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Dynamic relationship between Japanese Yen exchange rates and market anxiety: A new perspective based on MF-DCCA

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HIGHLIGHTS

- Dynamic relationship between the Yen FX and market anxiety are investigated.
- Cross-correlations between the Yen FX and VIX exhibit multifractal features.
- The cross-correlated behavior is susceptible to economic uncertainties and risks.
- The spread of two market anxiety gauges (VIX and TED) are compared. The sources of multifractality are also traced.

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ABSTRACT

This paper investigates the dynamic relationship between Japanese Yen exchange rates and market anxiety during the period from January 5, 1998 to April 18, 2016. A quantitative technique of multifractal detrended cross-correlation analysis (MF-DCCA) is used to explore the multifractal features of the cross-correlations between USD/JPY, AUD/JPY exchange rates and the market anxiety gauge VIX. The investigation shows that the causal relationship between Japanese Yen exchange rates and VIX are bidirectional in general, and the cross-correlations between the two sets of time series are multifractal. Strong evidence suggests that the cross-correlation exponents tend to exhibit different volatility patterns in response to diverse external shocks such as financial distress and widening in interest rate spread, suggesting that the cross-correlated behavior between Japanese Yen exchange rates and VIX are susceptible to economic uncertainties and risks. In addition, the performances of two market anxiety gauges, the VIX and the TED spread, are compared and the sources of multifractality are also traced. Thus, this paper contributes to the literature by shedding light on the unique driving forces of the Yen exchange rate fluctuations in the international foreign exchange market.

1. Introduction

Since 1999, Bank of Japan has kept the short-term interest rates quite close to zero to fight domestic deflation and adverse economic conditions. Starting from October, 2010, the Japanese central bank conducted a number of asset purchasing programs to inject large amount of liquidity into the banking system, thus decreasing borrowing costs and stimulating credit flows. On April 4, 2013, Bank of Japan launched a new expansionary monetary policy called "Quantitative and Qualitative

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Monetary Easing'' (QQE) to increase monetary base in the domestic market. The previous asset purchasing programs along with this QQE have resulted in the depreciation of Japanese Yen for years before its unanticipated appreciation at the beginning of 2016. This appreciation, however, took place when Bank of Japan lowered the interest rate that financial institutions hold at the Bank to a negative territory (minus 0.1%) on January 29, 2016. The Japanese Yen has, surprisingly to all investors, appreciated all the way to its historical record with more than 10% increases against the US dollars, causing large fluctuations in the exchange rate market. It is apparent that the strengthening of Yen this time has not been prompted by traditional forces like inflation, money supply, interest rate or economic growth [1,2]. It is driven by, instead, a rise in aversion to risk among market participants based on the following facts: Several Eurozone central banks have adopted negative interest rates; major oil-producers supplying nearly half of the world's output failed to reach consensus on curbing oil production on April 17th, 2016; the Fed took a quite vague attitude towards the Federal funds rate hikes; and China's economic growth is in deceleration, affecting international trade and economic development on a global scale. All these are risk factors that affect the investors' risk appetite and propel them to rush into the Japanese Yen, the safe-haven currency as defined by the market participants across the global FX markets. The Yen has thus been favored by investors in the FX markets, especially during financial turmoil or economic downturns. In tranquil periods, the Yen generally serves as a carry trade currency against the US dollars and a funding currency against the high beta Australian dollars. The exchange rates of the Yen against the US dollars and Australian dollars are thus subject to carry trade risks, transaction risks and economic risks.

Traditional analysis of exchange rate fluctuations generally takes historical data and employs VAR or GARCH family models for estimation [2,3], neglecting the impact of market expectations and sentiment on exchange rate determination. The VIX (CBOE Volatility Index), widely considered to be "the world's premier barometer of investor sentiment and market volatility," is a crucial gauge of market's expectations of near-term (30-day) volatility. Constructed by the implied volatility of S&P 500 stock index option prices, it is often taken as a forward-looking measure of market risks. VIX larger than 30 generally denotes higher volatility or investor fear and uncertainty, while VIX smaller than 20 generally signifies lower volatility or less stressful, more stable periods. As the global integration of financial markets, any movement in one market (e.g. the stock market) will be transmitted to another market (e.g. the exchange rate market) through international trade or spillovers. Hence, being the "The Investor Fear Gauge" for the US stock market, VIX can also be taken as an effective anxiety measure for other financial markets as well [4]. However, almost no existing research has integrated investors' expectations and sentiment into exchange rate analysis. To get a clearer picture and better understanding of the unique driving forces behind the Yen exchange rate fluctuations in the international FX markets, this paper explores (i) whether VIX serves as a market anxiety measure for the Yen exchange rate market. (ii) The cross-correlations between the Yen exchange rates and the Volatility Index.

The rest of the paper is organized as follows. Section 2 introduces the relevant methodology. Section 3 describes the data and preliminary test statistics. Section 4 reports the empirical results. Section 5 presents some economic implications and related discussions. Section 6 concludes the paper.

2. Methodology

Various methodology and approaches have been developed to analyze the long-term dependence and correlations in time series. These methods and approaches include but not restrict to the rescaled range (R/S) analysis initiated by Hurst [5,6], the wavelet transform modulus maxima (WTMM) method developed by Mallat and Hwang [7], the fluctuation analysis (FA) and the detrended fluctuation analysis (DFA) developed by Peng et al. [8,9], the detrended moving average analysis (DMA) proposed by Alessio et al. [10], the detrended cross-correlation analysis (DCCA) introduced by Podobnik and Stanley [11]. Kantelhardt et al. [12] extended the DFA to its multifractal form, and derived the so-called MF-DFA. Similarly, Jiang and Zhou [13] proposed the MF-X-DMA based on DMA and the work of Gu and Zhou [14] who proposed MF-DMA. Zhou [15] came up with multifractal detrended cross-correlation analysis (MF-DCCA) by integrating DCCA into the MF-DFA framework.

In addition to the methods mentioned above, researchers have developed a number of techniques and approaches related to MF-DCCA to detect long-term dependence and quantify cross-correlations between non-stationary time series: The multifractal height cross-correlation analysis (MF-HXA) by Kristoufek [16] as a generalization of the height–height correlation analysis [17]; multifractal cross-correlation analysis employing the partition function approach (MF-X-PF) proposed by Wang et al. [18] and generalized by Xie et al. [19] on the basis of joint multifractal analysis (see Meneveau et al. [20] for further details); multifractal cross-correlation analysis (MFCCA) introduced by Oświecimka et al. [21] to identify and measure the subtle characteristics of multifractal cross-correlations between two time series. Kwapień et al. [22] used this technique to investigate the power-law cross-correlations among the indicators that characterize stock market trading: Logarithmic returns, volatility, trading activity and volume traded. They found that the strongest power-law cross-correlations and fractal-like coupling exist between the trading activity and volume. As a generalization of the detrended cross-correlation analysis, multifractal detrended partial cross-correlation analysis (MF-DPXA) developed by Qian et al. [23] takes into consideration partial correlation analysis to quantify the hidden multifractal nature of two time series.

Empirically, Sidorov et al. [24] adopted FA, DFA and DMA to analyze the long-range dependence of economic news flow intensity. They found that the original and deseasonalized data produces diverse results but all confirm the existence of long-term autocorrelation. Gu et al. [25] used both DFA and MF-DFA to analyze the multifractal nature of WTI and Brent crude oil markets in the three periods divided by two Gulf Wars. Podobnik et al. [26] employed DCCA to investigate the