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Friction model and foreign exchange market intervention

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Abstract

The friction model is consistent with the hypothesis that a central bank intervenes in a foreign exchange market only if the necessity grows beyond certain thresholds. For this feature, the model is adopted in some recent studies as an attractive central bank reaction function. However, with official data on Federal Reserve and Bundesbank intervention, this paper shows that the friction model's advantage relative to a linear model may be negligible in terms of RMSE and MAE of in-sample fitting and out-of-sample forecasts. The implication is that intervention decisions are at the monetary authorities' discretion rather than dictated by a rule.
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1. Introduction

Under a floating exchange rate system, an exchange rate is supposed to be determined by market forces. However, as the survey results in Neely (2001) indicate, many central banks occasionally intervene to counter excessive exchange rate fluctuations by buying or selling a currency against another. In order to investigate how a central bank determines the amount of intervention or to evaluate whether observed intervention is consistent with policy objectives, it is necessary to specify and estimate the central bank's reaction function. A big challenge in modeling a reaction function is the infrequency of such intervention. The amount of intervention is zero for the majority of the observations, particularly with daily data, while explanatory variables are nonzero.

One way to proceed is to model the probability rather than the quantity of intervention using a probit approach as in Baillie and Osterberg (1997), or a logit approach as in Frenkel and Stadtmann (2001) and Frenkel, Pierdzioch, and Stadtmann (2005). If the interest lies in the quantity of intervention rather than the probability, one may rely on a Tobit model as in Humpage (1999) and Almekinders and Eijffinger (1994). However, a Tobit model may take either buying or selling intervention as the dependent variable but not both. The friction model of Rosett (1959), on the other hand, allows us to consider both types of intervention simultaneously in a single reaction function. In addition, the friction model is consistent with the reasonable assumption that while a central bank tends to abstain from intervention most of the time, it does intervene when the necessity grows beyond certain thresholds.

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Almekinders and Eijffinger (1996) adopt the friction model for the first time to estimate the reaction functions of U.S. and German central banks. The model is also adopted more recently by Neely (2002, 2006). While these studies and the original model of Rosett assume that the dependent variable is insensitive to small values of explanatory variables, Kim and Sheen (2002) consider a case where the insensitivity is to extreme values of explanatory variables which are harder to counter with limited foreign reserves.

Given that the underlying assumption of the friction model is consistent with the observed infrequency of foreign exchange market intervention, it seems reasonable to expect the nonlinear model to perform better than a simple linear model as a central bank's reaction function. But then one might raise the question of how much the friction model is better and in what sense. This is not a trivial matter in that the advantage of the nonlinear model may be insignificant if the reaction function is subject to frequent policy shifts, or if strategic approaches are taken in choosing the appropriate timing, such as occasional leaning with the wind rather than against the wind, to maximize the effects with limited resources. There is also the possibility that quite often the intervention decisions are made at the monetary authorities' discretion rather than dictated by a rule. To my best knowledge, no attempt has been made in the previous literature to answer this question. In this paper, the friction model is compared with a linear model in terms of in-sample fitting and out-of-sample forecast of the amounts of intervention measured by RMSE (Root Mean Squared Error) and MAE (Mean Absolute Error), with daily data on actual intervention in the Deutsche mark–U.S. dollar market between February 1987 and January 1993.

The main finding is that the friction model tends to have lower MAE but higher RMSE than the linear model both within and out of sample. The lower MAE is from the fact that the residuals or forecast errors of the model are smaller for the majority of the observations. The higher RMSE, however, indicates that the large-size errors of the friction model, e.g. largest 10% of the absolute errors, tend to be bigger than those of the linear model, and also the advantage in terms of MAE is not significant enough to offset the impacts of these large-size errors when the average is taken with squared errors. As it turns out, these large-size errors occur due to intervention when the necessity is less than the estimated thresholds or lack of intervention when the necessity exceeds the thresholds, which is the opposite of what the friction model predicts. These violations are too frequent to be treated as outliers. On the whole, the friction model fits the data slightly differently from the linear model, but not necessarily better especially when the amount of intervention is not zero.

The rest of this paper is organized as follows. In Section 2, the two reaction functions are presented with details about the methods of estimation, forecasting and performance comparison. The data set is described in Section 3 and the empirical results are in Section 4. Section 5 offers some concluding remarks.

2. A linear model and a friction model

A linear model of a central bank reaction function can be written as

$$y_t = \beta_0 + x_t\beta_l + u_t, \tag{1}$$

where y_t is the amount of daily intervention, x_i is the vector of explanatory variables and u_t is the error term. The amount of intervention is positive when a central bank purchases the U.S. dollar (USD), the numeraire currency in this paper, and negative when it sells the currency.

A friction model can be written as

$$y_t^* = x_t\beta + \varepsilon_t, \qquad \varepsilon_t|x_t \sim N(0, \sigma^2), \tag{2a}$$

$$y_t = \begin{cases} y_t^* - \delta^+ & \text{if} \quad y_t^* > \delta^+ > 0, \\ 0 & \text{if} \quad -\delta^- \leq y_t^* \leq \delta^+, \\ y_t^* + \delta^- & \text{if} \quad y_t^* < -\delta^- < 0. \end{cases} \tag{2b}$$

The latent variable y_t^*, which is known to the central bank but unobservable to outsiders, measures the necessity of intervention or the amount of intervention when the central bank attempts to counter any market instability as in a fixed exchange rate system. However, as can be seen in Eq. (2b), the model assumes that actual intervention under a floating system takes place only if y_t^* is above the upper threshold (δ^+) or below the lower threshold ($-\delta^-$).

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