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Are Successful Interventions Random Events?

by Owen F. Humpage

The characteristic day-to-day fluctuations in exchange rates virtually ensure that a high proportion of official foreign exchange interventions will appear successful—purely by chance and even in the absence of an actual connection. A count of intervention successes, however, often proves larger than pure randomness would suggest, raising unresolved questions about the nature of intervention.

From time to time, the United States enters the foreign exchange market in an attempt to influence the behavior of exchange rates. The objective may be to nudge an exchange rate more closely in line with some set of fundamentals or to dampen excessive volatility. Sometimes these interventions appear to be successful, and the dollar quickly reverses direction or moderates its movements. At other times, however, these interventions seem completely ineffectual.

Most economists would probably express little surprise at this lack of effect. Studies suggest that intervention influences exchange rates by changing traders' near-term expectations of underlying market fundamentals, not by affecting these fundamentals directly. To successfully alter expectations, then, the Federal Reserve must have better information than market participants possess —a case that generally seems quite unlikely.

In any event, however, the characteristic zigzag pattern of day-to-day exchange rates virtually ensures that a substantial proportion of interventions will *appear* successful, purely by chance—even if no causal link exists between official actions and exchange rates. Can we be sure, then, that successful interventions are not just random events?

In this *Economic Commentary,* I explore this question first by looking at the theoretical links between intervention and exchange-rate fundamentals and between intervention and market expectations. Next, I count the number of successful interventions over a period of frequent and heavy U.S. intervention and assess the likelihood that these outcomes could occur randomly. Although its mere presence in the foreign exchange market does not guarantee the intended response, the United States seems to have been fairly successful over this sample period in its efforts to smooth short-term exchange-rate movements.

Intervention and Exchange-Rate Fundamentals

The stated objective of U.S. intervention policy is to "counter disorderly market conditions," a goal that eludes a simple, precise, or even objective definition. The U.S. Treasury and the Federal Reserve identify disorderly markets subjectively, relying on a mutable set of macroeconomic and financial criteria. The Federal Reserve Bank of New York (FRBNY), which implements all U.S. interventions, typically intervenes only in German marks and Japanese yen.[1]

Most economists question the efficacy of exchange-market intervention because central banks typically undertake these operations in a way that does not appear to affect fundamental economic determinants of exchange rates. To be sure, economists have not enjoyed much success in specifying the manner in which key economic variables guide exchange-rate movements. Nevertheless, nearly all exchange-rate theories list cross-country differentials in money growth as the key

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underlying factor. Some also include changes in the stock of outstanding government securities. To have a lasting effect on exchange rates, intervention must alter either or both of these key determinants.

Suspicions about the effectiveness of U.S. intervention originate from the Federal Reserve's practice of routinely preventing interventions from interfering with monetary policy. When, for example, the Federal Reserve attempts to offset a dollar depreciation, it sells German marks to commercial banks and other foreign-exchange dealers, usually in the New York market.[2] The FRBNY receives payment in dollars by debiting the reserve accounts of the appropriate commercial banks. Other things being equal, this action shrinks bank reserves, the monetary base, and ultimately the U.S. money stock. Similarly, the injection of German marks into the exchange market increases Germany's money stock. As noted above, nominal exchange rates should respond to these monetary changes.

To avoid possible conflicts between exchange-rate and domestic price objectives, the Federal Reserve System routinely counterbalances its interventions through open market operations in U.S. Treasury obligations. In the example above, where the sale of marks drained bank reserves, the FRBNY would purchase an equal dollar amount of U.S. Treasury obligations from commercial banks and dealers, crediting reserve accounts in payment. The Bundesbank might undertake a similar offset to the expansion of the mark money stock by selling securities.

When central banks offset the monetary implications of their interventions, they eliminate the most obvious and direct influence on exchange rates, but in the process they alter the currency composition of publicly held government debt. In the previous example, the public ends up holding fewer U.S. Treasury securities and more German mark securities. As noted above, some exchange-rate theories hold that changes in the currency composition of publicly held government debt can affect exchange rates even if the relevant money stock remains unchanged. Unfortunately (and demonstrating a unanimity rare in economics), empirical studies find virtually no evidence that intervention alters exchange rates through this channel.[3]

Intervention and Market Perceptions

Even if intervention does not alter market fundamentals and thus has no lasting effect on exchange rates, it could still influence rates temporarily by affecting either the market's perception of current fundamentals or its expectations about future changes in fundamentals. Indeed, available research seems to suggest that intervention operates through such a mechanism.

