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**Intervention as Information:
A Survey**

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I. Introduction:

The consensus that has emerged from empirical research holds that central bank intervention in foreign exchange markets is largely ineffective. Overall, researchers have not found robust relationships between official transactions and exchange rates consistent with either monetary, or portfolio-balance theories of exchange-rate determination. However, much research suggests that intervention might *sometimes* affect exchange rates and that the impact might be related to informational asymmetries.

This is different from the treatment of information in previous work. For example, in early work, Mussa (1981) suggested that authorities might use intervention to signal (e.g. provide information about) future monetary policies. Even studies that view intervention as altering portfolios of government bonds denominated in different currencies make assumptions about the information available to investors. Recent work focuses more directly on informational assumptions and market microstructure.

The perception that intervention's impact is not robust is perhaps reflected in the sharp reduction in the frequency of U.S. monetary authorities interventions since the early 1990s (see figure 1). Between February 1987 and July 1990—the period associated with the Louvre Accord—the United States intervened on 235 occasions, approximately on one out of every four business days. Over the next 3 years, the United States intervened on only 38 times or on 3 percent of the business days. (Both of these episodes, however, pale in comparison with the frequency of U.S. intervention during the late 1970s and early 1980s.) Despite record breaking signal days of intervention, the average amount

transacted on a day of intervention, has increased from \$188 million in the late 1980s to \$418 million in the 1990s (see figures 2 and 3). Since August 1995, the United States has intervened only once. Moreover, events in 1989 and early 1990—when FOMC members complained that intervention sales of foreign exchange confused the markets about the Committee’s desire to tighten monetary policy—offered tacit official acknowledgement of intervention’s prospective influence on expectations.

This short survey discusses newer research analyzing informational aspects of intervention. It is intended to complement surveys by Edison (1993), Almekinders (1995) and Dominguez and Frankel (1993) and to suggest possible directions for further research. We focus on issues, rather than techniques, and focus on work published since Edison’s survey (1993). Section 1 defines intervention and distinguishes between sterilized and nonsterilized intervention. After briefly discussing asymmetric information in financial markets, section 2 discusses intervention as a signal of monetary policy and as a source of information more broadly. Section 2 also considers the connection between technical trading rules and intervention profits, as well as exchange-rate volatility. Section 3 reviews institutional aspects of U.S. intervention and the interpretation of reports of intervention. Section 4 concludes with a summary of what we know about sterilized intervention, and what needs to be learned.

II. Intervention, Sterilization, and Fundamentals.

We will define exchange-market intervention as official purchases and sales of foreign currencies that the monetary authorities undertake to influence the exchange value of currencies. This definition excludes other types of national policies, notably monetary

policy and ‘jawboning,’ that might affect exchange rates. The definition also delimits the motives underlying official foreign-exchange transactions. Central banks occasionally buy or sell foreign exchange for reasons other than influencing exchange rates. Between May and July 1990, for example, the United States undertook 17 sales of German marks to adjust the Treasury’s portfolio. These transactions, which may affect exchange rates, do not constitute intervention by our definition.¹

As just defined, intervention differs from a standard open-market operation only in terms of the instruments traded by the central bank, and like any open-market operations, intervention has the potential to alter the monetary base. This poses no particular problem for monetary policymakers when the exchange rate and inflation objectives of monetary policy are compatible, but it raises an important question that has received little attention: Do such interventions alter the effectiveness of a change in monetary policy on the exchange rate? Bonser-Neal, et.al. (1998) find that including measures of Federal Reserve interventions does not affect the response of exchange-rates to federal-funds-rate target changes. To the extent that intervention does not modify the impact of a consistent open-market operation on exchange rates, it would seem to be a redundant policy instrument.

Since the exchange rate and inflation objectives of monetary policy are often not necessarily compatible, the Federal Reserve sterilizes the intervention through offsetting open-market operations *whenever U.S. interventions threaten to compromise its federal-*

¹ Official Federal Reserve System intervention data does not always exclude such transactions. However, it is not clear that the newspapers or other media are able to distinguish these from other official foreign exchange transactions.

fund target.² As Glick and Hutchison (1999) report, the German and Japanese interventions are similarly sterilized, at least in the short-run.

