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A stopping time approach to assessing the effectiveness of foreign exchange intervention: An application to Japanese data

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ABSTRACT

I propose a new methodology to assess the effect of foreign exchange (FX) intervention, based on the probability of an FX rate reaching. The variable is the probability of an FX rate reaching a particular threshold before reaching another. Importantly, the probability depends on not only the level, but also the trend and volatility of a current FX rate. When an intervention changes the probability in a desired direction, the intervention is effective. The notable feature of the probability is that it considers both the level and volatility of an FX rate comprehensively, while previous studies have examined these effects of FX intervention separately. Empirical results based on regression and nearest-neighbor analyses applied to Japanese data indicate that publicity and size are significant in the effectiveness of intervention.

1. Introduction

I propose a new methodology to assess the effectiveness of foreign exchange (FX) intervention and apply the methodology to Japanese data. The novelty of this methodology is its introduction of a probability to assess the effect of intervention. This innovation is the probability of an FX rate reaching an upper threshold before reaching a lower threshold. Importantly, the probability depends on not only the level, but also volatility of a current FX rate. This probability enables me to examine the effect of intervention on an FX rate comprehensively, while effects on level and volatility have only been examined independently in previous studies regarding FX interventions. When these effects conflict (e.g., when an intervention causes a desired change in the level at the expense of higher volatility), the effectiveness of intervention is ambiguous.[1] Because high volatility implies uncertainty about an FX rate's future movement, the favorable movement of a current FX rate may be only temporary.

The proposed measure never excludes other approaches (e.g., the government loss function approach). Rather, it provides a new perspective from which to evaluate intervention policy when its conflictive effects on level and volatility of exchange rate cause disagreement regarding the effectiveness of intervention.

Takagi (2014) provides rich survey regarding Japanese FX intervention. He reviews about 30 studies. These studies focus on the impact of intervention on the U.S. dollar to Japanese yen (USDJPY) rate and its volatility for the period from May 1991 to March 2004. They use daily intervention data released by the Japanese Ministry of Finance. Many of the studies surveyed suggest that intervention changes the USDJPY rate in a desired direction when its scale is large and intervention is

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[1] The effectiveness of FX intervention is surveyed by Sarno and Taylor (2001) and Menkhoff (2010).

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infrequent. Moreover, its effect on the volatility of the USDJPY rate is ambiguous. When I focus on the former effect on level, I assess the effectiveness of intervention. However, the latter effect on volatility does not enable me to do so.

Importantly, Takagi examines the effects of intervention on the level and volatility of the USDJPY rate in *different* sections. Previous studies do not examine those effects comprehensively.

I introduce the probability of the USDJPY rate reaching an arbitrary upper threshold before a lower threshold is reached. Notably, this probability is a function of both the level and volatility of a current FX rate. I examine whether interventions change the probability in a desired direction. This examination enables me to assess the comprehensive effect of intervention on the level and volatility of an FX rate. I can, therefore, avoid ambiguous assessments of the effects of intervention. In order to highlight the utility of the new approach, I use the same set of data previous studies have used to yield a stronger, less ambiguous result by addressing level and variance simultaneously in a probabilistic framework.

Assuming a Brownian motion of the FX rate, I can calculate the probability of the USDJPY rate reaching the upper level (yen depreciation) before it reaches the lower level (yen appreciation). When the yen selling (buying) intervention increases (decreases) this probability, the intervention eases the appreciation (depreciation) pressure on the yen and is successful.

The studied probability has two notable features. First, the probability depends on not only the level, but also the volatility (plus trend) of a current FX rate. This allows me to comprehensively assess the effect of FX intervention on the level and volatility of the FX rate. Other studies regarding FX interventions perform separate regressions of an FX rate's change and volatility using variables related to FX intervention (e.g., Nagayasu, 2004; Fatum, 2015). The results of those regressions often conflict. They show that FX interventions cause a desired rate change and high volatility. This conflict does not enable one to assess whether the interventions are successful.

The studied probability is an increasing function of both the level and inverse volatility of a current FX rate. I construe an increase in probability as an easing of market pressure on the yen's appreciation against the U.S. dollar. When a yen selling intervention eases that pressure, the intervention is successful. Evaluating the probability avoids ambiguous conclusions, even when the effects of intervention on the level and volatility of an FX rate conflict.

Second, the probability enables me to process the nearest-neighbor (propensity score) matching analysis. This analysis compares a pair of neighbors that have similar probabilities. One of them is followed by the next day's FX intervention and the other is not. When the former is followed by a desired change in probability and the change is larger than that of the latter, I safely conclude that the intervention is successful.

Fatum and Hutchison (2010) employ the nearest-neighbor matching analysis by estimating the reaction function of Japanese FX interventions. The reaction function is unobservable, so they estimate it with several promising explanatory variables. They derive a probability from the unobservable reaction function, while my probability is derived from the Brownian motion of the FX rate.

I process the two analyses, time series and event study, which are distinguished by Neely (2005). The former uses all the time series data, in which sporadic and infrequent interventions are observed. The latter uses data only from periods of intervention.

In the time series analysis, I regress the probability against the amounts of FX intervention. My regression results indicate that the intervention can cause a desired change in probability.

The event study processes the nearest-neighbors matching analysis. To implement that analysis, I compare probability changes of the pairs. Each pair consists of two nearest-neighbors of equivalent probability; one is followed by the next day's intervention and the other is not. I expect the former neighbor to show a desired change in probability after intervention, and the change should be larger than that of the other neighbor. The result of the matching analysis supports the effectiveness of Japanese intervention in the sub-sample.

This paper is organized as follows. Section 2 reviews literature. Section 3 provides the empirical methodology. Section 4 explains the data set and provides empirical results. Section 4 summarizes the robustness checks. Section 5 concludes the paper.

2. Literature review

This section reviews recent literature regarding the effectiveness of Japanese intervention. Throughout this section, the word "intervention" refers to Japanese FX intervention, unless otherwise noted.

First, I review studies that identify intervention's effects on level and volatility. Hassan (2012) uses an exponential generalized autoregressive conditional heteroskedastic (EGARCH) model and finds that intervention successfully causes depreciation of the yen at the expense of higher volatility. This conflicting view is consistent with Nagayasu (2004). This result motivates me to propose a new measure to assess the effectiveness of intervention. The new measure is a function of both FX rate and its volatility. By examining the effect of intervention with this measure, I assess the effectiveness of intervention. I thus avoid the ambiguous conclusions that prior researchers have produced.

Second, I review literature that focuses on the size of intervention. Wan and Kao (2010) estimate a generalized autoregressive conditional heteroskedastic (GARCH) jump model and propose that "large in size" interventions reverse the trend of yen appreciation and reduce volatility. In turn, "small" interventions fail to alter the level of USDJPY rate in the desired direction and fail to reduce volatility. Fatum and Yamamoto (2014) produce a result consistent with that of Wan and Kao (2010). They use the threshold model to examine whether size of intervention is an important factor in the success of intervention.