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**Does Foreign Exchange Intervention Matter?
Disentangling the Portfolio and
Expectations Effects for the Mark**

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Introduction

Until recently, there was an unusual degree of consensus among economists, and among policy-makers and participants in the financial markets as well, that intervention by central banks in the foreign exchange market did not offer an effective or lasting instrument for affecting the exchange rate, at least not independently of monetary policy. The 1982 G-7 economic summit at Versailles commissioned a study of intervention, known as the Jurgenson report, which found that the effects were small and transitory at most.[2]

We think that the time is ripe for new statistical testing of the question. Many policy-makers and foreign exchange traders believe that the intervention operations that have taken place since the Plaza Agreement of September 1985 have had an effect. Moreover, the theoretical case against the effectiveness of intervention is not as clear as a reading of the economics literature might suggest.

The academic literature is predicated on the distinction between intervention operations that are sterilized and those that are not sterilized. Intervention operations that change the supplies of domestic and foreign money are considered nonsterilized. Sterilized intervention operations, in contrast, are accompanied by offsetting open-market operations which return the relevant money supply to its original level. In this paper we do not concentrate on this distinction. We study the intervention operations that actually took place between 1982 and 1987, regardless of whether they were sterilized. But we do begin in section II

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[2] Many of the econometric results, finding little or no effect, were reported in Rogoff (1984) and Henderson and Sampson (1983).

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with a review of the issues involved.[3]

In this paper we examine the two possible channels through which intervention (whether sterilized or not) can influence the foreign exchange rate: the portfolio and the expectations channels. Intervention can influence exchange rates through the portfolio channel if foreign and domestic bonds are considered imperfect substitutes in investor's portfolios. Intervention operations that, for example, increase the current relative supply of mark to dollar assets that private investors are obliged to accept into their portfolios, will force a decrease in the relative price of mark assets.[4] Intervention can also influence exchange rates, regardless of whether foreign and domestic bonds are imperfect substitutes, through the expectations channel. The public information that central banks are intervening in support of a currency (or are planning to intervene in the future) may, under certain conditions, cause speculators to expect an increase in the price of that currency in the future. Speculators react to this information by buying the currency today, bringing about the change in the exchange rate today.

While some previous empirical studies of foreign exchange intervention operations have found evidence from daily data that central banks have had a statistically significant effect on exchange rates (Loopesko (1984) and Dominguez (1987,1989)), the studies were not able to distinguish whether the effect was coming through the portfolio or the expectations channel. The goal of this study is to disentangle the

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[3] For authoritative statements, see Henderson (1984) or Obstfeld (1988).

[4] The exchange rate reaction to an increase in the relative supply of outside foreign assets may be reduced or eliminated by an increase in their expected rate of return that induces a corresponding increase in demand.

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influence of the two potential channels during the most recent experience with central bank intervention operations. The empirical work was made possible by an agreement with the German Bundesbank allowing use of confidential daily intervention data over the period 1982-1987.[5] While the Fed did not grant us official access to their daily intervention data over this period, we constructed a daily intervention series for the U.S. (including both Federal Reserve and Treasury initiated operations) from descriptions of foreign exchange desk operations published in the _Federal Reserve Bank of New York Quarterly Review_ (FNYQR) and other Federal Reserve publications.

The present study brings three distinct sources of information [related to past work by the authors] to bear on the effects of intervention. First, we measure expectations of the future spot exchange rate by means of survey data on the forecasts of market participants. These data were introduced in another context by Frankel and Froot (1987) and Dominguez (1986).[6] Second, we use daily newspaper reports of intervention and related news to distinguish public knowledge of intervention operations, a prerequisite for the expectations channel to be operative, from actual intervention operations, a prerequisite for the portfolio channel to be operative. Third, in the relationship connecting asset supplies to the risk premium, we impose the constraint that the coefficient is proportionate to the time-varying variance of the exchange rate, as it should be if investors choose their portfolios to diversify optimally.

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[5] With the understanding that it be used under certain restrictions.

