working paper

0110

Sterilized Intervention, Nonsterilized Intervention, and Monetary Policy

by Ben Craig and Owen Humpage

FEDERAL RESERVE BANK OF CLEVELAND

Working Paper 01-10 July 2001

Sterilized Intervention, Nonsterilized Intervention, and Monetary Policy

by Ben Craig and Owen Humpage

Sterilized intervention is generally ineffective. Countries that conduct monetary policy using an overnight interbank rate as an intermediate target automatically sterilize their interventions. Unsterilized interventions can influence nominal exchange rates, but they conflict with price stability unless the underlying shocks prompting them are domestic in origin and monetary in nature. Unsterilized interventions, however, are unnecessary since standard open-market operations can achieve the same result.

JEL Classification: F3
Key Words: intervention, sterilized, exchange rate, Federal Reserve System, U.S. Treasury

Ben Craig and Owen Humpage are at the Federal Reserve Bank of Cleveland.

Ben Craig may be reached at (216) 579-2061 or ben.craig@clev.frb.org
Owen Humpage may be reached at (216) 579-2019 or owen.f.humpage@clev.frb.org.

Introduction

Although the demise of Bretton Woods freed countries from the rigidities of maintaining exchange-rate parities, no country (or alliance) has allowed market forces free reign in determining its exchange rates. Even prime candidates for floating, like Canada, the European Monetary Union, Japan, the United States, and the United Kingdom, occasionally have altered their monetary policies, or have bought and sold foreign-exchange in an attempt to affect the exchange value of their currencies. Last summer, for example, the European Central Bank undertook coordinated interventions with Japan, the United Kingdom, and the United States in an effort to stem a depreciation of the euro against the U.S. dollar and the Japanese yen.

Economists have long cautioned against these exercises. When a country's central bank maintains an unchanged interbank rate as the intermediate operating target for its monetary policy, it automatically offsets (or sterilizes) the impact of any exchange-market intervention on its monetary base. Sterilized intervention will generally prove incapable of altering exchange rates. If, instead, the central bank alters the target interest rate, it creates the potential for conflict between price and exchange-rate stability. Only when the disturbance that initiates the central bank's response is domestic in origin and monetary in nature, can monetary policy achieve both price and exchange-rate stability. Ironically, however, transacting in foreign currencies is unnecessary in this circumstance, since conventional open-market operations are altogether sufficient.

The subsequent sections of this chapter illustrate each of these points in turn. Overall, we hope to demonstrate the near futility of exchange market intervention.

Intervention and the Federal Reserve's Balance Sheet

The central banks of most large industrial countries automatically sterilize all exchange-market interventions, whether undertaken for their own accounts or for the accounts of other government agencies, like the Ministry of Finance or the Treasury.[1] The Federal Reserve's operating procedure illustrates the mechanism.

In the United States, the Treasury has broad statutory responsibility for determining the nation's exchange rate system. Under that authority it maintains the Exchange Stabilization Fund—a portfolio of foreign-currency, and dollar-denominated, assets—for intervention purpose. The Federal Reserve, the independent monetary authority, has a separate portfolio of foreign exchange for the same purpose. Usually, the Federal Reserve and the Treasury intervene in concert. The Federal Reserve Bank of New York (FRBNY) acts as agent for both agencies and splits the proceeds of the transactions evenly between the two accounts. The FRBNY may transact directly with commercial banks or, using a commercial bank as its agent, with a foreign exchange broker. In either case, the FRBNY makes or accepts payment in dollars by crediting or debiting the reserve account of the appropriate commercial bank(s), as it would in a standard open-market transaction.

