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Exchange-Market Intervention: The Channels of Influence

by Owen F. Humpage

Owen F. Humpage is an economist at the Federal Reserve Bank of Cleveland.

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Introduction

The major developed countries abandoned the Bretton Woods system of fixed exchange rates in March 1973 in favor of a system of more generalized floating rates. Over the 13 years since the adoption of floating exchange rates, however, governments generally have refused to allow the private market fiee rein in determining the foreign-exchange values of their currencies. They fiequently have intervened in the foreign-exchange market to influence outcomes. The frequency and intensity of intervention has varied greatly over the years and among the countries. Most noticeable has been a sharp reduction in the intervention activity of the United States since early 1981. This reduction reflected a growing realization that exchange-market intervention, conducted independently of monetary policy, had only a limited effect on exchange rates.

Economic theory suggests three possible channels through which exchange-market intervention could alter exchange rates: the monetary channel, the portfolio-balance channel, and the expectations channel. The monetary channel allows intervention to influence exchange rates by altering the relative growth rates of nations' money stocks. There is little disagreement about the potency of such intervention; in fact, central banks can maintain fixed exchange rates through relative changes in their money stocks.

Central banks, however, have sought a means to influence exchange rates independent of their monetary policy. Portfolio-balance models of exchange-rate determination offer such a channel. According to this approach, intervention that alters the relative stock of domestic and foreign currency denominated government debt could influence exchange rates in a manner consistent with the objectives of the intervening monetary authority. The portfolio model seemed to offer support for fiequent intervention as conducted during the 1970s by the United States. Although not conclusive, subsequent empirical work has cast doubt on the ability of central banks to influence exchange rates through the portfolio-balance channel. This research, however, has left open the possibility that intervention can influence exchange rates by providing new information to the exchange market. In a highly efficient market, however, the instances when the monetary authority has better information than the market are few. The belief that intervention operates largely through the expectations channel forms the basis for the limited use of intervention by the United States in the 1980s.

Recent attempts to encourage an orderly depreciation of the dollar from its record levels in exchange markets have renewed interest in the feasibility of frequent exchange-market intervention. Consequently, this article surveys the literature on intervention for readers who are not necessarily specialists in international finance. After providing a definition of intervention and a discussion of why countries intervene, we focus on the theoretical channels through which intervention might alter exchange rates. Box 1 provides a bibliographic guide to many of the empirical studies on intervention.

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I. A Definition

Exchange-market intervention refers to official purchases and sales of foreign exchange, which nations undertake to influence the exchange value of their currencies. This definition describes intervention in terms of two criteria: the types of transactions and the motives guiding those transactions.

The distinction among various types of transactions is important because countries have many policy levers with which to affect the exchange value of their currencies. They can alter monetary and fiscal policies, institute broad or selective capital controls, or resort to various trade barriers. Almost any government policy can have exchange-rate repercussions in a floating exchange-rate regime with a high degree of integration among nations' capital and goods markets. The purchase and sale of foreign exchange, however, is the most direct and most flexible lever through which to affect exchange rates. It is, therefore, the most frequently used intervention device.

Usually a nation's central bank or exchange-stabilization fund conducts its interven-

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Some **Empirical** Studies of Intervention

Argy (1982) investigates the profitability of intervention by Japan, West Germany, and the United Kingdom, emphasizing the need to adjust for the accumulation or diminution of foreign-exchange inventories. He finds mixed results, depending on the time period chosen and on the specific country.

Bagshaw and Humpage (1986) find that the decision to cease systematic intervention from April 1981 to March 1982 generally had no effect on the volatility of exchange rates, as measured by the parameters of a stable Paretian distribution.

Danker, Haas, Henderson, et al.(1983) investigate intervention by Germany, Japan, and Canada using monthly and quarterly data in a portfolio-balance model that differentiates between bank and nonbank demands for bonds, and which incorporates rational and static expectations.

Greene (1984a) argues that intervention from January to March 1975 successfully broke a string of almost continuous declines in the dollar. The studies seems to illustrate the importance of coordinated intervention.

Greene (1984b) suggests that intervention, although effective on certain occasions, could not overwhelm the influence of market fundamentals and sentiments promoting a rapid dollar depreciation from September 1977 to December 1979.

Greene (1984c) investigates intervention from October 1980 to September 1981. She does not find strong evidence of an increase in exchange-rate volatility after the United States ceased intervention in February 1981.

Humpage (1985) constructs a daily time-series model of U.S. intervention (November 1, 1978 to October 31, 1979) suggesting the United States attempted to smooth unanticipated exchange-rate movements but found no evidence of the expected exchange-rate response.

Hutchison (1984) develops a portfolio-balance model of Japanese intervention and concludes that Japanese intervention would need to be massive to affect the yen-dollar exchange rates appreciably.