[6] Subsequent studies using such survey data include Frankel and Froot (1988), Froot and Frankel (1989), Froot and Ito (1988) and Ito (1989).

These additional sources of information allow us to estimate a two-equation system: an expectations-formation equation and a portfolio-diversification equation. Our novel conclusion, based on our findings for the dollar/mark exchange rate, is that both the portfolio and expectations channels were effective during the sample period.

II. The Standard Theory: Sterilized vs. Nonsterilized Intervention

There are three standard arguments as to why the effects of intervention should be very small: the small size of intervention relative to the total market, Ricardian equivalence, and high international asset substitutability. The latter two, if valid, imply that the effects of sterilized intervention should be small or zero. The first implies that the effects of intervention should be relatively small even if nonsterilized.

While the scale of intervention operations in recent years is unprecedented, it remains small relative to the stocks or flows in the foreign exchange market. A census of the volume of foreign exchange trading recently released by the New York Fed reported a total of $186 billion per day (eliminating double-counting) in the United States in April 1989. Adding in London and Tokyo, the worldwide total probably exceeds $600 billion. Daily net positions taken by banks and other individual institutions are much smaller than the gross positions. However, the total net stocks of currencies that could in theory be brought into the market at any time are considerably larger. U.S. M2, for example, currently exceeds $3,000 billion. By comparison the average coordinated intervention operation in support of the dollar during the period January 1985 to December 1987 involved $256 million, while the average coordinated sale of

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dollars involved $208 million (Dominguez (1989), p.34).

Standard models of exchange rate determination at least allow <u>non-sterilized</u> intervention to have an effect on the exchange rate in proportion to the change in the relative supplies of domestic and foreign money, just as any other form of monetary policy does. The idea that <u>sterilized</u> intervention operations, on the other hand, have any effect at all, is less accepted. Those that conclude that sterilized intervention can have no effect, base their arguments on either "Ricardian equivalence" or the high substitutability between foreign and domestic bonds. We consider these two arguments in turn.

If government bonds imply the public liability of future taxation to service them, and if investors look far into the future, optimize intertemporily, and internalize the welfare of future generations, then government bonds are not true "outside" assets; they have no more effect on market equilibrium than the issue of an IOU by one private citizen to another. If government bonds are not true outside assets, it follows that swaps in their currency composition have no effect on the foreign exchange market equilibrium.[7]

There are many arguments against Ricardian equivalence, both theoretical and empirical; it is the sort of proposition that one would like to test rather than impose. In any case, in recent years the lines of distinction between "money" and "bonds" have become increasingly blurred. It is not clear that the creation of a Money Market Deposit Account-- which is part of M2, but is the liability of a privately-owned financial institution rather than of the government -- should have a fully

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[7] For example, Frankel (1979) and Backus and Kehoe (1988).

proportionate effect on the exchange rate, while the issue of a Treasury Bill has no effect.

Even if it is granted that government bonds are "outside" assets, the second line of argument against the effectiveness of sterilized intervention is that domestic and foreign bonds are perfect substitutes, so that changes in their relative supply have no effect.[8] A less extreme version of the argument is that substitutability is very high, even if not literally infinite, so that intervention (in the relevant magnitudes) can have very little effect quantitatively. One point that is often missed is that, even if it is true that the effect of sterilized intervention on the differential in rates of return is very close to zero, the effect on the level of the exchange rate may be relatively large. As long as changes in bond supplies matter, they should have a proportionate effect on the exchange rate (which is the relative price of foreign bonds, in the portfolio model, not just the relative price of money) in the absence of changes in the risk premium, no matter how high the degree of substitutability.[9]

Even for those who hold either to Ricardian equivalence or to the assumption that foreign and domestic bonds are perfect substitutes, there remains a channel whereby sterilized intervention can have an effect on exchange rates. Intervention operations can effect exchange rates through the signalling channel if they are used by central banks as a means of

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[8] In terms of equation (1) below, it is argued that b is infinite, or, in terms of equation (4), that rv is zero.