The Federal Reserve's portion of a U.S. intervention has the potential (other things being held constant) to drain or add bank reserves, customarily with a two-day lag.[2] The Treasury's actions affect bank reserves only if the Treasury's cash balances at the Federal Reserve change.[3] In either case, the Federal Reserve never allows intervention to affect its monetary policy operations; it always sterilizes.[4]

Sterilization occurs automatically by virtue of the Federal Reserve's operating procedure. The FRBNY's Open Market Desk manages total reserves in the U.S. banking system in such a way as to achieve the federal funds target that the Federal Open Market Committee (FOMC) establishes in its monetary-policy deliberations. The FOMC actions are almost always taken with

---

[1] We define foreign-exchange-market intervention as purchases and sales of foreign exchange for the purpose of influencing exchange rates. This definition distinguishes foreign-exchange-market intervention from other policy actions, most notably open-market operations in domestic securities, that might also affect exchange rates.
[2] The two-day lag reflects the customary practices for concluding foreign-exchange transactions.
[3] For a more complete explanation under alternative means of financing an intervention, see Federal Reserve Bank of New York, *U.S. Monetary Policy and Financial Markets* at [http://www.ny.frb.org/pihome/addpub/monpol/].

domestic objectives—inflation, business-cycle developments, financial fragility—in mind. Given its estimate of depository institutions' demand for total reserves, the Desk manages the supply of reserves through open-market operations to keep the actual federal funds rate at the target. In the process, the Desk must take account of a number of factors that appear on the Federal Reserve's balance sheet and that can affect the amount of reserves in the banking system at any time. Among these items are changes in the Treasury's cash balances and changes in the Federal Reserve's portfolio of foreign exchange. The Federal Reserve staff will attempt to estimate these on a day-to-day basis, but whether anticipated or not, the Fed will respond to them quickly in defense of the federal funds target. Consequently, intervention is never permitted to change reserves in a manner that is inconsistent with the day-to-day maintenance of the federal fund rate target. All central banks, including the Bank of Japan and the European Central Bank, that use an overnight, reserve-market interest rate as a short-term operating target necessarily sterilize their interventions in this way.

Sterilized Intervention

The consensus of empirical research over the past twenty or so years holds that sterilized intervention is largely ineffective (see Edison 1993, Almekinder 1995 and Baillie et al. 2000). It may from time to time affect exchange rates, but its influence is unpredictable and small. To appreciate this finding, one must understand how sterilized intervention might influence exchange markets.

Sterilized intervention does not directly affect fundamental economic determinants of exchange rates, but it occasionally seems to influence market perceptions and expectations of those fundamentals. If information is costly, exchange rates cannot continuously reflect all available information. Access to costly information will differentiate traders, and each will incorporate information only to the point at which the expected marginal benefits from acquiring

---

[4] If the Federal Reserve did not routinely sterilize all interventions, the U.S. Treasury could affect the money supply through its purchases and sales of foreign exchange. This might compromise the Federal Reserve's independence.

and trading on information equals his or her marginal costs. A substantial literature seems to confirm that exchange markets are not perfectly efficient processors of information, even publicly available information. We cite three examples: Ito (1993) finds that expectations, as revealed in survey data, are not homogeneous, suggesting that traders have asymmetric information sets. Peiers (1997) finds evidence in the pattern of exchange-rate quotes following a Bundesbank intervention that is consistent with insider information and price leadership. Neely et al. (1997) demonstrate that *ex ante* trading rules generate profits, a finding that is not consistent with informationally efficient markets along the lines presented in Fama (1970). In such a market, exchange rates perform a dual role of describing the terms of trade between national currencies and transferring information from more to less informed agents.[5] If monetary authorities have better information than the market and if they can convey that information through their official actions, sterilized intervention could influence exchange rates.

Taking a cue from Mussa (1981), some economists contend that central banks have better information about future monetary-policy changes than the market and might signal those changes (intentionally or unintentionally) through their currency transactions. Such signals could be particularly credible, since intervention would give monetary authorities an exposure to a foreign currency that would result in a loss if they failed to validate them. (Of course, a validated intervention signal would no longer be sterilized!) As a general description of the informational effects of intervention, this view lacks compelling empirical support. Compare, for example, Bonser-Neal et al. (1998) who find some support for the proposition, and Fatama and Hutchison (1999), who find no support (see the references listed therein). As an explanation of certain episodes, however, this view may have some merit. Humpage (2000) suggests that successful interventions are more likely during periods of monetary uncertainty.