Jacobson (1983) calculates the profitability of U.S. intervention, showing the problems of evaluating inventories of foreign exchange. The results are mixed.

Loopesko (1983) tests for a systematic relationship between intervention and unexploited interest arbitrage profits, using daily data on six major currencies against the dollar. About half the cases do not support a portfolio-balance channel.

Mayer and Taguchi (1983) investigate the profitability of German, Japanese and British intervention, emphasizing the need to adjust for interest earnings on foreign exchange reserves. They develop a rule for assessing a leaning-against-the-wind intervention strategy.

Pippenger and Phillips (1973) find that Canadian intervention during the Canadian float (1952 to 1960) reduced day-to-day fluctuations in exchange rates; the study uses daily data and spectral analysis.

Rogoff (1984) investigates Canadian intervention within a portfolio-balance framework with weekly data, but finds no evidence that intervention operates through this channel.

Taylor (1982a, 1982b) calculates the profitability of intervention by the major developed nations under floating rates and finds that nearly all countries experienced losses over the period. For many countries, and for the group as a whole, the probability of experiencing similar large losses through random intervention was very small.

Tryon (1983) provides a review of empirical models of intervention that utilize the portfolio-balance framework

Wilson (1982) discusses the empirical difficulty of making profit comparisons.

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tion. Some governments occasionally have directed banks and public or private corporations to carry out exchange-market transactions and have subsidized such transactions (see Jurgensen [1983]). Although difficult to identify, these transactions constitute intervention.

Central banks *can* intervene in either the spot-or forward-exchange market. Because covered interest arbitrage links the spot and forward markets, intervention in either market could affect both exchange rates. Most central banks, however, show a preference for spot-market intervention.[1]

An understanding of the motives for buying or selling foreign exchange is a necessary component of the definition of intervention. While all official purchases and sales of foreign exchange place pressure on exchange rates, this is not always the purpose of such transactions. Central banks often buy or sell foreign exchange for customers, usually the home-country government, which otherwise would undertake the transactions through normal commercial channels. The home-country government might use the funds to repay official foreign-currency debts or to purchase military equipment. Central banks also buy foreign currency to build up or to replenish foreign-currency reserves. Sometimes central banks enter the exchange markets to convert interest payments on foreign reserves (which are paid in foreign currency) into domestic currency. Such transactions would not seem to constitute intervention according to a strict interpretation of our definition.

Unfortunately, the distinction is not always very clear. Adams and Henderson (1983) discuss this issue and note that such transactions often constitute a type of "passive intervention." Central banks *can* conduct commercial transactions in a manner consistent with the overall aims of their intervention policy. Adams and Henderson favor a broader definition of intervention and would characterize a transaction as intervention if it altered the currency composition of assets in the hands of the public from that which otherwise would have resulted had all transactions occurred through normal commercial channels.

II. Sterilized and Nonsterilized Intervention

Central-bank intervention in foreign-exchange markets *can* be *sterilized* or *nonsterilized*.[2] Sterilized intervention refers to purchases and sales of foreign exchange whose impact on the home country's money stock is offset through domestic open-market operations. Nonsterilized intervention refers to purchases and sales of foreign exchange whose effects on the money stock are not offset by the home country's monetary authorities. If sterilized intervention is effective, it gives the intervening country a policy tool, independent of monetary or fiscal policy, with which to alter the exchange rate; hence, the interest in sterilized intervention.

The important distinction between sterilized and nonsterilized intervention is illustrated in table 1, which presents a consolidated balance sheet for a hypothetical central bank. On the asset side of the ledger are net foreign assets (NFA), which consists of foreign reserves less liabilities to foreign official holders, and domestic assets (DA), which consists primarily of loans to depository agencies and government securities. On the liability side is the monetary base (MB), which consists of currency in the hands of the public and reserves in the banking system. Both sides of the ledger must balance. Consequently, the balance-sheet identity is:

$$NFA + DA = MB.$$

When a central bank intervenes in the exchange market, buying or selling foreign assets (NFA), two things happen: First, the composition of its assets changes; that is, NFA/DA rises or falls. Second, the monetary base changes by an amount equal to the change in net foreign assets; that is, $\Delta MB = \Delta NFA$. The change in the monetary base results fi-om the balance-sheet identity and leads to a multiple change in the domestic money stock.

