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U.S. Intervention in the Exchange Market for DM, 1977-80

Paul Wonnacott

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
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The author of this Study, Paul Wonnacott, is Professor of Economics at the University of Maryland, College Park. His other works include *The Canadian Dollar* (2nd ed., 1965) and *Free Trade between the United States and Canada: The Potential Economic Effects* (with R. J. Wonnacott, 1967). He has served on the staffs of the Council of Economic Advisers, the Board of Governors of the Federal Reserve System, and the U.S. Treasury. This Study was written while he was a visiting scholar in the Office of International Monetary Research, U.S. Treasury, between January 1980 and August 1980. The opinions are solely those of the author and do not necessarily reflect the views of the Treasury.

PETER B. KENEN, *Director*
International Finance Section

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1 INTRODUCTION

Exchange-market intervention by national treasuries and central banks is a controversial topic, centering on two related issues: (1) Are authorities capable of intervening in exchange markets in such a way as to stabilize them? (2) If the authorities are indeed capable of stabilizing the exchange rate, should they attempt to do so? The primary purpose of this study is to investigate the first of these questions by examining U.S. official intervention in the market for the Deutsche Mark (DM). This investigation leads to tentative suggestions for future intervention strategy.

We look at daily data for the period starting on October 1, 1977, and ending two and a half years later, on March 31, 1980. The last quarter of 1977 was chosen as the beginning point because sizable intervention recommenced then, after several years of very limited intervention. The end point was dictated by the availability of data during my period on the Treasury staff. During this period, U.S. intervention averaged $42.5 million per business day. Of the 618 business days, intervention occurred on something less than half (284 days), and average intervention on those days was $92.6 million. This study is based solely on U.S. data and takes no account of German intervention.

In addition to the main question, whether intervention was stabilizing, several related issues are studied:

a. Did U.S. intervention in the market for the DM during this period conform to the general pattern that has been observed for official intervention by many countries—resisting movements in exchange rates, or leaning against the wind?

b. Is there evidence that the authorities outpredicted the market when they intervened?

c. Is there evidence of inefficiency in the market for the DM during this period?

This study is divided into seven chapters. Chapter 2 considers not only question (a), whether the U.S. authorities followed the strategy of leaning against the wind, but also the relationship between leaning against the wind and exchange-rate stabilization. This discussion raises a fundamental question about the meaning of stabilization. That question is addressed in Chapter 3. Chapter

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4 constitutes the core of the study. It considers whether the U.S. authorities behaved in a stabilizing manner. Chapter 5 addresses questions (b) and (c), concerning evidence of official outprediction of the market and of market inefficiency. Chapter 6 puts forward a tentative suggestion for an intervention strategy, and Chapter 7 presents tentative conclusions.

2 U.S. INTERVENTION IN THE MARKET FOR DM: LEANING AGAINST THE WIND?

Three related objectives have been ascribed to official intervention: to combat disorderly conditions in exchange markets, to smooth exchange-rate movements, and, on occasion, to correct an exchange rate that is considered inappropriate.

It is hard to get a handle on the concept of a "disorderly market," since whether or not a market is disorderly seems to depend on a subjective evaluation by market participants. It is sometimes said that a disorderly market cannot be defined but that traders know one when they see one. When pressed, those who hold this view suggest that a disorderly market is characterized by a rapid change in the rate. Volume may be high, as market participants jump on a bandwagon; or it may be very low, as they withdraw from the market because of uncertainties. Another characteristic may be a large spread between buy and sell quotations.

The main purpose of most of the nascent empirical literature on official exchange-market intervention has been to get good equations to explain the intervention behavior of the various national authorities—that is, to get good statistical fits. Examples of this literature can be found in the work by Artus (1976) on Germany, Black (1980) on the G-10 countries, Longworth (1980) on Canada, and Quirk (1977) on Japan, and in the papers by Clark (1979), Hernandez-Cata (1979), and Howe (1978), which contribute to the Federal Reserve Board's multi-country model. In some cases, an explanation of intervention behavior has been sought in order to complete larger models (notably, the Fed's multi-country model). Although the purposes of this literature are quite different from our objective of evaluating intervention, it is nevertheless a good place to begin.