[9] Frankel (1985, 213-215). Once effects on the expected future rate of change in the exchange rate are taken into account, the exchange-rate effect of a one percent change in the relative supply of foreign assets could be either more or less than one percent.

conveying (or signalling) to the market inside information about future monetary policy. If market participants believe central bank intervention signals, then even though today's money supply has not changed, expectations of future monetary policy will change.[10] When the market revises its expectations of future money supplies, it also revises its expectations of the future spot exchange rate, which brings about a change in the current rate. The signalling channel is thus one example of the expectations channel mentioned in the preceding section.

It is known that daily intervention by the Federal Reserve Bank of New York is fully and automatically sterilized: the foreign exchange trading room immediately reports its dollar sales to the open market trading room, which then buys that many fewer bonds, so that the daily money supply is precisely what it would have been if no intervention had occurred. This leaves open the possibility that a Federal Reserve Board decision to try to influence the exchange rate will result in both intervention and a different money supply, say on a monthly basis. To the extent that the market learns about such decisions by observing intervention, that is a case of the signalling hypothesis. But trying to test the signalling hypothesis by observing what happens to the money supply ex post, in finite samples, would be a dubious way of approaching the question. Intervention is at best but one of many factors relevant for determining the future money supply; in finite samples the relationship might not be detectable. This is especially true of one particular argument why an increase in the supply of government debt today implies an increase in the money supply in the future. The Sargent-Wallace "unpleasant monetarist arithmetic," which

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[10] An influential statement is Mussa (1981). See also Kenen (1981).

says that an increase in debt may be explosive if it is not eventually monetized, might not take effect until far after the end of the sample period.

The Bundesbank and other smaller central banks are less prone to complete sterilization than are the U.S. authorities; during periods of undesired dollar weakness, the Bundesbank often buys dollars for marks, and to some extent allows the increase in reserves to swell the German money supply. In this study, we do not prejudge the sterilization question. To summarize, the expectations channel may or may not require that intervention be allowed to affect future money supplies. The portfolio channel presumably would require that sterilized intervention be effective, but we allow the data to tell us whether this channel is in fact operative.

III. The Standard Econometrics

The portfolio-balance theory says that investors diversify their holdings among domestic and foreign assets -- including bonds, if we do not rule them out a priori on the grounds of Ricardian equivalence -- as functions of expected rates of return. Measuring the expected rates of return requires both data on interest rates, which is easy, and data on investors' expectations of exchange rate changes, which is very hard. Some early tests assumed away this problem by setting expected depreciation equal to zero, and simply looking for a relationship between the level of the exchange rate and the supplies of domestic and foreign assets.[11] But, even aside from the expectations problem, these studies were plagued by a

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[11] For example, Branson, Haltunnen and Masson (1977). A more recent attempt, with better measures of asset supplies, is Golub (1989).

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second econometric difficulty: simultaneity.[12]

A regression specification that avoids this simultaneity problem takes the dependent variable to be the differential in expected <u>rates of return</u> between domestic and foreign assets, rather than the <u>level</u> of the exchange rate, and uses <u>ex post</u> changes in the exchange rate to measure investors' expectations by invoking the methodology of rational expectations.[13] Begin by considering the asset-demand function that determines the portfolio share x that is allocated to mark assets, as a function of the risk premium rp:

$$x = a + b \, rp \tag{1}$$

where $rp = i^{DM} - i^{\$} + \Delta s^e$, i^{DM} is the euroDM interest rate, $i^{\$}$ is the eurodollar interest rate, and Δs^e is the expected change in the dollar/mark spot exchange rate. Now invert the equation to express the risk premium as a function of the aggregate supplies of assets that must be held in market equilibrium:

$$rp = -ab^{-1} + b^{-1}x. \tag{2}$$

The special case where domestic and foreign assets are perfect substitutes is the special case where b is infinite, the coefficient b^{-1} in equation (2) is zero, and changes in assets supplies have no effect on the risk premium. According to the rational expectations methodology, the <u>ex post</u> change in the exchange rate, Δs, can be substituted for the expected change, Δs^e, because the only difference is a forecast error e that is

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[12] Coefficients on asset supplies often appeared statistically significant, but with the wrong signs. When the Bundesbank reacts to an increase in the dollar/mark rate by buying dollar assets and selling mark assets, an apparent perverse relationship between the exchange rate and the supply of dollar assets results.