To the extent that this view does have merit, however, it is a two-edged sword. For example, the Federal Reserve System's euro purchases on September 22, 2000 seemed

[5] Baillie, Humpage, and Osterberg (2000) survey intervention from an information perspective.

inconsistent with the increases that it authorized in the federal funds target between June 1999 and May 2000. We doubt that any FOMC member viewed these interventions as an expression of future ease. The Federal Reserve did not ease policy until January 2001, well after the euro-dollar exchange rate was a pressing issue. Similarly, intervention in late 1980s and early 1990s often conflicted with the FOMC's monetary-policy designs and caused some FOMC members to express their dissatisfaction with intervention by dissenting on related issues. At times, the Federal Reserve refused to intervene for its own account and only executed interventions for the U.S. Treasury's account. These examples suggest that if one believes that intervention always acts as a monetary-policy signal, then it has created as much uncertainty about monetary policy and confusion about the strength of Committee's commitment to price stability than it has cleared away. Fatama and Hutchison (1999) show that intervention adds to volatility in the federal funds futures market. This suggests that intervention can increase the difficulties associated with implementing monetary policies.

Intervention could provide much more information than hints about future monetary policy moves. In general, however, the empirical literature on sterilized intervention suggests that it is largely ineffective. Humpage (1999, 2000), for example, found that the probability of a successful U.S. intervention was low—less than one-half of all cases. When it seemed successful, intervention tended only to slow rates of appreciation or depreciation; it did not alter the direction of an exchange-rate movement. Hence, sterilized intervention cannot cause a depreciating currency to appreciate. Successful interventions were also concentrated in periods of extreme uncertainty, such as after the October 1987 stock-market crash or immediately after the 1985 Plaza Accord.

Nonsterilized Intervention and Monetary Policy.

As Furlong (1989) illustrates, the FOMC on rare occasion has adjusted its monetary-policy stance in response to movements in the dollar's exchange value. Other central banks have done likewise. This section addresses problems that arise when a central bank simultaneously pursues a price-level and an exchange-rate objective with a single policy instrument. We show that a central bank must compromise these objectives in all cases, except when the underlying economic shock is domestic in origin and monetary in nature. The central bank then loses some credibility and creates uncertainty with respect to both of these objectives. How much inflation will it accept to avoid a further exchange-rate appreciation? How big of an appreciation will it accept to avoid inflation?

Our simple model considers only one time period.[6] We allow for two countries (the domestic nation and the rest of the world), each of which is endowed with a single good, which it either consumes or trades with the other country. Both countries have central banks, which create money for transactions purposes. By setting the money supply equal to a simple transactions demand for real cash balances and by taking the logarithmic first differences of the variables, we derive following expressions for inflation in both countries:

1) $\pi = \dot{m} - \dot{y} + \dot{e}$

2) $\pi^* = \dot{m}^* - \dot{y}^*$

In equation 1, π is the domestic inflation rate; $\dot{m}$ is domestic money growth; $\dot{y}$ is domestic real output growth, and $\dot{e}$ is a domestic money-supply shock. Equation 2 contains similar terms with asterisks for the foreign country. As these equations indicate, inflation results when the money stock expands faster than the public's money demand.

We assume that individuals hold only domestic money balances but allow them to instantaneously exchange domestic currency for foreign currency at the market exchange rate to

6 See Turnovsky (1997) for a short review of these types of models and for further references.

buy the foreign good. Following Stockman (1987), the logarithmic first difference of the nominal exchange rate, $\dot{s}$, equals the logarithmic first difference of the real exchange rate, $\dot{r}$, plus the difference between inflation abroad and at home:

3) $$\dot{s} = \dot{r} + \pi^* - \pi \ .$$

The nominal exchange rate is the price of the domestic currency in terms of the foreign currency, that is, the number of foreign currency units that trade for one domestic currency unit. In our model, the real exchange rate, *r*, equals the terms of trade, which is expressed in units of exports per unit of import.[7] As equation 3 indicates, nominal exchange-rate variations reflect either changes in the relative price of traded goods, differences between the domestic and foreign inflation rates, or both.

Substituting equations 1 and 2 into equation 3 shows how the nominal exchange rate responds to changes in either countries' money demand or money supply:

4) $$\dot{s} = \dot{r} + (\dot{m}^* - \dot{y}^*) - (\dot{m} - \dot{y} + \dot{e}) \ .$$

If the foreign country generates a higher rate of excessive money growth than the domestic country, the domestic currency will appreciate. Likewise, the domestic currency will depreciate if excessive money growth at home outpaces that abroad.