Exchange rates specify the price of one nation's currency in terms of another, and—as with the prices of all financial assets—expectations of their future values strongly influence current exchange rates. Foreign exchange dealers, trading for profit on narrow margins, face strong incentives to acquire all possible information about current and anticipated economic developments that could influence exchange rates. If these dealers are successful, current quotations incorporate all available information, and only new information that causes revisions in traders' expectations will affect exchange rates. To the extent that traders formulate their expectations without systematic errors, revisions will be random and will impart a zigzag pattern to exchange-rate movements. Statistical studies of exchange rates typically describe them as having an equal probability of appreciating or depreciating on a given day.

Although economists generally regard foreign exchange markets as highly efficient processors of information, markets are probably not always *perfectly* efficient. Information is costly, and some time must elapse—minutes, hours, or days—between the receipt of new information and its full incorporation into exchange rates. Traders' expectations may at times be dissimilar or highly uncertain. Consequently, monetary authorities might sometimes possess better information than other market players. A central bank, for example, could have more knowledge about an impending change in monetary policy. Nevertheless, it remains open to debate whether a central bank routinely has better information than the market—even about monetary policies—and can exploit its advantage in pursuit of exchange-rate objectives.

Assessing the Probability of Success

One way to assess the efficacy of intervention is to define success in terms of objective, verifiable criteria and then to count the number of successes in a reasonable sample of interventions. A high frequency would imply that monetary authorities could routinely influence market expectations and that observed successes were not merely random events attributable to the normal fluctuations in daily exchange rates. If, for example, exchange rates have an equal probability of rising or falling, one should not be surprised to find that half of the interventions are successful, since even random, unrelated interventions could produce such a score.

In the following analysis, I define success in terms of the ability of intervention to smooth exchange-rate movements.[4] Accordingly, U.S. interventions succeed:

1) if sales and purchases of foreign exchange are associated with dollar appreciations and depreciations, respectively, on the same day as the intervention, or

2) if they are associated with smaller dollar depreciations and appreciations when comparing the exchange-rate fluctuation on the day of intervention with its change over the preceding day.

While it certainly does not encompass all possible definitions of calming market disorder, smoothing is consistent with stabilizing the rate at a given level, and with reducing near-term volatility.

Using this definition, I counted the number of successful interventions between February 1987 and February 1990—a period of heavy, concerted interventions by the Group of Seven (G7) designed to

TABLE 1 U.S. INTERVENTION SUCCESSES, FEBRUARY 20, 1987 TO FEBRUARY 20, 1990

	Number of interventions	Number of successes	Probability of observing more successes[a]	Probability of observing more successes[b]
German marks				
Sales	36	27	7 percent	4 percent
Purchases	108	65	85 percent	65 percent
Japanese yen				
Sales	64	50	1 percent	<1 percent
Purchases	71	51	4 percent	4 percent

a. Based on a binomial probability distribution with the probability of an individual success determined by counting the number of times smoothing occurred in the sample period after excluding intervention days.
b. Based on a binomial probability distribution with the probability of an individual success determined by the mean number of times smoothing occurred in 1,000 replications of an artificial random-walk exchange rate. Each replication included 616 observations on the German mark and 625 observations on the Japanese yen.
SOURCE: Owen F. Humpage, "U.S. Intervention: Assessing the Probability of Success" (footnote 4).

stabilize dollar exchange rates.[5] Table 1 distinguishes U.S. sales and purchases of both German marks and Japanese yen. Of the 144 U.S. interventions against the mark over this three-year period, 92 successfully smoothed day-to-day exchange-rate movements. Of the 135 U.S. interventions against the yen, 101 were successful.

Although the number of successes may seem large, as noted above, one must account for the characteristic zigzag behavior of day-to-day exchange rates before reaching any conclusions. To do this, I excluded the days on which U.S. monetary authorities intervened, and I found that on approximately 65 percent of the remaining days, exchange rates still exhibited a smoothing pattern. This suggests that an individual intervention—even if totally ineffectual—would stand about a 65 percent chance of being associated with exchange-rate smoothing.

