any strike price K.[4] All prices are in USD terms, with i and i^f denoting the USD and foreign one-month interest rates, respectively. There are also FX forwards and bonds available, where the prices are denoted as $F_{t,T,}$ and $B_{t,T}$ respectively, subscripted with its initiation date t and maturity date T. The forward price is defined as $F_{t,T} = S_t\, e^{(i-i^f)(T-t)}$ and the USD zero coupon bond $B_{t,T}$ equals $e^{-i(T-t)}$. The forward log return is defined as $r_{t,T} = \ln(F_{T,T} / F_{t,T})$.[5,6] Call and put options will be priced according to Garman and Kohlhagen (1983) proposed option price formula, denoted as $C_{t,T}(K)$ and $P_{t,T}(K)$ respectively, with strike price K in parentheses and the same time subscripts.

In the following sections, two newly developed variance definitions will be briefly introduced that also play a role in deriving the third-moment risk. All measures of moment risk are based on log returns of the underlying asset and have the desired AP. A thorough derivation of the proposed g-functions is well beyond of the scope of this paper, so these functions are taken as given and well-defined.[7]

[3] The theory of pricing contingent claims with static option positions was primarily developed by Breeden and Litzenberger (1978).

[4] It is assumed that the stochastic spot price process S_t follows a standard Wiener process and therefore has the martingale property.

[5] Please be reminded that the term $F_{T,T}$ is equal to the spot exchange rate at time T, S_T.

[6] For notational convenience, the time subscript of the log return r will be dropped out.

[7] Especially Proposition 2 in Neuberger (2012) is recommended for a more thorough derivation of g-functions that approximate the second or third moment risk of log returns and their corresponding proofs in Appendix A.

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