Sterilized intervention is ineffective within the standard monetary model of exchange-rate determination. The process of sterilizing intervention, however, alters the amount of publicly held government debt, and therefore could affect exchange rates through a portfolio-balance channel. Direct examination of the portfolio balance mechanism requires data on holdings of government securities and thus is limited to monthly frequencies or lower. The most recent such study is Dominguez and Frankel (1993b) who find significant impacts of U.S. and German intervention in the early 1980s. However, Edison (1993)'s comprehensive survey of this approach reports many findings of statistical or economical insignificance.

III. Sterilized Intervention and Expectations

The well-known empirical shortcomings of standard macro-models of exchange-rate determination and evidence that technical trading rules can generate excess profits has heightened interest in the role of information and in the microstructure of foreign exchange markets. We suggest that it is useful to view recent work on intervention within this framework.

As Grossman and Stiglitz (1980) have argued, if information is costly, markets prices cannot continuously reflect all available information, implying that informationally

² Notice that the issue of sterilization becomes a bit murky if the FOMC sets its federal-funds-rate target to achieve an exchange-rate objective. Researchers should probably always attempt to control for monetary policy changes when investigating the effectiveness of intervention, even though the Federal Reserve routinely sterilizes intervention.

efficient markets, ala Fama (1970), must breakdown.³ Prices will instead reflect information up to the point where the marginal benefits from acquiring and trading on information equal the marginal costs. Access to information differentiates traders, while random shocks mask public information and heighten asymmetries. In such a market, prices perform a dual role of describing the terms of trade and of transferring information from more, to less informed agents. Knowledgeable traders may behave strategically, however, further distorting the information in prices (see Admati 1991).

The volume of foreign exchange trading, estimated at more than \$1.2 trillion per day, seems large relative to the volume of cross-border commercial transaction. Much of this trading (including market making) is speculative, resulting necessarily from heterogeneous information. Numerous papers offer evidence in favor of asymmetric information in foreign exchange markets. Ito (1993), for example, finds that survey data imply that expectations are not homogeneous. Ito, Lyons, and Melvin (1998) find evidence of private information in the change in intradaily volatility patterns subsequent to the introduction of lunchtime trading in the Tokyo foreign exchange market. Goldberg and Frydman (1996) show that ‘theories consistent expectations’ can generate exchange-rate patterns more consistent with observed exchange-rate behavior than can the assumption of rational-expectations. This literature suggests new mechanisms through which intervention might provide information to the market, or at least a reformulation of

³ Even if the foreign-exchange market were perfectly efficient, differences in risk aversion and wealth could produce unexploited profit opportunities.

the sense in which authorities have a clearer understanding than some private traders of market conditions.⁴

Signaling Future Monetary Policies

Early work on signaling followed Mussa (1981) who suggested that central banks might signal future changes in monetary policy through interventions, with sales or purchases of foreign exchange implying, respectively, monetary tightening or ease. Such signals could be particularly credible because the intervention would give the monetary authorities an open position in a foreign currency that would result in a loss if they failed to validate their signals. Of course, when validated these intervention signals are not sterilized. They consequently do not provide monetary authorities with an independent influence over exchange rates. Several empirical investigations (discussed below) have cast doubt on the efficacy of this mechanism for intervention.

Reeves (1997) presents a theoretical model where the central bank faces a tradeoff between meeting targets for the exchange rate and money. Key parameters determining the response of the exchange rate to intervention relate to the extent of credibility and deviations from rational expectations. She concludes that only partial credibility justifies the use of costly foreign exchange intervention. Unlike most signaling theories, here the size of the intervention influences the market's response.⁵

Policy signaling is effective only if the market did not already anticipate a monetary-policy change. Expectations about future monetary policy can be measured

⁴ Bhattachary and Weller (1997) also note that central banks might use intervention in the short run to bring about an exchange rate that is inconsistent with market fundamentals. This would, however, dissipate their future ability to signal.