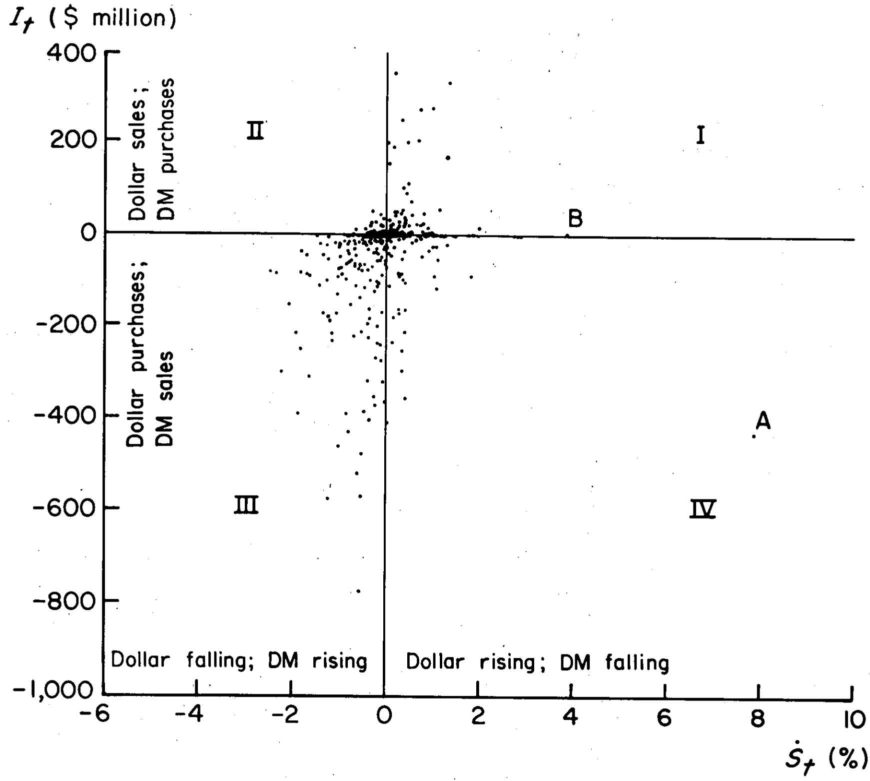
A number of explanatory variables appear in the literature. For example, Black (1980) found the stock of reserves to be a significant explanatory variable for intervention by Canada, Japan, and the United States. This suggests that the authorities were trying to maintain a target level of reserves. Quirk (1977) found that the desire to maintain a target exchange rate helped to explain Japanese intervention. But one variable is predominant in the empirical literature: the change in the exchange rate itself. Authorities lean against the wind, tending to buy their currencies when they are falling and to sell them when they are rising. For example, Quirk (1977) found leaning against the wind to be the most powerful explanation of Japanese intervention, Longworth (1980) found the same for Canada, and Black (1980) found the change in the weighted price of foreign exchange to be a significant explanatory variable for intervention by 7 of the 10 countries he studied.

Let us turn now to our examination of U.S. intervention. The scatter diagram in Figure 1 provides general confirmation of the hypothesis that U.S. authorities leaned against the wind during the 1977–80 period under study. Intervention during day t, I_t, is measured by sales of U.S. dollars in exchange for DM. The change in the spot exchange rate on day t, $\dot{S}_t$, measures the percentage change in the price of the dollar in terms of the DM. (The day's change is measured as the difference between the closing quotation and the previous day's closing in New York.) The general tendency of the authorities to lean against the wind shows up in the preponderance of observations lying in the first and third quadrants (excluding the 300-plus days when $I_t = 0$).

Before beginning our statistical analysis of leaning against the wind, we observe that there are two outliers in Figure 1. Point A, lying far into the southeast quadrant and thus representing large sales of the DM when the mark was

FIGURE 1

INTERVENTION AND DAILY EXCHANGE-RATE CHANGES, OCTOBER 1977–MARCH 1980



falling, is the plot for November 1, 1978. At that time, the U.S. government took the position that the dollar was oversold on the market and should be strengthened by intervention. Because this observation is associated with peculiar circumstances and is so far removed from the usual pattern, it is excluded from the initial statistical tests in Table 1. (It will be included in the later statistical work, when we get to our main topic of whether U.S. intervention tended to stabilize the exchange rate between the dollar and the DM.)