With this estimate of the probability of randomly observing an individual success, one can calculate that the probability of randomly finding, for example, at least 51 successes in 71 purchases of Japanese yen is only 4 percent (column 3).[6] A value of less than 5 percent is too small to attribute to chance.

As a further check, I constructed artificial exchange rates to mimic the behavior of both the mark and yen, while guaranteeing that each exchange-rate change is fully independent of any previous movement.[7] In this case, the probability of an individual success is approximately 62 percent, and column 4 indicates the probability of finding the observed number of successes, or more, over the sample period.

Both calculations tell a similar story: U.S. interventions against the yen seemed highly successful in smoothing near-term changes in the yen–dollar exchange rate over the February 1987 to February 1990 sample. One can be 95 percent certain that the observed outcome did not result from the zigzag pattern of daily exchange rates.

The results for U.S. interventions against the mark, however, were mixed. The probability of observing at least 27 successes in 36 sales of German marks is approximately 4 to 7 percent, but the probability of observing at least 65 successes in 108 purchases is 65 to 85 percent. Chance fluctuations in daily exchange rates seem to account for the number of successful mark purchases.

Explaining the differences between U.S. interventions against marks and yen is more difficult than uncovering them. The United States bought marks more frequently than yen. Perhaps the frequency of intervention reduces its information content and its effectiveness. The average amount of a German mark purchase—$156 million equivalent—was larger than a typical sale of foreign exchange, but was not substantially different from the average purchase of yen. Overall, the market seemed to focus more on developments affecting the yen–dollar exchange rate, and Japan seemed somewhat more willing than Germany to adjust domestic monetary policy for exchange-rate purposes. These interpretations, however, are fairly speculative.

Conclusion

The calculations presented here suggest two tentative conclusions about the success of U.S. foreign exchange intervention. As the results for U.S. purchases of German marks confirm, the mere fact that the United States enters the foreign exchange market does not guarantee that the desired exchange-rate response will follow. Nevertheless, the results generally indicate that the United States was fairly successful at smoothing near-term exchange-rate movements over the sample period.

In most cases, the market immediately seemed to interpret official U.S. interventions as having information important to the pricing of foreign exchange. The exact nature of this information and the duration of its influence remain mysteries for further research. In any event, if intervention fails to alter fundamental determinants of exchange rates, as most studies suggest, then the United States cannot pursue an exchange-rate objective independent of its monetary policy.

Footnotes

1. Under the Gold Reserve Act of 1934, the U.S. Treasury Secretary maintains primary responsibility for U.S. intervention through the Exchange Stabilization Fund. The Federal Reserve also maintains separate and independent accounts for intervention. The FRBNY implements interventions for both accounts. A typical U.S. intervention amounts to $100 million to $200 million and is split equally between the two accounts. This amount is small relative to the average daily volume of all foreign exchange transactions —approximately equivalent to $1 trillion. See Owen F. Humpage, "Institutional Aspects of U.S. Intervention," Federal Reserve Bank of Cleveland, *Economic Review,* vol. 30, no. 1 (1994 Quarter 1), pp. 2–19.

2. This example follows a U.S. *sale* of German marks. The effects of a U.S. *purchase* of marks would operate similarly, but in reverse.

3. For a survey of the empirical evidence, see Hali J. Edison, "The Effectiveness of Central-Bank Intervention: A Survey of the Literature after 1982," Princeton University, Special Papers in International Economics, No. 18, July 1983.

4. Details on the methodology and empirical findings discussed in this paper appear in Owen F. Humpage, "U.S. Intervention: Assessing the Probability of Success," Federal Reserve Bank of Cleveland, Working Paper, 1996 (forthcoming).

5. The Group of Seven industrialized nations consists of Canada, France, Germany, Great Britain, Italy, Japan, and the United States.

6. The probability of observing a specific number of successes in a set number of independent trials has a binomial distribution.

7. The binomial distribution assumes that each trial is independent. Exchange-rate changes have a mean value of zero and exhibit no serial dependence. Some dependence, however, exists in the variance. See Richard Baillie and Patric McMahon, *The Foreign Exchange Market: Theory and Econometric Evidence,* New York: Cambridge University Press, 1989.

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