with data on federal funds futures. Evidence from this market suggests that participants anticipate policy moves fairly accurately within a two-month horizons (see Carlson, et. al. 1995). The largest prediction errors occur around monetary-policy reversals. Hutchison and Fatama (1999) show that dollar interventions between 1989 and 1993 did not signal changes in future monetary policy since they were not correlated with changes in federal-funds-futures. However, the conditional variance of federal funds futures increased, suggesting that intervention increases uncertainty about future policy. In contrast, Bonser-Neal et.al. (1998) find evidence that intervention, cumulative over the previous two weeks, signals future changes in the federal funds target rate between 1987 and 1994.⁶

Lewis (1995) also offers evidence that intervention affects the federal funds rate and various monetary variables, but because the significance and the signs of the estimated coefficients are sensitive to the measurement horizon and lag structure, the results do not unambiguously support monetary signaling. Lewis also finds some evidence of reverse causation—changes in monetary variables predict offsetting changes in intervention.

Kaminsky and Lewis (1996) provide evidence that intervention predicts future monetary policies, but the sign is opposite that implied by the signaling hypothesis. They also find that when intervention is supported by consistent movements in monetary

⁵ Klein (1989) found disproportionate impacts of ‘small’ interventions.

⁶ An explanation for these starkly different results over a similar time period might focus on cumulative intervention. Does cumulative interventions convey a stronger or more credible signal than one-day interventions? If intervention does not signal changes in the federal funds rate, does it signal monetary reversals?

policy, exchange rates tend to respond in the expected direction, but when intervention is followed by inconsistent monetary policy, exchange rate tend to move in the opposite direction. This highlights the essential ambiguity in the signaling story: If intervention only works when it is consistent with monetary policy, what policy information does intervention add?

Signaling In General

There are other signaling mechanisms beyond the one highlighted in the previous section. More generally, if the central bank has consistently better information than do private traders, intervention might cause them to modify their prior estimates of the distribution of exchange-rate changes. Dominguez and Frankel (1993a) provided evidence that news reports of intervention and official policy statement during the 1980s had the ‘intended’ effect on the Deustchemark/Dollar exchange rate. While several other studies are consistent with this possibility, none specify the information being transmitted.

Bhattacharya and Weller (1997) construct a theoretical, asymmetric-information model of the foreign exchange market that explicitly incorporates intervention. In their model, the central bank can make accurate inferences about speculators’ private information, and speculators get better—but incomplete—information from observing the interventions of the central bank. This model has several implications that are consistent with empirical findings. For one, the sensitivity of the exchange rate to an intervention is not necessarily constant. Second, the sign of the response of the exchange rate depends

on the relative precision of the market's information about the exchange-rate target and market fundamentals.⁷

Humpage (1999) tested whether the Federal Reserve routinely had better information about exchange-rate movements than the market by counting successful interventions for three years following the Louvre Accord. The frequency of success was relatively low, imply that U.S. intervention generally lack forecast value. The sole exception was intervention as a predictor that recent exchange rate movements would moderate, but not reverse (leaning against the wind). Humpage found, however, that coordination and, possibly, the amount of intervention increased the probability of success.⁸ Murray, Zelmer and McManus (1996) and Beattie and Fillion (1999) use the existence of a 'non-intervention band' for the Bank of Canada to distinguish between expected and unexpected intervention. Murray, Zelmer, and McManus (1996) find that expected intervention failed to reduce the implied volatility of the Canadian dollar/US dollar exchange rate the day after intervention but that unexpectedly heavy intervention might be effective. Beattie and Fillion (1999) confirm this finding with intradaily data.

Researchers know little about the duration of an intervention's impact on spot exchange rates. Osler (1998) shows that speculators cause transitory shocks to exchange rates—like interventions—to die out slowly. Baillie and Osterberg (1997a) find evidence consistent with intervention affecting a risk premium in 30-day forward rates. Using high

⁷ A “perverse” coefficient could be consistent with a “leaning against the wind” intervention strategy. Another possible explanation for the “perverse” coefficients reported in Dominguez and Frankel (1993) or in Humpage (1989), is a failure to control for simultaneity between exchange rates and intervention in high frequency data

⁸ This raises the questions as to what constitutes a successful intervention?

frequency data, Dominguez (1997) finds that G3 intervention significantly affected dollar exchange rates, but that Japanese intervention did not affect the yen-dollar rate. She found evidence of mean reversion following Fed intervention, which was completed on average within 3 hours. This suggests that the impact of intervention is temporary.