The elimination of a specific outlier can, of course, substantially affect statistical results, as we shall see shortly (see footnote 2). It might be justified, however, along the following lines. As noted at the beginning of this chapter, the authorities can have more than one objective when they intervene. Leaning against the wind ties in most closely with the general objective of smoothing exchange-rate movements. On occasion, however, and most conspicuously at the beginning of November 1978, the authorities have declared their intention to pursue another objective, namely, the correction of an exchange rate that they consider to be inappropriate. By eliminating such a special case, we can get a better idea of their general approach to smoothing the exchange rate. In a longer-term context, intervention on November 1, 1978, may be considered a reaction to the declines in the value of the dollar that had taken place in preceding months (see Fig. 2) and thus to the "wind" that had been blowing strongly for some time.

Point *B* in Figure 1 is also excluded as a special case. It refers to January 4, 1978, when it was announced that a Treasury-Bundesbank swap had been arranged and that there would be joint intervention by the U.S. and foreign authorities to counter exchange-market speculation. Although there were no official U.S. transactions on that day, the authorities were in a sense "intervening" by announcing their intention to engage in market transactions. Once again, this observation is consistent with the desire of the authorities to provide strength to the dollar after a period of significant decline.

Table 1 presents regression results after the elimination of these two special cases. The first section includes data for all days except the two outliers; the second section includes only the days when intervention actually took place. Equation T-1 in Table 1 reports the results for the following simple equation:

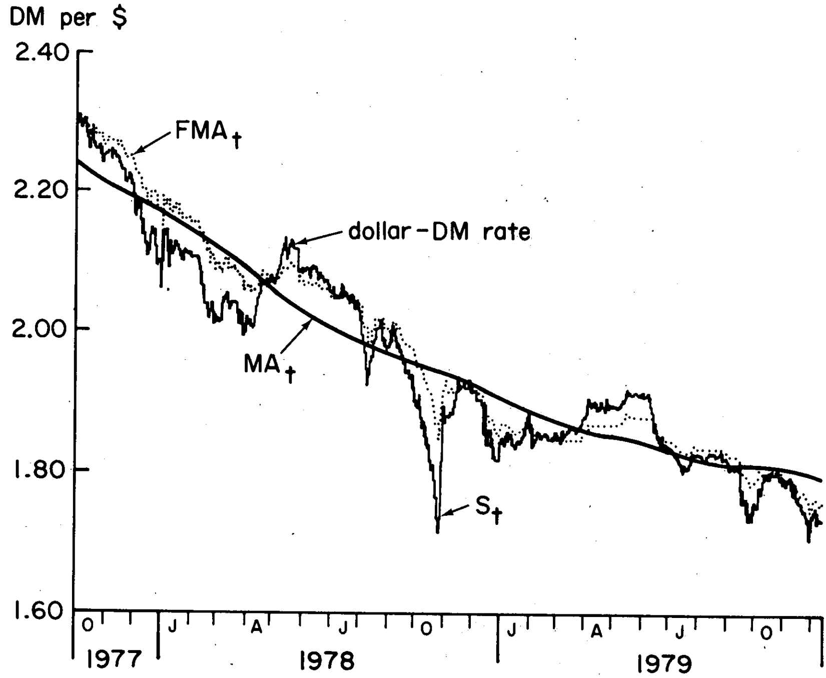
$$I_t = a + b\dot{S}_t , \tag{1}$$

where I_t is intervention on day t, measured as sales of millions of dollars in exchange for DM, and $\dot{S}_t$ is the change in the spot exchange rate on day t, measured as the percentage change in the price of the dollar in terms of the DM.

In equations (T-2) through (T-5) in this table, selected lagged variables are added to equation (1): $\dot{S}_{t-1}$ is the change in the exchange rate in the day prior to t, while $\dot{S}_{t-30}$ and $\dot{S}_{t-90}$ are the changes in the exchange rate over the 30- and

FIGURE 2

THE DOLLAR IN TERMS OF THE DM, OCTOBER 1977–DECEMBER 1979



90-day periods prior to day t. All equations except (T-5) are reported after Cochrane-Orcutt correction.[1]

Several results stand out. First, there was an unmistakable tendency for the U.S. authorities to lean against the wind. In each regression, the coefficient of $\dot{S}_t$ is positive and significant at the 95 per cent confidence level. Second, intervention clearly did not follow any *simple* leaning-against-the-wind rule. Using only the single independent variable $\dot{S}_t$, we find a low $\overline{R}^2$ of only 0.13.[2] This

[1] Ordinary-least-squares results are reported in Wonnacott (1982). The Durbin-Watson statistics for equations (T-1) through (T-4) were between 1.06 and 1.11, indicating strong positive serial correlation.

