

Central bank intervention, threshold effects and asymmetric volatility: Evidence from the Japanese yen–US dollar foreign exchange market

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Abstract

Recent empirical evidence of nonlinearities in the time series behaviour of exchange rates suggests that a linear model of the exchange rate may yield invalid inference when used to assess the effectiveness of central bank intervention. Using a double threshold GARCH model of the Japanese yen–US dollar exchange rates, we find that interventions by the Bank of Japan and the Federal Reserve are more effective in changing the direction of the exchange rate movements and reducing its volatility level in a regime when the exchange rates are severely misaligned. There is also evidence in such a regime for a negative return innovation to elicit higher levels of volatility than a positive innovation of equal magnitude. The presence of asymmetric volatility in exchange rate returns may be a result of active central bank intervention.

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1. Introduction

The large body of economic literature on the effectiveness of central bank intervention in the foreign exchange market to date reveals mixed evidence that support its use to calm excessive volatility and/or change the level of the exchange rate in its intended direction (Sarno and Taylor, 2001). The results documented in several empirical studies show that interventions tend to increase exchange rate volatility in the short run (Beine et al., 2002; Baillie and Osterberg, 1997; Bonser-Neal and Tanner, 1996), or move the exchange rate in the wrong direction (Baillie and Osterberg, 1997). Such findings pose serious concerns to policy makers and inevitably raise the question on why do the central banks continue to intervene. Does this mean that official intervention policies are misguided? Or is the evidence showing the effectiveness of intervention being overlooked? Arguably, findings may vary substantially between

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studies because of the different exchange rate data, sample periods and exchange rate models used. There is therefore no concrete necessity for central banks to stop intervening.

Alternatively, it may be possible that the models used in the empirical studies do not correctly capture the exchange rate dynamics and with it, the impact that intervention has on the dynamics. It is this view that we consider in this paper. Of the different models considered throughout the literature, the majority of the time-series approaches use linear models of exchange rate determination, usually incorporating generalised autoregressive conditional heteroskedasticity (GARCH) specifications to account for excessive kurtosis commonly found in exchange rate data and to proxy for exchange rate volatility.¹ However, many studies have established the presence of nonlinearities in the behaviour of exchange rates that linear models fail to account for (Hsieh, 1989, 1993; Brooks, 2001; Basci and Caner, 2005). Nonlinearities in the nominal exchange rates could arise from transaction costs (Michael et al., 1997), changes in policy regimes (Lucas, 1976) or the diversity of opinion amongst market practitioners regarding the direction of change in the exchange rate as it deviates from its equilibrium level (Kilian and Taylor, 2003). Theoretical and empirical studies of nonlinear models of exchange rate determination have rapidly expanded in recent years, with substantial evidence in support of their performance in modelling exchange rate dynamics relative to linear specifications (Kräger and Kugler, 1993; Kilian and Taylor, 2003; Taylor and Peel, 2000). Despite this, there has been very little application of nonlinear models in the analysis of central bank intervention.

The purpose of this paper is to assess the effectiveness of foreign exchange intervention using an exchange rate model that accommodates regime dependence in both its conditional mean and variance. The self-exciting threshold autoregressive (SETAR) model of Tong and Lim (1980) is chosen for the conditional mean specification as it allows for a dynamic asymmetric process, whereby the returns to the JPY–USD exchange rate follow a different linear process whenever the exchange rate crosses a particular level of threshold. Similarly, the conditional variance specification is governed by a threshold so that the exchange rate return volatility dynamics would differ across regimes. Shocks to the exchange rate can cause it to transition between regimes as and when the threshold is crossed. In this regard, the regime varying model of the exchange rate discussed in this paper differs from the Markov-switching exchange rate models estimated by Taylor (2004) and Beine et al. (2003). Although the underlying exchange rate process is linear in each regime, the model is nonlinear in its overall specification. Therefore the use of a threshold model would account for the nonlinearities in exchange rate dynamics.

Incorporating the threshold model into the empirical investigation of intervention effectiveness is important as it is known that exchange rates are crucially dependent on expectations of future events, particularly government economic policies. Wu and Chen (2001) suggest that parameters of monetary models change with different economic policies, therefore the use of a regime-switching model may play a part in better determining the efficiency of intervention as it allows for economic policy to differ in times of strong depreciation and appreciation. Moreover, Kilian and Taylor (2003) have suggested that in periods when the exchange rate is severely misaligned, there will be a greater degree of consensus on the appropriate direction of exchange rate movements even if agents disagree about the equilibrium level. We extend the idea put forth by Kilian and Taylor (2003) by verifying the effectiveness of intervention during periods of strong depreciation or appreciation given the lesser degree of diversity in opinions regarding the direction of exchange rate movements. The double threshold GARCH model which accommodates varying dynamics of exchange rate returns in periods of strong appreciation, from mild appreciation or depreciation, is suitable for testing this hypothesis. More specifically, we examine the effectiveness of intervention in calming market volatility, as well as changing the direction of exchange rate movements.

Using a new empirical characterisation of the JPY–USD exchange rate, we show substantial evidence that interventions by the Bank of Japan (BOJ) and the Federal Reserve Bank (Fed) have significant effects on the daily returns to exchange rate, which contrasts the results based on linear models. For the period 1995–2003, we find that their interventions do exert some effects on the mean level of the JPY–USD exchange rates. However Fed's intervention, which is a proxy for coordinated intervention, appears to be the most effective overall. The effectiveness of intervention also seems to be associated with a regime when the exchange rate experiences massive appreciation. Both central banks' interventions are found to be more effective in reducing the volatility levels of the JPY–USD exchange rate returns in such a regime. These results appear to corroborate Taylor's (2004) findings that intervention will tend to be more effective the greater is the degree of exchange rate misalignment. There is further evidence that

¹ The use of option price implied volatility is one other measure of exchange rate volatility (Bonsler-Neal and Tanner, 1996).

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