[13] See Dooley and Isard (1983) and Frankel (1982a).

independent of **x** (and all other variables that are contemporaneously observable), and so we can run a regression on the resulting equation.

$$i^{DM} - i^\$ + \Delta s = -ab^{-1} + b^{-1}x + e. \qquad (3)$$

The regression estimate of the coefficient b^{-1} in equation (3) is generally found to be insignificantly different from zero, a failure to reject the null hypothesis of perfect substitutability.[14] One possible explanation for this result is that there is insufficient power in the test. One way of bringing additional information to bear is to assume that investors choose their portfolio allocation, **x**, to optimize a function of the mean and variance of end-of-period wealth, from which it follows that equation (1) holds with a constraint imposed: the coefficient is inversely proportionate to **v**, the variance of the return differential.[15] In the case where goods prices are nonstochastic, **v** is simply the variance of the exchange rate, and **a**, the minimum-variance portfolio, is closely related to the share of German goods in the consumption basket of the investor. The inverted form, equation (3), becomes:

$$i^{DM} - i^\$ + \Delta s = -a(rv) + (rv)x + e, \qquad (4)$$

where we have defined **r** to be the constant of proportionality, which is the

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[14] At least that is what studies find when assets supplies **x** are computed to include not only foreign exchange intervention, but also government budget deficits, and other forms of asset creation that usually dwarf intervention in magnitude. [E.g., Dooley and Isard (1983), Frankel (1982a), and Boothe, Clinton, Cote, and Longworth (1985).] Studies that focus more narrowly on daily changes in asset supplies through foreign exchange intervention do sometimes find an effect on the differential in rates of return: Loopesko (1984) and Dominguez (1989).

[15] References include Kouri and de Macedo (1978), Dornbusch (1983), Frankel (1982b), Adler and Dumas (1983), and Branson and Henderson (1985).

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coefficient of relative risk-aversion.[16]

The rational expectations methodology assumes that the regression error and forecast error are identical, so that the equation can be estimated subject to the constraint that the coefficient is proportionate to the variance of the error term. Despite the presumed increase in power, the empirical literature generally fails to reject the null hypothesis of perfect substitutability, which is now interpreted as risk-neutrality $(r=0)$.[17] This finding is the same when the variance v is allowed to vary over time, as in the popular ARCH models.[18]

Notwithstanding the elegance of the rational expectations methodology, several econometric problems remain in the estimation of an equation like (4), and they may be responsible for the results. First, the asset supplies x may be measured with error, or the asset demand equation (1) may hold only subject to an error term. In theory, either source of error would be fairly easy to handle, provided that the error (like investors' forecast error e) were independent of x.[19] But it seems likely that simultaneity bias has been a problem in practice, particularly since the definition of the righthandside variable, the asset share, includes the

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[16] This is the simplified form of the equation in Dornbusch (1983), where a is interpreted as equal to the share of German goods in the consumption basket of the investor in question. Krugman (1981) pointed out that a correct treatment of the convexity term that arises from Jensen's Inequality makes the constant term $-(ra - a + 1/2)v$, instead of $-a(rv)$. In what follows, the variable in the regression is v in either case, and it is only the interpretation of its coefficient that is affected.

[17] Frankel (1982b).

[18] For example, Engel and Rodrigues (1989), Attanasio and Edey (1987), and Giovannini and Jorion (1989).