If the change in the money stock resulting from intervention is not consistent with the central bank's domestic monetary-growth objectives, the central bank could offset (sterilize) the effect on its money stock of a change in its net foreign assets. The intervention authority can sterilize intervention by buying or selling domestic assets through open-market operations, or by making loans to depository institutions through discount-window operations until:

$$\Delta NFA = -\Delta DA.$$

Sterilized intervention involves only an asset-composition effect. It is a stronger asset-composition effect than nonsterilized intervention, because it involves changes both in net foreign assets and in domestic assets. Nonsterilized intervention involves both an asset-composition effect and a money-supply effect. Consequently, nonsterilized intervention is ana-

1 The reluctance to intervene forward might reflect a fear that, if the situation necessitating intervention persists at the time the forward contracts mature, a central bank could find that the volume of intervention necessary to defend its currency has increased greatly. Essentially, it must offset past pressures, as well as any new pressures. See Tsiang (1959).

2 Adams and Henderson (1983), Batten and Ott (1984), Genburg (1981), and Jurgensen (1983) also discuss the distinction between sterilized and nonsterilized intervention.

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lytically indistinguishable from sterilized intervention, plus a change in monetary policy.

Sterilized intervention *can* be complete or partial. Even when the home country sterilizes the impact of intervention on its currency unit for unit, the transaction *can* alter the money stock of the foreign country whose currency was purchased or sold. The foreign country also can sterilize the impact of home country intervention on its money stock through the instruments of its domestic monetary policy. In addition, either the home or the foreign government can elect not to offset intervention unit for unit.

Monetary Authority's Balance Sheet

Assets	Liabilities
Net Foreign Assets (NFA)	**Monetary Base (MB)**
Gold	Currency in hands of public
Foreign currency	Reserves
SDR	
Net position in IMF	
Domestic *Assets* (DA)	
Government securities	
Loans to depository institutions	
Other	

TABLE 1

Many foreign countries lack money markets with sufficient breadth to offset intervention on a continual basis. Some sterilize through changes in their discount rate or their reserve requirements. Some, like Switzerland, use foreign-currency purchases and sales to execute domestic monetary policy. As long as countries attain their monetary objectives in the face of intervention, we can conclude that they have neutralized the monetary effects of intervention (see Jurgensen [1983]).

Completely sterilized intervention is analytically equivalent to a trade of public securities denominated in home-country currency for securities denominated in foreign-country securities. It results in a change in the currency composition of securities held by the public, the mirror image of which is a change in the currency composition of assets held by the central banks. When the United States and Germany conduct completely sterilized intervention to support the dollar vis-a-vis the mark, for example, they reduce (increase) the amounts of U.S. government obligations held by the public (Federal Reserve System) and increase (decrease) the amount of German government bonds held by the public (Bundesbank).

III. Why Do Central Banks Intervene?

According to official publications, governments intervene to "calm disorderly exchange markets." Yet, no clear definition of what constitutes a disorderly exchange market exists, and the official perception of disorder seems to vary among central banks and over time. The experience with floating exchange rates, however, suggests two broad reasons for exchange-market intervention: First, exchange-rate movements can have important macroeconomic implications; nations have viewed intervention as a means of influencing these movements independently of monetary and fiscal policies. Second, governments view exchange markets as periodically inefficient, justifying market intervention.

Exchange rates are the price of one nation's monetary unit in terms of another nation's monetary unit. They are endogenous variables; that is, exchange rates respond to changes in other economic variables such as monetary and fiscal policies at home or abroad. Because exchange rates are endogenous variables, one cannot easily ascribe causality to exchange-rate movements. The record appreciation of the dollar from 1980 to 1985, for example, seemed to reflect the huge increase in federal borrowing associated with the budget deficit. Was it then the dollar or the budget deficits that contributed to the deterioration in the trade balance since 1982?

Nevertheless, policymakers often seem to view exchange-rate movements as exogenous events. One possible explanation for this view is that developments in foreign countries, beyond the control of the home-country government, *can* produce exchange-rate movements. From this perspective, exchange-rate movements appear responsible for altering the relative prices of goods, services, and financial assets in one country vis-a-vis other countries. These relative price changes *can* have important influences on real economic growth, employment, and prices in the aggregate national economy or in specific sectors. Consequently, despite the adoption of floating rates, nations have continued to regard exchange rates as important policy targets and, in varying degrees, have attempted to manage their exchange rates. From this perspective, central banks found intervention, especially sterilized intervention, interesting. It seemed to offer nations an "additional" policy variable with which to influence exchange rates, while leaving monetary and fiscal policy free to pursue domestic economic objectives.

Monetary authorities have not taken this view to the extreme; that is, they have not attempted to peg an exchange rate with sterilized intervention.3 Nor did they regard monetary policy as irrelevant in determining exchange rates. Nevertheless, policymakers appeared to

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believe that through sterilized intervention they could influence the speed at which exchange rates adjusted. This view is evident in the fact that many central banks have intervened frequently, often following a strategy of leaning against the wind (see Jurgensen [1983]).