We assume that the objective of domestic monetary policy is to maintain a zero rate of inflation, minimize variation in the exchange rate, or achieve some optimal combination of both objectives.[8] Consequently, we specify the domestic central bank's loss function as:

5) $$L = -\left[\frac{A}{2}(\dot{s}^2) + \frac{\pi^2}{2} \right]$$

where *A* is the relative weight attached to the exchange-rate objective. *A* may range from 0 to infinity, where 0 implies that the domestic central bank only cares about inflation and infinity

[7] In models with both traded and nontraded goods the relative price of trade to nontraded goods will also affect the real exchange rate.

implies that it cares only about exchange-rate volatility. In any case, the domestic central bank always chooses a monetary growth rate ($\dot{m}$) that minimizes its loss function. This yields the following optimal money-growth rule:

$$6) \qquad \dot{m} = \left(\frac{A}{1+A}\right)\left(\dot{r} + \dot{m}^* - \dot{y}^*\right) + \dot{y} - \dot{e}\,.$$

If the domestic central bank ignores exchange-rate volatility ($A = 0$), it will supply just enough money to satisfy the demand for money and to offset any random money-supply shocks.[9] As the weight that the domestic central bank assigns to exchange-rate volatility rises, real-exchange-rate changes and excess foreign monetary growth will become relatively more important factors in determining the optimal monetary-growth rate than the growth in the domestic demand for money and shocks to the money-supply.

When the domestic central bank acts follows the optimal money growth rule (equation 6), the inflation rate is given by:

$$7) \qquad \pi = \left(\frac{A}{1+A}\right)(\dot{r} + \dot{m}^* - \dot{y}^*)\,,$$

and the exchange rate is given by:

$$8) \qquad \dot{s} = \left(1 - \frac{A}{1+A}\right)\dot{r} + \left(1 - \frac{A}{1+A}\right)(\dot{m}^* - \dot{y}^*)\,.$$

We obtain equations 7 and 8 by substituting equation 6 back into equations 1 and 2. If the domestic central bank ignores exchange-rate volatility, $\frac{A}{1+A} = 0$, the domestic inflation rate becomes zero, since the domestic central bank only sets money growth to accommodate domestic money-demand growth or to offset money-supply shocks. In this case, the nominal exchange rate will fluctuate one-for-one with changes in the real exchange rate and with changes in excessive

---

[8] We assume that the foreign central bank, which represents the rest of the world, does not operate so as to minimize a obvious loss function. Footnote 10 discusses the results, if we allowed the foreign central bank to minimize a similar loss function.

foreign money growth. If instead, the domestic central bank cares only about exchange-rate volatility, $\frac{A}{1+A}$ approaches 1 and $\dot{s}=0$. In this case, changes in the real exchange rate and excessive money growth abroad will determine the domestic inflation rate. These results are standard in the literature on the relative merits of fixed and floating exchange rates. Bretton Woods, for example, broke down because the United States generated an inflation rate that many European countries found excessively high. Floating exchange rates allow countries to determine their own inflation rates independently.

Most countries, however, seem to care both about eliminating inflation and about minimizing exchange-rate variations. Within the context of our model, they choose a value of A somewhere between the extremes. In doing so, however, they establish the potential for conflict between price and exchange rate stability. To illustrate the problem, we will consider a domestic money-supply shock, excessive foreign money growth, and changes in the real exchange rate.

Domestic money supply shock

Our one-period model (equations 7 and 8) suggests that domestic money-supply shocks have no effect on the domestic inflation rate or on the nominal exchange rate when the domestic central bank acts optimally. By stretching the model's timing conventions, however, we can show that domestic monetary shocks never create a conflict between policy objectives. Assume that a money-supply shock ($\dot{e}>0$) occurs at the opening of the period. Absent an offsetting change in monetary policy, this shock will cause domestic inflation to increase (equation 1) and will cause the domestic currency to depreciate (equation 3). By offsetting the money supply shock, the domestic central bank promotes both price, and exchange-rate stability. A similar result would follow from a domestic money-demand shock. In general, when the shock affecting the economy is domestic in origin and monetary in nature, an offsetting monetary-policy response

---

[9] Shocks to the money supply might emanate from changes in banks' holding of excess reserves or from changes in the public's currency holdings.

can simultaneously achieve both objectives. This unfortunately is the only case in which a conflict between the monetary-policy objectives does not result, as our remaining examples illustrate.