[19] See Lewis (1988) and Engel and Rodrigues (1989).

spot exchange rate s as part of its computation:

$$x = (s \ DM \ / \ W),$$

where DM is the quantity of deutschemark assets supplied to the public, and W is total wealth expressed in dollars. Addressing this possible source of simultaneity bias in the estimation of portfolio-balance equations is one of the several goals of this study.[20]

IV. Expectations, and Our Two-Equation System

The second set of econometric difficulties with estimating equation (4) concern the measurement of the expectations variable in the risk premium. Even if the rational expectations methodology is valid, i.e, the forecast error e is uncorrelated in-sample with all other contemporaneous variables, there is the undeniable problem that the magnitude of the error term is extremely large. This could lead to low power: a failure to reject risk-neutrality even though the coefficient of risk-aversion is in reality greater than zero. Furthermore, there is reason to think that ex post changes in the exchange rate are a particularly bad measure of what investors expected ex ante. Independent estimates of market forecasts of exchange rates, drawn from survey data, suggest that expected depreciation varies closely with the forward discount, while ex post changes in the exchange rate do not, and tend if anything to lie in precisely the opposite direction.[21] We choose to measure expectations by using the survey data rather than ex post changes, on the grounds that (a) the evidence of bias is damaging ⸱ᴜ⸱ the latter, and (b) the magnitude of the measurement error

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[20] In terms of the identification problem, the excluded exogenous variable that will help us estimate the equation is the one that captures public news.

[21] Froot and Frankel (1989).

is almost certainly larger for <u>ex post</u> changes than for the survey data.

Thus the equation now becomes:

$$i^{DM} - i^{\$} + \Delta \hat{s}^e = -a(rv) + (rv)x + u , \qquad (6)$$

where the error term u is now meant to reflect any measurement error in the data, rather than investors' forecasting errors. In light of the many studies concluding that exchange rate changes have variances that are autocorrelated over time, we choose to estimate the variance **v** as the daily variance of exchange rate changes over the preceding week. To our knowledge, despite the incipient spread of the use of the survey data, they have not been used together with data on asset supplies and variances to estimate a risk premium equation.

Equation (6), which captures the portfolio channel through which intervention may have an effect, is only one of two equations in the system we estimate. The other is an equation of expectations formation, where the dependent variable, investors' forecast of the expected future spot rate, is measured using the survey data.

Past work with the survey data shows clearly that the expected future spot rate, in general, fluctuates roughly one-for-one in proportion to the most recent realized spot rate. But other factors enter the equation as well. Frankel and Froot (1987,1988) considered in turn three possible alternative candidates for the other factor: (1) the lagged spot rate, in which case the specification is extrapolative expectations, (2) the lagged expectation, in which case the specification is adaptive expectations, and (3) a long-run equilibrium measured by Purchasing Power Parity, in which case the specification is regressive expectations. In each case, the

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variable in question entered with statistical significance.[22]

Although a number of different surveys at different horizons are available, we use here the 1-week and 4-week ahead survey forecasts conducted by Money Market Services, International, for the period October 24, 1984 to December 18, 1987. Unlike some other surveys, it is conducted on a weekly basis (since July 1985; before that it was conducted every two weeks). Longer horizons do not seem relevant for the majority of trading in the foreign exchange market.[23]

In addition, we report results for the earlier period November 17, 1982, to October 10, 1984, when the survey was conducted every two weeks and pertains to 3-month ahead forecasts. One might expect that intervention would have a greater effect in the later period, since the Reagan Administration's firm commitment to free-floating began to change when Don Regan and Beryl Sprinkel were succeeded at the Treasury by James Baker and Richard Darman in January 1985 and when the Plaza Agreement followed in September.[24]

The specification we choose here is extrapolative expectations, in part because the data for the lagged spot rate are available on a weekly basis.

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[22] Its coefficient is only positive, with a slightly less-than-unit coefficient on the contemporaneous spot rate, when the forecast horizon is 3 months or longer.

[23] There is evidence that most foreign exchange trading takes place among banks, with rapid turnover and correspondingly short investment horizons. The recent New York Fed census of foreign exchange trading found that in April 1989 only 4.9 per cent of banks' trading was with a nonfinancial firm. In other words, banks trade with each other much more than with ultimate customers. See Goodhart (1988) and Frankel and Froot (1988) for more on this theme.

