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Central bank intervention and exchange rate volatility: Evidence from Japan using realized volatility[☆]

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ABSTRACT

This paper presents new empirical evidence on the effectiveness of Bank of Japan's foreign exchange interventions on the daily realized volatility of USD/JPY exchange rates using high frequency data. Following Huang and Tauchen (2005) and Barndorff-Nielsen and Shephard (2004, 2006), we use bi-power variation to decompose daily realized volatility into two components: the smooth persistent and the discontinuous jump components. We model exchange rate returns, the different components of realized volatility and the central bank intervention using a system of simultaneous equations. We find strong support that interventions by Bank of Japan had increased both the continuous and the jump components of daily realized volatility. This suggests that the interventions by Bank of Japan had increased market volatility which not only caused short-lived positive jumps, but were also persistent over time. We did not find any evidence that interventions were effective in influencing the exchange rate returns for the entire sample period.

1. Introduction

The effect of foreign exchange intervention on exchange rates has been a constant topic of discussion in the academic and policy circle ever since the collapse of the Bretton-Woods system in the early 1970s. Despite the move to floating exchange rates, central banks of several countries have intervened heavily in the foreign exchange (FX hereafter) market to manipulate their nominal exchange rates and 'calm' disorderly markets.[1] The Bank of Japan (BOJ hereafter) on behalf of the Ministry of Finance carried out extensive interventions in the FX market in efforts to reduce the value of the yen. During the period of April 1991 and August 2006, the total amount of interventions conducted by BOJ was about 68 trillion yen

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[1] These actions by the central banks have been implicitly defined in two major international agreements: the goal of the Plaza Accord in September 22, 1985 was to seek central bank cooperation to sharply depreciate the US dollar and the Louvre Accord in February 22, 1987 emphasized the need to stabilize the exchange rate volatility.

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(approximately 600 billion U.S. dollars).[2] These actions on the part of the Japanese monetary authorities are understandable given the role of the export sector in their economic recovery. Had the BOJ been effective in its intervention operations? Had the BOJ been successful in depreciating the yen and reducing the volatility of the yen? Given the significance of understanding how central bank interventions (CBIs hereafter) affect the FX markets, it is important to critically examine the answers to these questions.

Several authors have analyzed the effects of CBI on the FX market by looking at the impact on both the level and the volatility of exchange rate. In general, the literature is inconclusive about the impact of CBI on exchange rate returns. For example, Humpage (1988) and Baillie and Humpage (1992) have found that intervention was ineffective in influencing the level of exchange rate. Baillie and Osterberg (1997) finds that the effect of CBI on spot exchange rate returns are counterproductive, i.e. purchase of US dollars leads to a depreciation of the US dollar.[3] This result holds for both unilateral and coordinated interventions. Others like Dominguez and Frankel (1993), Fatum and Hutchison (2005), Dominguez (2003), Humpage (2003), and Ito (2003) conclude that CBI had a significant impact on the exchange rate, at least in the very short run, when it was publicly announced, coordinated, large, and infrequent.

The studies looking at the effect of interventions on the volatility of exchange rates are more conclusive. Most studies, employing different measures of volatility, conclude that CBI tends to increase exchange rate volatility. For example, Bonser-Neal and Tanner (1996) and Dominguez (1998) used measures of implied volatility to find that CBI increases exchange rate volatility. Other studies like Dominguez (1998) and Beine et al. (2002) using GARCH-type models, and Beine, Laurent, and Palm (2009), Dominguez (2006) using realized volatility models, arrive at the same conclusion. This finding is contrary to the aim of the central bank which intervenes to counter disorderly FX markets[4]. However, there are some studies that either do not find any impact of CBI on exchange rate volatility (Galati, Melick, & Micu, 2005) or find that CBI is associated with less exchange rate volatility at least for parts of the sample period (Hillebrand, Schnabl, & Ulu, 2009).[5]

In this paper, we seek to further advance our understanding of the impact of CBI on the two different components of exchange rate volatility – the 'continuous' persistent part and the discontinuous 'jump' component. To the best of our knowledge, no previous study, with the exception of Beine, Lahaye, Laurent, Neely, and Palm (2007), has analyzed the relation between CBI and the volatility components. Beine et al. (2007) had captured the long memory in the volatility process with an ARFIMA specification in the spirit of Andersen, Bollerslev, Diebold, and Labys (1999). The authors, however, have not addressed the the problem of endogeneity of intervention and exchange rates which is a key issue in these studies.[6] We have modelled the different components of exchange rate volatility and intervention in a simultaneous equation framework, explicitly accounting for the endogeneity in the coefficient on contemporaneous interventions.

The empirical literature examining the effect of CBI on exchange rate volatilities have mostly modeled volatility in the framework of GARCH-type models. However, recent developments in econometric methodology and the increasing availability of high-frequency data have shifted the paradigm from the discrete-time GARCH class of models to the non-parametric approach for modeling and forecasting time-varying daily market volatility. The empirical results in Andersen, Bollerslev, Diebold, and Labys (2003) strongly indicate that models of realized volatility outperform the popular GARCH-type and related stochastic volatility models in out-of-sample forecasting. Other studies such as Andersen and Bollerslev (1998), Andersen, Bollerslev, Diebold, and Labys (2001a, 2001b), and Barndorff-Nielsen and Shephard (2004, 2006) have shown the importance of explicitly allowing for jumps, or discontinuities, in the estimation of continuous time stochastic volatility models.[7] In particular, it has been found that many (log) price processes are best described by a combination of a very slowly mean-reverting continuous sample path process and a discontinuous jump component. Thus it is important to distinguish the jump from the non-jump movements. One advantage of separating out the smooth and persistent volatility component and the much less persistent jump process is that it can describe the in-sample price (exchange rate) processes better and also provide out-of-sample forecasts accurately.[8]

Due to extreme market events or macro announcements, there might be presence of unusually large movements in the price processes relative to what continuous-time diffusive models in finance would suggest. Our approach to modelling exchange rate volatility builds directly on the theoretical results in Barndorff-Nielsen and Shephard (2004, 2006) and Huang and Tauchen (2005). We decompose the daily realized volatility into a jump and a persistent process using bi-power variation as indicated by the authors. It has been shown that realized volatility is a consistent estimator for both, the integrated variance and the jumps, in the return process. We calculate the realized bi-power variation based on adjacent

[2] Dominguez (2006) reports that during New York trading hours on May 31, 1995, BOJ and Fed coordinated their interventions: BOJ purchased $767.4 million against yen on one occasion and the U.S. Government purchased a total of $500 million against yen on three occasions. This had resulted in a 2% increase in the value of dollar against yen over the course of the day.

[3] Similar result was obtained by Beine, Benassy-Quere, and Lecourt (2002).

[4] Article 40 of The Bank of Japan Law states that "The Bank shall buy and sell foreign exchange as an agent of the government, in accordance with the provisions of Article 36, Paragraph 1, when its purpose is to stabilize the exchange rate of the national currency."

[5] Hillebrand and Schnabl (2009) find that intervention by BOJ has decreased the yen-dollar exchange rate volatility since 2000.

[6] Kearns and Rigobon (2005) show that failing to account for the endogeneity will likely bias the coefficient on contemporaneous intervention downwards.

[7] Andersen et al. (2001a, 2001b) provide an extensive examination of the statistical properties, modelling and forecasting of realized volatility of foreign exchange rates.

[8] Andersen, Bollerslev, and Diebold (2007) demonstrate important gains in accuracy at daily, weekly, and even monthly forecast horizons by explicitly differentiating the jump and continuous sample path components.