[2] If the two special cases (January 4, 1978, and November 1, 1978) are reintroduced, the $\overline{R}^2$ in equations (T-1a) and (T-1b) in Table 1 falls to 0.03, reinforcing the conclusion that this simple leaning-against-the-wind equation does not go very far in explaining intervention behavior. Incidentally, exchange-market studies are not marked by high $\overline{R}^2$s, even the studies cited earlier whose primary purpose was to explain intervention. Using between 7 and 9 explanatory variables in his equations, Black (1980) found $\overline{R}^2$s ranging from 0.23 for the United States to 0.81 for France. Quirk (1977) found $\overline{R}^2$s ranging from 0.27 to 0.61 in his 9 explanatory equations of Japanese

TABLE 1

INTERVENTION AND EXCHANGE-RATE CHANGES

(dependent variable is I_t)

Equation No.	$\dot{S}_t$	$\dot{S}_{t-1}$	$\dot{S}_{t-30}$	$\dot{S}_{t-90}$	I_{t-1}	Intercept	$\bar{R}^2$
	Independent Variable						
	All Days Except Two Outliers; N = 616						
(T-1a)	48.3° (9.84)					−26.0° (−4.04)	0.13
(T-2a)	56.6° (10.07)	16.6° (2.95)				−24.9° (−3.97)	0.15
(T-3a)	50.0° (10.05)		4.6° (2.26)			−22.8° (−3.61)	0.14
(T-4a)	50.2° (10.16)			5.9° (4.27)		−10.3 (−1.47)	0.16
(T-5a)	59.7° (10.57)				0.47° (14.05)	−12.4° (−3.63)	0.33
	Only Days When Intervention Occurred; N = 283						
(T-1b)	55.1° (6.60)					−50.9° (−3.57)	0.13
(T-2b)	58.4° (6.57)	10.8 (1.07)				−49.4° (−3.50)	0.13
(T-3b)	55.8° (6.63)		3.8 (0.68)			−46.9 (−3.27)	0.13
(T-4b)	54.9° (6.52)			7.7° (3.06)		−28.9 (−1.97)	0.16
(T-5b)	65.5° (7.01)				0.58° (10.85)	−23.6° (−3.32)	0.39

NOTES:
t-values shown in parentheses.
Regression results shown after Cochrane-Orcutt correction, except for equation (T-5).

°Statistically significant at 95 per cent confidence level.

result can readily be confirmed by a glance at Figure 1. The points are greatly dispersed around any single line that might be drawn. Third, lagged variables show up significantly. Thus, intervention responds not only to the change in the exchange rate during the day but also to the previous day's change, as reported

intervention. Low $\bar{R}^2$s are not surprising in this field. Those engaged in official intervention stress the tone of the market, psychological considerations, and other intangibles not easily fitted into a statistical equation. My own primary purpose (particularly in Chap. 4) is to evaluate whether the authorities stabilized the rate, not to explain their behavior. Thus, my primary pursuit has not been high $\bar{R}^2$s, and I warn the reader in advance that my $\bar{R}^2$s are low.

in equation (T-2), and to changes over the 30-day and 90-day periods prior to t, as reported in equations (T-3) and (T-4). Of the lagged variables, I_{t-1} is most noteworthy; it carries a coefficient of approximately 0.5. On average, half the intervention of any day is repeated on the next. United States authorities intervene when they have been intervening; intervention tends to go in strings.[3]

I argue in the next chapter that the lagged variables introduced into the leaning-against-the-wind rule, particularly in equations (T-3) and (T-4), have significance for whether official intervention is likely to stabilize the rate. But before I look at the implications of leaning against the wind for the stability of the exchange rate, I must pause to consider just what is meant by "stabilization" of an exchange rate.

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[3] Quirk (1977, p. 649) found similar results for Japan. A simple regression of I_t on $\dot{S}_t$ with monthly data gave an $\bar{R}^2$ of only 0.27. When I_{t-1} and the volume of exchange-market transactions were added to the equation, $\bar{R}^2$ rose to 0.60. The high value for the coefficient of I_t in my results is consistent with the strong serial correlation for the ordinary-least-squares estimates reported in Wonnacott (1982).