Foreign excess money growth

If the shock affecting the exchange market stems from a change in foreign excess money growth—either a change in $\dot{m}^*$ or in $\dot{y}^*$—an attempt to stabilize the exchange rate comes at the expense of price stability and vice versa. Assume that foreign money growth accelerates beyond what is necessary to accommodate foreign money demand. This causes an increase in the foreign rate of inflation and a depreciation of the foreign currency ($\dot{s} > 0$ in equation 8). Excess foreign money growth has no direct effect on domestic prices in our model, but if the domestic central bank attempts to prevent an appreciation of the domestic currency ($A \neq 0$) by increasing the domestic money supply, it will then also cause an increase in the domestic rate of inflation. Achieving the exchange-rate objective comes at the expense of the inflation target when the underlying shock is foreign in origin and monetary in nature.[10]

An Increase in the Supply of Home Goods

Although the model does not directly specify the types of events that will change the real exchange rate, any change in either the supply or demand for domestic or foreign goods will alter it. An increase in the productivity of domestic workers, for example, would increase the supply of the domestic good and lower its price relative to the price of foreign output. Real and nominal depreciations (equation 3) would follow from this relative price change.

In addition to this relative-price effect, the productivity-induced increase in real output would simultaneously increase the demand for real money balances. Ignoring temporarily our assumption about the optimal behavior of the domestic central bank, the domestic inflation rate

[10] If the foreign central bank reacts to the same loss function as the domestic central bank, then foreign nominal variables drop out of the equations for the optimal money supply, the inflation rate, and the change in the nominal exchange rate, but the real exchange rate remains an argument in each of these equations. A coordinated response does not eliminate the problems associated with maintaining an exchange-rate objective for monetary policy.

would fall as money demand increased, and the nominal exchange rate would appreciate (see equation 3). In the absence of an optimal monetary response, the combined relative-price and money-demand effects stemming from an exogenous increase in the supply of domestic goods will reduce the domestic inflation rate, but it will have an ambiguous effect on the exchange rate.[11]

If, however, we continue to assume that the central bank responds optimally, the domestic inflation rate will fall and the domestic exchange rate will depreciate. Both of these results obtain because the domestic central bank, in attempting to achieve both objectives by adjusting the money supply, will supply less money than is necessary to fully accommodate the increase in domestic money demand, but this action will induce a nominal exchange-rate depreciation. In general, when the economic shock is real in nature and domestic in origin, policy must negotiate a trade-off between price and exchange-rate stability.

An Increase in the Supply of Foreign Goods

For much the same reason, an increase in the supply of foreign goods could also create a policy conflict if the domestic central bank attempts to maintain both price and exchange-rate stability. An increase in foreign supply would lower the relative price of the foreign good and thereby alter both the real and nominal exchange rates. If the domestic central bank attempts to offset the appreciation of its currency through an increase in the domestic money supply, it generates a higher rate of inflation. Nonsterilized intervention is not compatible with both objectives when the shock is foreign in origin and real in nature.

The foregoing examples suggest that only when the underlying shock is domestic in origin and monetary in nature will nonsterilized intervention be compatible with both price and exchange-rate stability. In all of the other examples, nonsterilized intervention did not achieve both objectives at the same time, and the domestic central bank must compromise one or both of its policy goals. Such compromises could reduce the central bank's credibility for attaining these

[11] On this point, see Stockman (1987).

objects. A central bank that has a stated price objective weakens its commitment to that objective when it also alters policy in response to exchange-rate volatility.