Since the early 1980s and the findings of the Jurgensen Report, the proposition that sterilized intervention offers an independent policy lever with which to affect exchange rates has not found wide acceptance. As the next section discusses more fully, the preponderance of research suggests that intervention probably has a very limited, if any, ***independent*** influence on exchange rates. Nevertheless, many policymakers believe that intervention, when undertaken in conjunction with other (monetary) policies, affords a market impact substantially greater than one would expect from the sum of the two policies taken independently. That is, intervention can augment monetary and fiscal policies. As the Jurgensen Report noted:

> ... most members felt that the impact of the simultaneous application of the two instruments exceeded their individual effects. In other words, these members argued that exchange market intervention and monetary policy changes reinforced each other and thus enhanced the size and duration of their respective effects (pp. 20-21).

Extending this view, many argue that coordinating international monetary, fiscal, and intervention policies also augments their individual effectiveness.

The preceding discussion assumes that policymakers want to change the exchange rate in order to achieve some macroeconomic objective; it also assumes that exchange markets are efficient. However, the second general reason for intervention is that policymakers regard exchange markets as not always efficient. Because of inefficiencies, exchange rates can become "misaligned" or exhibit excessive volatility or both. &change-rate misalignments and volatility can impose real resource cost on all nations, affecting economic growth, employment, and prices.[4] As the Jurgensen Report illustrates, monetary authorities often have intervened to "dampen erratic fluctuation," to "calm disorderly markets," or to "keep exchange rates in line with fundamentals." All these suggest that something is wrong with the market and that the monetary authority is capable of correcting the deficiencies.

IV. The Channels of Influence

Economic theory offers three possible channels through which foreign-exchange-market intervention could influence exchange rates. First, nonsterilized intervention and, to a lesser extent, partially sterilized intervention alter the relative supplies of domestic and foreign money. These monetary shifts could affect relative interest rates, relative price levels, and exchange rates. Second, sterilized intervention alters the relative supplies of government interest-bearing debt held by international investors. Any resulting portfolio adjustments could affect exchange rates. Third, both sterilized and nonsterilized intervention could alter expectations in the foreign-exchange market. Exchange rates, like all asset prices, are very sensitive to changes in market participants' expectations. This section discusses each of these possible channels of influence.

A. The Monetary Channel

Economists have recognized a relationship between changes in countries' monetary-growth rates and changes in their exchange rates (or balance of payments under fixed exchange rates) at least since Hume's price-specie-flow doctrine.[5] Although international economists might disagree about the relevant time frame and relative importance of money in exchange-rate models, few would object on theoretical grounds to the inclusion of money among the determinants of exchange rates. Most recent models of exchange-rate determination either include relative money growth rates among their arguments, or represent the reduced form of models whose structural forms include money.[6]

Under classical assumptions of the neutrality of money and of the constancy of velocity in the long run, a given percentage increase in a nation's money stock will result in a similar percentage increase in that nation's price level. Given purchasing-power parity, that nation also will experience a depreciation of its nominal exchange rate equal to the percentage rise in its price level. The real exchange rate remains unaffected.

While economists have challenged the strict versions of classical assumptions and have observed that purchasing power parity need not hold strictly even in the long run, the tenet that relative rates of money growth are important determinants of nominal exchange rates continues. In fact, one current approach to exchange-rate

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3 The European Monetary System comes the closest to using intervention to peg an exchange rate. However, it is not clear that EMS intervention is routinely sterilized and therefore independent of monetary policy.

4 For a discussion of the effects of exchange-rate volatility, see International Monetary Fund (1984).

5 Keynesian economics did not emphasize the role of money in balance-of-paymenis adjustment problems; rather it focused on the elasticities approach and later the absorption approach. One can trace the recent re-emphasis on money, at least, to Johnson (1968).

6 For a recent survey of approaches to exchange-rate determination, see Schafer and Loopesko (1983).

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determination, the monetary approach, views relative patterns in the supply of and demand for nations' money as the key determinant of exchange rates?

Modern approaches differ from historic treatments in that they allow for instantaneous adjustment in asset markets through a rational-expectations framework, and they allow for sticky prices in goods markets. One important consequence of these assumptions is that the channel of influence between monetary changes and exchange-rate movements does not necessarily run through relative prices and trade flows, as in the classical models. Modern approaches to monetary theory allow, at least in the short run, for influences of money on interest rates, and exchange rates through an interest-rate parity mechanism. Contemporary models suggest that a change in relative monetary growth rates will produce both nominal and real exchange-rate changes in the short run, but not in the long run. Another important implication of modern models is that, following a monetary expansion, nominal exchange rates initially can overshoot their long-term equilibrium value (given by purchasing power parity) because of the slow adjustment in goods prices. The extent of the overshoot will depend on all the interest elasticities and price elasticities embodied in the model. However, if goods prices adjust instantaneously, no exchange rate overshooting will result.[8]

Nonsterilized intervention, which changes nations' relative money supplies, has the potential to alter exchange rates rapidly and lastingly. International economists rarely disagree with this proposition. Sterilized intervention, as typically conducted by the United States, also could have an effect on exchange rates if foreign monetary authorities did not completely sterilize the transactions.