Peiers (1997) analyzes the flow of asymmetric information around announcements of Bundesbank intervention. She assumes that the Bundesbank intervenes through Deutsche Bank, the primary market maker in the mark-dollar market, and finds that the Deutsche Bank is a temporary price leader among less well informed commercial banks. Specifically, Deutsche Bank's price adjustments Granger cause other commercial banks' price changes, especially up to 60 minutes *prior* to the Reuters report of intervention.

Technical Trading Rules and Intervention Profits

A substantial number of studies have found that fairly simple technical trading rules—including *ex ante* rules, as in Neely, Weller, and Ditmar (1997)—generate profits that are difficult to explain in terms of standard risk measures.⁹ Profits generated from technical trading rules are consistent with asymmetric information. LeBaron (1999), and Neely and Weller (1997) have shown that technical trading rules generate excess returns during periods of central bank intervention. Szakmary and Mathur (1997) associate technical trading rule profits with “leaning against the wind” intervention. If central banks smooth out, but do not reverse, exchange-rate movements, they will inevitably

⁹ Osler (1996) suggests that more elaborate trading rules largely mimic much simpler rules.

sustain valuation losses.¹⁰ By taking a position opposite that of the central bank, technical traders apparently stand to profit.

As Sweeney (1997) notes if central banks have better information than the market, then they should be consistently able to earn profits on their interventions. Sweeney (1996a) finds that on a risk adjusted basis, central banks did not incur losses (and probably made profits). Leahy (1995) demonstrates that on balance from March 1973 through December 1992, the Federal Reserve earned economically significant profits from its intervention. His calculations include valuation adjustments and net interest earning over opportunity cost.¹¹ Leahy's analysis of profits suggests superior Federal Reserve forecasting ability.

Neely (1998) reconciles the technical trading results with Leahy's profit calculations by showing that intervention profits occur over a longer time horizon than technical trading profits. In the short-run, intervention often generates losses, a point that Goodhart and Hesse (1993) also illustrate. Hence, it is possible that technical traders profit against the central bank in the short-run, while central banks profit in the long-term. Further work on these seemingly anomalous results is warranted.

Volatility

An often stated objective of intervention is to calm disorderly markets, which many researchers have interpreted as reducing conditional (expected) variance. The time series of most exchange rates exhibits distinct periods of high and low volatility with

¹⁰ Despite assertions to the contrary, unprofitable central bank intervention is not necessarily destabilizing. This is only true if the fundamental equilibrium rate is constant.

some persistence. Moreover, exchange rate changes have leptokurtotic distributions, with more of the probability mass bunching in the tails of the distribution than a normal distribution would predict. This pattern is possibly consistent with distinct configurations of information flows in the market. Admati and Pfleiderer (1988) consider a theoretical model with informed traders (speculators) and liquidity traders (driven by customer orders). In their model, periods of high variance correspond to periods of high concentrations of knowledgeable traders and of information exchange. Periods of low information suggest that information is more homogeneous. Consistent with this theoretical model, Hsieh and Kleidon (1996) show that intraday volatility may reflect market learning at the beginning of the day and inventory management by dealers at the end of the day. In a study of dollar-German mark futures prices, Ederington and Lee (1993) found that intraday and day of the week volatility patterns were mainly due to the timing of major macroeconomic announcements. Although most of the price adjustment occurs within the first minute, volatility remains considerably higher than normal for another fifteen minutes, or so, and slightly higher than normal for several hours.

Change and Taylor (1998), Baillie and Osterberg (1997b), Bonser-Neal and Tanner (1996), Huang (1997) and Dominguez (1993) find evidence that intervention tends to increase exchange-rate volatility. Galati and Melick (1999) derive the probability of one-month forward exchange rates from option prices and find that perceived intervention increases the variance of the expected future exchange rate, but not its skewness nor the kurtosis of the process. Using a simple theoretical model of

¹¹ As Leahy notes, if interest rate differentials compensates for valuation losses, a leaning-against-the-wind strategy could be profitable.

speculative behaviour, Szpiro (1994) suggest that strong interventions could produce chaotic exchange-rate dynamics. While these findings might be made consistent with theoretical models such as Admati and Pfleiderer, much further work is necessary to develop the connection between intervention, volatility, and the objectives of exchange-rate policy.