On the Redundancy of Nonsterilized Intervention

Most countries, nevertheless, seem to manage some trade-off between exchange-rate and price stability apparently with no deleterious effect on their central bank's credibility for price stability. As already noted, the Federal Reserve has on occasion adjusted its monetary policy stance with an exchange market objective in mind, and it has sometimes intervened in the foreign exchange market while altering its federal funds target (see Humpage 1999). Whether one refers to such interventions as nonsterilized or as a combination of a sterilized intervention in conjunction with a monetary policy change is inconsequential. In either case, the intervention is completely unnecessary since domestic open-market operations alone can achieve the same objective.

One might expect that implementing such a policy change through the purchase or sale of foreign currency would have a bigger exchange-rate response than purchasing or selling domestic Treasury securities, but two recent empirical studies suggest otherwise. Using an event-study methodology, Bonser-Neal et al. (1998) show that federal-funds-rate-target changes are correlated significantly with changes in the spot German mark–U.S. dollar exchange rate and with changes in the Japanese yen–U.S. dollar forward premiums. Intervention undertaken in conjunction with the federal-funds-rate-target changes, however, has no apparent effect on exchange rates, even though the researchers cumulate it over the previous two weeks. We obtained essentially the same results when we repeated their experiment for the spot German mark and Japanese yen exchange rates, and when we extended their sample period somewhat (see Table 1). Unlike the original study, we do not cumulate intervention. Instead, we assume the market incorporates any information associated with intervention almost immediately. This change, however, makes no difference to the results. In Bonser-Neal et al. and in our extension of their work, intervention adds nothing to a change in the federal funds target.

In their study, Bonser-Neal et al. consider only the two-day exchange-rate response surrounding changes in the federal funds target, and they include intervention only if it is roughly contemporary with the change in the federal funds target. They do not consider the exchange-rate response to intervention when the federal funds target is unchanged. Humpage (1999) does just the opposite. He considers only exchange-rate movements immediately around intervention episodes and includes only those changes in the federal funds target that occur contemporaneously with the intervention. He estimates the probability of an intervention's success, allowing for the size of the intervention, whether or not it is coordinated, and for adjustments in the federal funds target. His estimates show that when a change in the federal funds rate accompanies an intervention, the combined operation is virtually certain to affect exchange rates. The equations, however, indicate that a changes of in the federal funds rate target alone guarantees success; as in the Bonser-Neal et al., intervention did not exert a separate influence on exchange rates.

Policy Implications

Sterilized intervention does not provide a central bank with a means of systematically influencing its exchange rates independently of its monetary policy. In general, attempts to achieve exchange-rate objectives will either prove ineffective or will succeed at the risk of possibly compromising the bank's credibility with respect to price stability. Central banks may find this risk worth taking from time to time, and our conclusions do not dispute this point. They do suggest, however, that transacting in foreign exchange—and maintaining a large open position in foreign exchange for that purpose—is wholly unnecessary. Convention instruments of monetary policy are sufficient to achieve exchange-rate objectives.

REFERENCES

Almekinders, Geert T. *Foreign Exchange Intervention, Theory, and Evidence*. Brookfield, Vt: Edward Elgar, 1995.

Bonser-Neal, Catherine, V. Vance Roley, and Gordon H. Sellon, Jr. "Monetary Policy Actions, Intervention, and Exchange Rates: A Reexamination of the Empirical Relationships Using Federal Funds Rate Target Data," *Journal of Business*, 71 (April 1998) 147-177.

Dominguez, Kathryn Mary and Jeffrey A. Frankel. "Does Foreign Exchange Intervention Matter? The Portfolio Effect, *American Economic Review* 83 (December 1993) 1356-1369.

Edison, Hali. "The Effectiveness of Central Bank Intervention: A Survey of the Literature after 1982," Princeton University, Special Papers in International Economics, No. 18, July 1993.

Baillie, R. T., O.F. Humpage, and W.P. Osterberg, "Intervention from An Information Perspective," *Journal of International Financial Markets, Institutions & Money* 10 (September/December 2000) 407–423.

Glick, Reuven and Michael M. Hutchison, "Foreign Reserve and Money Dynamics with Asset Portfolio Adjustment: International Evidence, *Journal of International Financial Markets, Institutions & Money* 10 (September/December 2000) 229-248.

Fama, Eugene, F. "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance* 25 (May 1970) 383–417.