As indicated earlier, U.S. intervention to alter the dollar's exchange rate can change the money stocks of the nations whose currencies the Federal Reserve buys or sells, unless those nations take appropriate offsetting actions. The major developed countries, such as Germany and Japan, can sterilize the effect of foreign or domestic intervention on their money stocks. Smaller developed and developing countries often lack credit markets with sufficient depth to undertake such sterilization activities on a routine basis through open-market operations. They can undertake reserve-ratio changes or discount-rate changes, but these have a fairly dramatic impact on monetary growth and are not well-suited for routine adjustments to sterilized intervention. They do, however, provide a mechanism whereby the foreign central bank could offset the impacts of intervention over a longer period.

B. The Portfolio-Adjustment Channel

Economists have extended the closed-economy, portfolio-balance models of asset demand, initially developed by Tobin (1958, 1969), to the open-economy case. In a portfolio model of asset demand, risk-averse wealth holders, facing uncertain rates of return on an array of assets, diversify their portfolios across assets instead of holding only the single asset currently yielding the highest rate of return. When exchange risk and political risk are introduced into the model, a strong incentive exists for wealth holders to diversify their portfolios across currencies.[9] The resulting demands for assets denominated in foreign currencies affect exchange rates. The open-economy portfolio model illustrates an important channel through which completely sterilized intervention might affect exchange rates and the conditions that must hold for sterilized intervention to work.

In a world with no transaction cost and no restraints on capital flows, arbitrage will equate returns on assets denominated in dollars with returns on assets denominated in other currencies:

(1) $r = r^* + f - s$

In equation 1, r is the log of the interest return on U.S. bonds and r^* is the log of the interest return on foreign bonds. (We assume that the bonds mature in one year.) The forward exchange rate, f, is the log of the current dollar price of foreign currency for delivery in one year. The spot price of foreign currency is s.[10] Assuming that domestic and foreign assets are perfect substitutes, so that the forward exchange rate equals the expected future spot exchange rate, arbitrage ensures that the return on domestic bonds, equals r^*, the return on foreign bonds, plus any capital gains associated with holding foreign-currency-denominated assets as exchange rates change.

When wealth holders do not view domestic and foreign bonds as perfect substitutes, the forward exchange rate will differ from

7 For examples of the monetary approach to exchange-rate determination see Frenkel (1976) and Bilson (1978).

8 The overshooting model is attributable to Dornbusch (1916)

9 Initial applications of portfolio models to the study of capital movements under fixed exchange rates are Branson (1970), and Kouri and Porter (1974). Early applications to floating exchange rates include Girton and Henderson (1977) and Kouri (1980). Discussions of sterilized intervention within the context of portfolio models are found in Tryon (1983), Genburg (1981), Henderson (1984), and Hutchison (1984).

10 Equation 1 is the log form of the covered interest-rate parity condition:
$(1 + r) = f/s \quad (1 + r^*)$

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the expected future exchange rate (s^e) by a premium, 8, that reflects the risks associated with holding an open position in dollars. That is:

(2) $f - s^e = 8$.

Substituting yields:

(3) $r = r^* + (s^e - s) + \theta$.

As can be seen from equation **3,** wealth holders demand an extra return for holding the risky dollar asset above the interest return and expected appreciation from holding the foreign bond. (One could specify the problem with the foreign asset as the risky asset without affecting the analysis.)

Rearranging equation **3** provides an expression for the risk premium:

(4) $\theta = r - r^* + s - s^e$.

With interest rates and the expected future value of the dollar held constant, an increase (decrease) in the risk premium on dollar assets is associated with a depreciation (appreciation) of the dollar relative to the foreign currency. This depreciation of the dollar in the spot market is necessary to give wealth holders a capital gain over the holding period sufficient to compensate them for the additional risks of holding dollar-denominated assets.

Before explaining intervention within the context of this model, we should specify the determinants of the risk premium. Underlying the risk premium is the preference of individuals to hold assets in their home currency, an aversion to risk, and a desire to hold assets which maximize a return from a portfolio, given the risks. These risks include exchange risk (the uncertainty associated with unanticipated movements in exchange rates) and political risk (the probability that governments will impose future capital controls). In the case of major developed countries, most analysts attach greatest importance to exchange risk (see Dooley and Isard [1980] and Frankel [1979]). In specifying a function to explain the risk premium, most research includes, among other terms, the ratio of domestic bonds to total wealth (see Frankel [1984, 1979] and Hutchison [1984]).