3 WHAT IS "STABILIZING" INTERVENTION?

The evaluation of exchange-market intervention is complicated by the difficulty of defining what is meant by stabilization. There are at least five possible definitions. Intervention might be deemed to be stabilizing if it:

1. Reduces the variance of the exchange rate around its equilibrium.
2. Reduces the variance of the exchange rate around its welfare-theoretic optimum.
3. Reduces the variance of the exchange rate around its trend.
4. Reduces the amplitude of exchange-rate swings, that is, the difference between the "highs" and "lows."
5. Slows the rate of change of the exchange rate.

There are some similarities among these definitions. For example, if the amplitude of swings is reduced (4), the variance around the trend should be reduced (3). But there are also some clear differences. For example, the variance can be reduced (3) without reducing the amplitude (4) if the peaks and valleys are made sharper without being made higher or lower.

Furthermore, intervention that is stabilizing according to definition (5) may be destabilizing according to other definitions. For example, if the authorities slow an exchange rate that is moving toward its equilibrium or optimum or trend, intervention would be stabilizing according to definition (5) but destabilizing according to definitions (1), (2), or (3) . This point was made by Friedman (1953, p. 176) in his early essay on flexible exchange rates. In commenting on the speculation of the 1930s, which had generally been considered destabilizing because it threatened to change exchange rates, he observed:

> In retrospect, it is clear that speculators were "right"; that forces were at work making for depreciation in the value of most European currencies relative to the dollar independently of speculative activity; that the speculative movements were anticipating this change; and hence, there is at least as much reason to call them "stabilizing" as to call them "destabilizing."

Because of this conflict, we should discard either definition (1) or (5). My choice is to discard (5), in part because it is defective when there is a trend in the rate. Intervention that slows the rate can keep it away from trend and thus create the need for a very sharp correction later. This scarcely seems to be what is meant by "stabilization." Furthermore, definition (5) may not be sufficiently demanding. Since the authorities in the United States and elsewhere generally lean against the wind when they intervene, there is a presumption that they slow down exchange-rate movements, at least in the short run. Under definition (5), we would be led by a relatively short series of steps to the conclusion that intervention is stabilizing. By rejecting definition (5), we avoid the conclusion that leaning against the wind is stabilizing simply because it slows down exchange-rate movements.

Of the other four definitions, the second is the tightest, and it has the advantage of collapsing the two questions in the first paragraph of this study into one: if the authorities can stabilize the rate, in the sense of moving it toward the optimum, then they should presumably do so. However, this definition has a major shortcoming, which is shared by definition (1). In both cases, a judgment on whether intervention is stabilizing requires a complete model of the economy. We do not know the equilibrium rate or the welfare-theoretic optimum without a complete model.

Thus, any logically tight evaluation of intervention requires a complete economic model. I do not intend to use such a model, however, for several interrelated reasons. First, any economist should entertain doubts about whether he has the "right" model.[1] Second, formal exchange-rate models are extremely simple, in that they do not include many of the variables, both economic and political, that are inputs into actual decision making. Third, it is not clear that any model we might use should be given precedence over the model explicit or implicit in the minds of the authorities. Put another way, the authorities might reasonably claim that it is illegitimate to judge their policies on the basis of a simple model. The real-world events that they take into account in designing their strategy are in fact complex.

Having given up a logically tight approach, I will focus on a rough-and-ready definition of stabilization:

> **Assumption 1:** *Intervention will be judged to be stabilizing if it moves the exchange rate toward its 12-month centered moving average.*

While this assumption is reasonable, it is nevertheless arbitrary. A 12-month moving average is not clearly better than a 6-month or 24-month average; it is simply the most obvious. Furthermore, one might object to the series implicitly defined as perfectly stable under this assumption, that is, a series that tracks its own moving average perfectly. Only with such a series is there no further possibility of stabilization. In other words, a smooth series with a constant change every day is implicitly defined as perfectly stable. Once more, this is reasonable, but it is not the *only* reasonable concept of stability. For example, we might extend Friedman's argument and conclude that the most stable path between

[1] Meese and Rogoff (1981) have reviewed the difficulties of explaining actual exchange-rate movements with existing exchange-rate models, even when *ex post* values of explanatory variables are used. None of the three major models that they considered outperformed a random walk outside the sample period.

A and B is one where the exchange rate adjusts quickly to its final value at B, that is, one where the exchange rate moves more quickly at first than it moves later.