IV. Implementation of Intervention Policies

The nature and amount of information conveyed by central bank foreign exchange intervention depends partly on the way in which such policies are implemented. Three aspects of the institutional setup in the United States might be explored. First, the way in which the transactions are carried out makes it unlikely that all market participants have equal and immediate information about details of the transactions.¹² This has been discussed by Dominguez and Frankel (1993a) and also by Osterberg and Wetmore-Humes (1993, 1995). Second, it is possible that intervention authorities do not seek to signal in quite the manner suggested by academic economists. Rather they might operate directly through trading rule signals or other indicators of the market's strength and tendencies. Hung (1997) has explored this possibility for the U.S. Third, since both the U.S. Treasury (through its Exchange Stabilization Fund) and the Federal Reserve System are involved in intervention operations, the relation between the two agencies may be relevant to the interpretation of U.S. interventions. This has been discussed at length by Humpage (1994) and by Todd (1992).

¹² The model proposed by Bhattacharya and Weller (1977) has among its implications that the central bank might not want to reveal the scale of its intervention operations.

U.S. foreign exchange intervention is implemented through a trading desk at the Federal Reserve Bank of New York (FRBNY). Not surprisingly, the interventions are not announced in advance but rather the market is usually expected to circulate information about the official activities. This information might include not just the amount of the official transaction but also hints of official intentions.

The FRBNY maintains routine contact with counterparties through whom it might conduct official transactions. Potential counterparties are obligated to be available to FRBNY representatives in the early morning to discuss market developments. This contact provides part of the information that the Fed uses to determine any course of official action and also provides opportunity to hint at official intentions. Obviously the Fed can follow and assess the market's anticipations of official actions.

The list of potential counterparties is not publicly available. However, there is some reason to believe that it can be closely proxied by the membership of the Foreign Exchange Committee (FEC). The FEC includes commercial banks, brokers, and others with a presence in the foreign exchanges markets. It also includes as officers two FRBNY representatives. Among its major activities is the publication, every three years, of a survey of developments in the foreign exchange markets.

Once the U.S. officials have decided to trade foreign currency, a subset of the list of counterparties is chosen. The next intervention presumably starts farther down the list. Although the list is not public information there might well be reputational benefits to being perceived to be on it. Thus there might be reputational costs associated with being removed from it.

If the counterparty with which an order has been placed is a commercial bank acting as a dealer, then it is expected to report to the market the fact that the Fed has placed an order. On the other hand, if the Federal Reserve operates through the brokers' market with a commercial bank as its agent, then the presence of the Fed presumably would not be reported to the market. Dominguez and Frankel (1993a) have equated the distinction between the two types of intervention to a distinction between public and 'secret' intervention and have claimed to find that the latter is less effective. However, the distinction might not be quite so clear. First, although counterparties in the first group are expected to inform the market, they might do so only after a delay, albeit at the risk of some sort of official sanction. Second, it is far from clear that the information, once conveyed by the placing of an official transaction directly with a commercial bank is circulated evenly through the market.

Skepticism about the assumption that information about intervention circulates evenly through the market might be supported by consideration of the information reported by newspapers. Klein (1993), Dominguez and Frankel (1993), and Osterberg and Wetmore-Humes (1993, 1995) have each tabulated newspaper reports of intervention and have compared them to official data. (The results are not always consistent across surveys.) Moreover, newspaper reports of intervention activity are quite ambiguous, often failing to mention the currencies involved or the specific countries. The exact amount is seldom mentioned and the different newspapers often do not report the same information about intervention. Since the newspapers reputedly contact market participants directly and routinely, wide disparity among the newspaper reports appears inconsistent with the view that accurate information about intervention circulates quickly

and evenly through the market. The unavailability of official data on details such as the exact time and individual amounts of intervention is unfortunate given the recent proliferation of theoretical analyses of the microstructure of foreign exchange markets and interest in the transmission of information.

One alternative to coding newspaper reports might be to utilize information reported by wire services. However, since no individual counterparty necessarily knows the total amount of the intervention it is not clear how to interpret such reports, which have been analyzed by Goodhart and Hesse (1993). Anecdotal evidence suggests that those reporting to the wire services prepare an estimate of the total intervention based not only on their involvement but also on whatever knowledge they might have of other transactions. Since there have been few tabulations of wire service reports of intervention, it is difficult to evaluate the empirical significance of any inaccuracy in the wire service reports.