The assets relevant to the portfolio balance model are government bonds. Individuals generally do not hold large balances of foreign currency, since they would earn no interest. In addition, bondholders must view the bonds as additions to their net wealth. Private bonds are assets to lenders and liabilities to borrowers; therefore, they do not represent net additions to wealth. Government bonds will equal net additions to wealth if bondholders do not associate with an increase in government debt a future tax liability sufficient to retire the debt and all interest accrued on the debt (see Barro [1974]).

The portfolio balance model provides a channel through which sterilized intervention can alter exchange rates *permanently* since, as demonstrated earlier, sterilized intervention alters the relative supplies of domestic and foreign government bonds in the hands of the public and, when the bonds are imperfect substitutes, alters the risk premium. Assume, for example, that the United States intervenes in the foreign exchange market to support the dollar relative to the German mark The Federal Reserve buys dollars in the foreign exchange markets with German marks and sterilizes the intervention by buying Treasury bonds at the open-market desk. Assume that Germany also sterilizes by selling mark-denominated bonds. The Federal Reserve's purchase of Treasury securities initially creates an excess demand for Treasury securities that tends to lower U.S. interest rates, while the German sale of mark-denominated bonds creates an excess supply and tends to raise German interest rates. Because U.S. and German bonds are not perfect substitutes, U.S. bondholders are not willing to hold all of the excess supply of German bonds. The interest-rate movements tend to increase U.S. money demand and to lower German money demand. Yet, the money supplies in both countries have remained unchanged. With the expected future spot rate constant, the dollar will appreciate relative to the German mark.[11] The exchange-rate change, which occurs as money-demand shifts alter the terms of trade, is necessary to restore balance in both the money and bond markets. The appreciation of the dollar relative to the German mark reduces the attractiveness of domestic bonds relative to mark bonds by increasing (decreasing) the expected future depreciation (appreciation) of the dollar relative to the mark, hence, it also reduces expected capital gains on dollar assets.

In terms of equation 4, therefore, intervention has produced movements in interest rates and the spot exchange rate associated with a reduction in the risk premium on dollar assets. The movement in the exchange rate, moreover, is compatible with the designs of the intervening monetary authorities.

If assets are perfect substitutes, wealth holders expect the same return from each bond. Under these assumptions, sterilized intervention will not affect the exchange rate, because individuals have no incentive to alter portfolios given a change in the relative stocks of bonds. Asset holders are perfectly willing to hold more mark-denominated bonds in place of dollar-

11 Analysts usually assume that long-term determinants, such as purchasing power parity, or a sustainable current account deficit, maintain the level of s^e.

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denominated bonds in their portfolios. When the bonds are perfect substitutes, intervention also will leave interest rates unaffected because the intervention transactions, although altering the currency composition of bonds, have not changed the total value of bonds relative to money in portfolios. Wealth holders, therefore, have no incentive to diversify out of bonds and into money.

Given the other assumptions mentioned previously, the extent to which intervention alters exchange rates depends on the degree of substitutability between dollar-denominated and mark-denominated securities. Other things equal, if dollar and mark bonds are close substitutes, the change in the exchange rate will be small. If the assets are not close substitutes, a larger change in the exchange rate will be required to compensate for the risks. This implies that completely sterilized intervention might be feasible in some markets where assets are imperfect substitutes, but infeasible in other markets, where assets are perfect substitutes.[12] Therefore, the United States might intervene successfully against lira but not against marks. Clearly, one must evaluate the portfolio effects of completely sterilized intervention on a case-by-case basis.

Empirical investigations to date generally do not find strong support for the contention that intervention affects exchange rates through a portfolio-adjustment mechanism (see box 1). Although the issue remains unresolved, the evidence of the existence of a risk premium between similar assets denominated in currencies of different major developed countries is mixed.[13] These investigations involve simultaneously testing the joint hypothesis that markets are efficient and that bonds are perfect substitutes. Consequently, a finding that the yield on domestic and foreign securities differs significantly from zero is subject to two interpretations. First, this result could indicate that assets are imperfect substitutes in an efficient market. Hence, intervention would work through the portfolio-balance mechanism. Second, and equally plausible, the finding could result if assets are perfect substitutes, but if markets are not perfectly efficient. This second finding suggests that intervention does not operate through a portfolio-balance channel.[14] Loopesko (1983), Hutchison (1984) and Danker, Haas, Henderson et al. (1985) offer three investigations of intervention within the portfolio-adjustment framework. None finds strong support for the existence of a portfolio-adjustment channel for intervention.