The Effects of Intervention on the Exchange Rate

If I were using a complete model of exchange-rate determination, I would be able to identify not only the equilibrium exchange rate but also the effects of intervention. In avoiding the use of such a model, I not only give up a tight definition of stabilization but I also have to address the question of how intervention affects the exchange rate.

The simplest theory is based on the assumption that the assets of different nations are perfect substitutes for one another, with one exception. The various national moneys are not perfect substitutes. In this case, the effects of an official purchase of a foreign currency on the exchange market depend entirely on its effects on national money stocks.

On the one hand, the potential monetary effects of exchange-market intervention may be completely sterilized by open-market policy, leaving monetary fundamentals unchanged. The money stock, interest rates, prices, and competitiveness are unaffected, so that the long-run equilibrium exchange rate is likewise unaffected. Even in the short run, the exchange rate is not affected. When assets are perfect substitutes, any incipient change in exchange rates causes private capital flows sufficiently large to prevent the exchange rate from moving away from its long-run equilibrium. The net effects of sterilized intervention consist of compensating changes in official and private asset portfolios: in official portfolios, there is an increase in foreign assets and an equal decrease in domestic assets; in private portfolios, exactly the opposite changes occur.[2]

On the other hand, the purchase of foreign currency need not be sterilized. The money stock increases, the long-run equilibrium price level rises, and the long-run equilibrium exchange value of the home currency declines. As a consequence, asset holders are not willing to buy domestic-currency assets sufficient to bring the present price of the currency back to its initial value. To do so would result in losses as the currency depreciated. Furthermore, if the monetary expansion is associated with a fall in interest rates in the short run, the price of

[2] Much more detail on the determinants of exchange rates can be found in such works as Bilson (1979), Dornbusch and Krugman (1976), and Genberg (1981) and in the literature surveyed by Gray and Shafer (1981). Genberg (p. 454) mentions an exception to the argument that completely sterilized intervention will have no effect on the spot exchange rate if assets are perfect substitutes. Such intervention can still affect exchange rates if the market takes it as a signal of future monetary changes, that is, if the intervention affects expected future fundamentals and exchange rates in spite of complete current sterilization. This point is also made by Mussa (1980, p. 4).

the home currency will be even lower than the long-run equilibrium price because of the forward-parity condition:

$$\frac{S_a}{F_a} = \frac{1 + r_a}{1 + r_b}, \tag{2}$$

where S_a and F_a are the spot and forward prices, respectively, of currency A in terms of currency B; and r_a and r_b are the interest returns on short-term securities in countries A and B, respectively, over the term of the forward contract.

In brief, the spot price of the home currency falls not only because fundamental price forces are affecting expectations and therefore the forward rate, F_a, but also because a lower domestic interest rate reduces the ratio on the right-hand side of equation (2).[3]

If national assets are imperfect substitutes, exchange-market intervention affects exchange rates even in the event of complete sterilization. The intervention has a direct effect on demand and supply conditions in the exchange markets. Private capital flows will not completely offset the intervention: an increase in the attractiveness of domestic assets (a depression of the spot price of the domestic currency relative to the expected future price) is required to induce portfolio adjustments.[4]

I proceed on the basis of

> **Assumption 2:** *The purchase of a currency in the exchange market by the authorities will act to raise the value of that currency in the short run, specifically on the day when the intervention takes place.*

This assumption does not hold in the first case, where nonmoney assets are perfect substitutes and intervention is completely sterilized. It is valid, however, if we make either or both of two assumptions: (a) national assets are imperfect substitutes in private portfolios; (b) intervention is not completely sterilized.

The longer-term effects of intervention depend in large part on whether it is sterilized. In this study I ignore the longer-term effects, even though they may be important in their own right and can also have significant implications for the strength of short-run exchange-rate responses. The principal reason for avoiding this important complication is the intractable problem of identifying

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[3] See Dornbush (1976) for a more extensive discussion in which domestic monetary policy rather than exchange-market intervention is the factor initiating changes. On the short-run and ultimate effects of exchange-market intervention, see Henderson (1979). He comes to the "robust" conclusion (p. 48) that when the foreign currency is purchased, "the home currency depreciates and home nominal income rises."

[4] Again, this is a simplified summary of a complex theoretical question. For more detail on the case where domestic and foreign assets are imperfect substitutes, see Dooley and Isard (1979) and Kenen (1981).