Peier's (1997) analysis of Bundesbank foreign exchange intervention provides additional support for the view that information about intervention operations is asymmetric among market participants. Peiers finds activity in the DM/\$ market around times of Bundesbank foreign exchange interventions to be consistent with price leadership by Deutsche Bank. Although it is not known whether Deutsche Bank has an advantaged position as a counterparty with the Bundesbank, market share and liquidity considerations imply that such might well be the case. The price leadership hypothesis in this case would require that the Bundesbank be using Deutsche Bank as a dealer in its intervention operations, thus granting Deutsche Bank insider information.

Writing from the FRBNY, Hung (1997) suggests that U.S. intervention, particularly that which is ‘covert’, might operate through a ‘noise-trading channel’ whereby the central bank utilizes up-to-date information about market conditions and the reaction functions of the noise-traders. According to this hypothesis, noise traders using positive feedback rules (including chartists) might incorporate covert intervention into their trendline and thereby amplify or perpetuate the initial impact of the intervention. In this story, the initial impact of the intervention is related to its size relative to the volume of the market in a short-term, flow equilibrium, especially if the market is thin. This counters the familiar claim that intervention is dwarfed by the approximately \$1 trillion daily turnover in foreign exchange markets. There are several interesting implications of this analysis, one being that intervention might seek to increase volatility in order to discourage ‘one-way speculation’ so as to correct a misalignment of exchange rate level. Hung’s (1997) hypothesis suggests an important role for the communication between the central bank and its counterparties.

Consideration of the important role of the U.S. Treasury in U.S. foreign exchange interventions might provide a qualification to the common assumption that intervention is a signal of future monetary policy. In fact, the Treasury takes the lead in formulating and recommending U.S. interventions although since 1962 the Treasury and the Fed have usually intervened in equal amounts and in the same direction. Operations for both agencies are conducted at the Federal Reserve Bank of New York.¹³ This apparent

¹³ The Federal Reserve System and the Treasury maintain separate accounts for intervention. A typical intervention is split evenly between both accounts. Countries differ on how this responsibility is shared between their central bank and their Ministries of Finance or the Treasury.

unanimity of view between the two agencies belies the possibility that intervention desired by the Treasury, say to support the currency of a major trading partner, might be at odds with the existing monetary policy stance vis-à-vis the domestic inflationary impact of a depreciating dollar. The fact that the stated policy of coordinating with the Treasury might place the monetary policy stance in jeopardy has not been lost on Fed critics of its involvement in U.S. intervention operations.

V. Conclusion: State of the Art

Empirical work to date suggests that exchange-market intervention does not operate through portfolio-balance or by a direct link with future monetary policy. However, it might sometimes influence market expectations about future fundamentals. Consequently, exchange-market intervention does not afford policy makers a means with which to routinely influence exchange rates independent of monetary policy. Successful intervention though still requires that monetary authorities have some informational advantage over private market participants pertinent to the pricing of foreign exchange. This is likely the rare exception rather than the norm.

Despite important advances in our understanding of intervention, further work is necessary. For one thing, we know very little about how the information conveyed by official foreign exchange transactions filters through the market. The findings of many studies that intervention increases exchange-rate volatility might be consistent with several mechanisms for information flow. More work needs to be done to determine how long this effect persists, and whether it can be squared with official objectives of calming

market disorder. Another unresolved question is whether the manner in which counterparties are used is of relevance to determining intervention's efficacy.

Studying the use of technical trading rules appears a promising avenue for improving the relevance of economists' modeling of exchange rate determination and it is possibly that this path will generate new insights into how agents process information about intervention. The evidence relating official intervention to the profitability of technical trading rules suggests further work on the issue of whether private speculators gain from intervention at the expense of the monetary authorities.

Finally, very few studies have looked at the role of intervention within the overall macro-policy mix. Despite much evidence on the ineffectiveness of foreign exchange intervention, authorities appear to view open-market operations conducted through the foreign exchange market as having a different exchange-rate response than open market operations undertaken through government securities.

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