Even if the relevant bonds are imperfect substitutes, it appears that the response to small changes in the risk premium is quite low. Hutchison (1984) notes that changes in the cumulative total publicly held government debt is the relevant variable for the portfolio-adjustment model. Total government debt responds to intervention, to the surplus or deficit in the government budget, and to monetary policy. In his study of Japanese intervention, Hutchison (1984) suggests that intervention is usually too small, relative to the total volume of outstanding debt, to have a significant impact on portfolio choices. With the publicly held federal debt in excess of $1.5 trillion, U.S. intervention probably would need to be massive before the cumulative volume had significant impact on portfolio decisions.[15]

C. The Expectations Channel

Exchange-market intervention also could alter exchange rates if it changed expectations in the foreign-exchange markets. Most economists regard foreign-exchange markets as highly efficient. An efficient market is one that "fully reflects" all relevant, available information about today's events as well as about all predictable future events, including policy decisions (see Fama, [1970]).[16] An implication of this is that exchange rates respond to unanticipated events or "news." When the exchange market and other markets are efficient, transactions based on observed exchange rates ensure the optimal allocation of resources.

While exchange markets are highly efficient, they probably are not perfectly efficient. Tests of market efficiency generally search for unusual profits from arbitrage or trading rules. In an efficient market, unusual profits should not exist; their existence would imply that certain transactors consistently have better information than others. Although these tests generally are

12 See Fukao *(1985)* for an interesting discussion of similar problems with coordinated intervention within the context of a portfolio-balance model.

13 For a survey, see Levich *(1983)*. See also references to portfolio models in box 1.

14 This does not preclude the possibility that sterilized intervention could influence the exchange rate by improving market efficiency.

15 Batten and Ott *(1984)* make a similar argument, which does not result from a portfolio model, noting that the average daily volume of funds flowing through the exchange market is quite large relative to the typical volume of intervention.

16 Levich *(1983)* writes the spot rate, S, as:
$S_t = Z_t \beta[E(S_{t+1}) - S_t]$,
where Z_t is a collection of contemporaneous variables that explain S_t. Collecting terms and substituting repeatedly for lagged values:

$$S_t = (1+\beta)^{-1} \sum_{k=1}^{\infty} (\beta/1-\beta)^k E(Z_{t-k}).$$

Hence, the spot exchange rate depends on current expectations of the relevant "fundamentals" in Z from the present to the indefinite future.

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inconclusive, they have raised serious doubts about perfect exchange-market efficiency.[17]

In addition, casual observations have raised questions about whether the rnarket consistently uses all available information when setting exchange rates (see Dornbusch [1983]). Many exchange-market analysts contend that the exchange market often focuses on one piece of information to the exclusion of other important information and sometimes trades on false information or the wrong model. Trades on false information can be self-fulfilling. If, for example, traders believe that a full moon causes dollar depreciation and sell during full moons, their expectations will be met. Such activity can lead to abrupt, potentially disruptive adjustments in exchange rates as the market changes its focus to a different set, or eventually to the correct set, of fundamentals. &change-market analysts also have argued that exchange rates periodically are subject to speculative runs or bubbles. When information is incomplete, traders might rely on recent exchange-rate movements to indicate market sentiment and future movements in the rate. Traders may buy an appreciating currency or sell a depreciating currency, thereby reinforcing exchange rate movements. It is important to emphasize that most economists regard the inefficiencies in the exchange market as minor and as generally not contributing much to exchange-rate volatility. Nevertheless, to the extent that inefficiencies exist, intervention could alter exchange rates by altering expectations in the market.

Most monetary authorities attempt to conduct intervention policy in such a way as to improve the information flow through the market; according to the Jurgensen (1983) report:

> The authorities in each of the Summit countries at times undertook large-scale intervention when they judged that market participants had not taken full account of fundamental factors, [or] had only reacted slowly to changes in fundamentals... (p.21).

There are a number of difficulties in implementing intervention designed to influence market expectations. Such intervention involves a judgment on the part of the monetary authorities that first, the current volatility in the market reflects inefficiencies and not adjustments (or expectations of adjustments) in fundamental determinants; and second, that the monetary authorities possess better information than the market about market developments. In the processing of normal information flow about real economic developments, prices, interest rates, or routine policy, there is little reason to suspect that policymakers are any better informed than market participants. At times, however, the Federal Reserve and the U.S. Treasury could have better information than the market. This might occur, for example, when policymakers are considering a change in monetary or fiscal policy that differs from past policy reactions. The market already will incorporate a policy reaction function into the exchange-rate quotations. The need to provide new information to the market limits the instances when sterilized intervention is feasible.