Furlong, Frederick. "International Dimensions of U.S. Economic Policy in the 1980s." Federal Reserve Bank of San Francisco, *Economic Review* (Spring 1989) 3–13.

Ito, T. "Foreign Exchange Rate Expectations: Micro Survey Data," in Das, D.K. (ed.) *International Finance: Contemporary Issues*. New York: Routlege Press (1993).

Humpage, Owen F. "The United States as an Informed Foreign-Exchange Speculator," *Journal of International Financial Markets, Institutions & Money* 10 (September/December 2000) 407–423.

Humpage, Owen F. "U.S. Intervention: Assessing The Probability of Success," *Journal of Money, Credit and Banking* 31 (November 1999) 731–747.

Neely, Chris, Paul Weller, and Robert Dittmar. "Is Technical Analysis Profitable in the Foreign Exchange Market? A Genetic programming Approach," *Journal of Financial and Quantitative Analysis* 32 (December 1997) 405-426.

Mussa, Michael. "The Role of Official Intervention." in L. Melaned (ed.) *The Merits of Flexible Exchange Rates*. Fairfax, VA: George Mason University Press, 1981.

Peiers, Bettina "Informed Traders, Intervention, and Price Leadership: A Deeper View of the Microstructure of the Foreign Exchange Market," *Journal of Finance* 52 (September 1997) 1589-1614.

Stockman, Alan C. "The Equilibrium Approach to Exchange Rates," Federal Reserve Bank of Richmond, *Economic Review* (March/April 1987) 12–30.

Turnovsky, Stephen J. "Exchange Rate Management: A Partial Review," in Reuven Glick and Michael M. Hutchison (eds.) *Exchange Rate Policy and Interdependence*, Cambridge University Press: Cambridge, U.K. 1994.

Table 1: Two-Day Exchange Rate Response to Federal-Fund-Target-Rate Change

Time period	10/28/87 to 11/15/94	10/28/87 to 11/15/94	10/28/87 to 12/31/98	10/28/87 to 12/31/98
Observations	51	51	59	59
Dependent variable	DM per $	Yen per $	DM per $	Yen per $
Constant	-0.2516*	0.0325	-0.2311*	0.0157
	(0.1267)	(0.0840)	(0.1170)	(0.0878)
Federal funds target	0.8720**	-0.2457	0.72947*	-0.3305
	(0.4498)	(0.2444)	(0.4160)	(0.2538)
Intervention	-0.0026	0.0001	-0.0026	0.0001
	(0.0026)	(0.0008)	(0.0025)	(0.0009)
$\overline{R}^2$	0.11	0.01	0.07	-0.02
Q-statistic p-value	0.897	0.991	0.942	0.272

Note: We measured exchange-rate changes from the day before to the day after a federal-funds-target (FFT) change: $\Delta S = 100 \cdot \ln(S_{t+1}/S_{t-1})$ where *S* is foreign currency units per dollar. A federal-funds-target change is measured as: $\Delta FFT = FFT_t - FFT_{t-1}$. Bonser-Neal et al. (1998) estimate their equations from October 28, 1987, through November 15, 1994. We extend the sample through December 31, 1998. On three days, consecutive changes in the federal funds target appear in the sample data. Whereas, Bonser-Neal et al. delete these from their data set, we include them. We measure intervention on day *t*. Cumulating intervention over the previous ten days, as in Bonser-Neal et al., made no difference to the results. Estimated standard errors appear in parentheses. Single and double asterisks indicate significance at the 5% and 10% levels, respectively. The *p*-value for the Q-statistic refers to a test for first-degree autocorrelations. Regressions for the German mark-U.S. dollar exchange rates are adjusted for first-order autocorrelation using the Cochrane-Orcutt procedure. German mark-U.S. dollar regressions showed no higher-order autocorrelation. Japanese yen-U.S. dollar regressions exhibited no autocorrelation. Heteroskadasticity was never a problem.

Federal Reserve Bank
of Cleveland
Research Department
P.O. Box 6387
Cleveland, OH 44101

Address Correction Requested:
Please send corrected mailing label to the
Federal Reserve Bank of Cleveland,
Research Department,
P.O. Box 6387,
Cleveland, OH 44101