A highly efficient market will interpret intervention activity quickly. Hakkio and Pearce (1985) found that unanticipated money-supply announcements had a significant effect on exchange rates, but that the adjustment usually occurred within twenty minutes of the announcement. One would expect the exchange-rate change in response to new information to be permanent.

The decision of the Group of Five countries to intervene in late September of 1985 (the Plaza decision) seems to represent a recent example of successful intervention that altered expectations in the foreign exchange markets. At the time, the dollar was depreciating in the foreign-exchange market, but the market seemed uncertain about the future course of monetary and fiscal policies. The money stock, narrowly defined, was growing in excess of its target range, suggesting that the Federal Reserve might take steps to reduce money growth. On the other hand, economic activity seemed weak at the time; many complained that the dollar was overvalued, and banks continued to experience difficulties with agricultural and international loans. These events suggested that the Federal Reserve might not tighten. At the same time, there was increasing talk in Congress about the need to reduce the federal budget deficit, but little concrete action. Under these circumstances, the market seemed to view the decision to intervene as a signal that U.S. policy would not move in a direction that might strengthen the dollar in exchange markets. The United States intervened forcefully, but did not continue to intervene beyond the quarter.

A second important question concerns the appropriateness of using intervention to alter expectations. Given that monetaty authorities can provide new information to the exchange market about future monetary policy and alter expectations in the market, is intervention the appropriate vehicle for providing this information? Could the central bank provide the same information through the announcement of monetary policy intentions or by providing an interpretation of recent events? This issue has not received much attention in the literature on central-bank intervention. Perhaps actual currency purchases or sales are necessary to convince the rnarket about cen-

[17] See Levich (1983) for a survey

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tral bank intentions because it represents a bet by the central bank on its own information. Profitable intervention tends to stabilize the exchange rate. Moreover, as Henderson (1984) notes:

> ...losses on foreign exchange positions *can* lead to significant political problems for the authorities. Thus, if the authorities undertake an intervention policy which would generate foreign exchange losses if their pronouncements about future monetary policy were not put into effect, there might be more reason for private agents to take these pronouncements seriously. (p. 391)

We also should question the extent to which one truly can regard intervention that alters expectations about future monetary policy as being sterilized. While such intervention might intensify the effects of the change in monetary policy, as suggested in Jurgensen (1983, pp. 20-21), it is clearly dependent on fulfillment of the expectations.

While the expectations channel offers the most promise as a means of accomplishing sterilized intervention, it probably is the most difficult channel for a central bank to navigate. It is important to emphasize that the purchase or sale of foreign exchange per *se* is not affecting the exchange rate; the critical factor is the information these transactions might provide. Such intervention must be unanticipated and convey new, convincing information to the market. Because it is difficult to determine how expectations are forged and how strongly they are carried, attempts to alter expectations through intervention could be very expensive.

V. Conclusion

This article has discussed three channels through which central bank intervention could alter exchange rates. These are the monetary channel, the portfolio-balance channel, and the expectations channel. Two broad conclusions emerge from our review of these channels. First, changes in a nation's money growth relative to money growth abroad *can* have a profound effect on that nation's nominal exchange rates. This holds true whether the money stock change is engineered through conventional methods of monetary policy —open-market operations, discount-rate changes or reserve-ratio changes—or whether the money stock change is engineered through nonsterilized intervention in foreign exchange markets. Changes in a nation's monetary growth, however, may have only temporary effects on that nation's real exchange rates, especially if goods prices adjust slowly to changes in money growth rates.

However, nations have been most interested in conducting sterilized intervention, that is, intervention independent of monetary policy. Such intervention would allow them the opportunity to influence exchange rates without interfering with domestic monetary objectives. Our second conclusion is that sterilized intervention has a limited, but not necessarily insignificant, impact on exchange rates. The portfolio-balance approach to exchange-rate determination suggests that sterilized intervention could influence exchange rates permanently by altering the relative supplies of government bonds in the hands of the public. If wealth holders perceive these bonds as net wealth and as imperfect substitutes, sterilized intervention could alter the exchange rate in the desired direction by changing the risk premium on these bonds. Unfortunately, empirical investigations to date have not demonstrated unequivocally that a risk premium exists on government bonds issued by the major developed countries. Nor have they shown that intervention in the magnitudes typically undertaken by the major central banks is sufficiently large to influence the risk premiums. The expectations channel suggests that sterilized intervention can influence exchange rates by altering the flow of information in the exchange market. However, this requires that the intervening central bank be able to identify periods of market inefficiency and that it have information, for example, about future monetary policy, which the market lacks. The exchange market seems highly efficient, so that opportunities for the central bank to exploit this channel probably are not great. Nevertheless, under the proper conditions, such intervention can have an immediate and permanent impact on exchange rates.

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