[24] The Germans began to intervene seriously to try to push the dollar down in February 1985 [Frankel (1985, pp.213) and Funabashi (1987)].

At the 4-week horizon, respondents have been observed to put negative weight on the lagged spot rate and more-than-unit weight on the contemporaneous spot rate, so that they are extrapolating the recent trend into the future to get their forecast.[25] We also include a constant term in the expectations equation, to represent the long-term equilibrium toward which investors may expect the spot rate to regress (or away from which investors may expect the spot rate to explode, as the case may be).

The third variable in our expectations equation is a NEWS variable meant to capture information appearing in the newspaper about the central bank's exchange rate policy. NEWS is set equal to +1 if there were reports of central bank action in support of the dollar, -1 if there were reports of action against the dollar, and 0 if there were no such reports. Thus we expect NEWS to have a negative effect on expectations of the future dollar/mark rate. The NEWS variable included not only reports of actual intervention but also, for example, official statements by Treasury and Central Bank officials that they would like the exchange rate to go in a particular direction, or that a G-7 meeting may be scheduled in response to exchange rate worrries.

We also include a variable for "reported intervention" equal to a dummy variable for newspaper reports of intervention (a subset of the reports captured by the NEWS variable) multiplied by the amount of true

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[25] Frankel and Froot (1988). Models based on technical analysis (which often essentially extrapolate past trends) are more widely-used by professional forecasting services, especially at short horizons, than models based on macroeconomic fundamentals (which could be viewed as regressive expectations). Euromoney magazine runs a yearly review of foreign exchange forecasting services; of 27 firms covered in 1988, 12 used only technical models, only 1 relied exclusively on fundamentals models, and 12 used a combination of the two techniques.

intervention. This variable allows us to quantify the difference between publically known intervention of a given size and discrete (so-called "stealth," or secret) intervention.

The second equation in our system is thus:

$$\hat{s}^e_{t+k} - s_t = \alpha_0 + \alpha_1(s_{t-j} - s_t) + \alpha_2 NEWS_t + \alpha_3 REPI_t + u_t \quad (7)$$

where s_t is the log of the contemporaneous spot rate, s_{t-j} is the log of the spot rate on the day of the last survey, and REPI is reported Bundesbank and Fed intervention measured in dollars. We choose to date the "contemporaneous" spot rate at 7:00 a.m. EST, so that we can be sure that it is known to market participants when they formulate the forecasts that they report to MMS International the next morning. Nevertheless simultaneity may be a problem: if demand for dollars relative to marks at 7:00 a.m. EST is in part determined by expectations reflected in the next morning's survey, then the contemporaneous spot rate s_t is endogenous. But our set-up is designed to deal with precisely this problem: we have two endogenous variables, s and s^e, and two equations to be estimated simultaneously. In terms of the identification problem, the exogenous variables that are excluded from equation (7) and that can serve as instrumental variables for s are the variance v and the total quantity of marks sold in foreign exchange intervention (measured in marks) IDM.

V. The Estimation Results

The regression results for the expectation equation (7) and the portfolio equation (6) are presented in six pairs of tables. All tables with the "A" suffix present regression results over the period November 1982 through October 1984 using 3-month-ahead survey expectations of the dollar/mark exchange rate. Tables with the "B" suffix present results over

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the period October 1984 through December 1987 using 1-month-ahead survey expectations. [Results using 1-week-ahead survey expectations also over the latter period are presented in the Appendix.] Further, in the first three pairs of tables we present single-equation estimates to provide a basis for comparison. The instrumental variable estimates for the two equations are presented in the second three pairs of tables. Finally, in all of the tables we present results for three measures of the intervention variable. "1-day" intervention is Fed and Bundesbank purchases of dollars on the day before the survey. "14-day" or "7-day" intervention is cumulated between survey dates, so that it measures total Fed and Bundesbank dollar purchases since the last survey. "Total" intervention is cumulated from the beginning of the sample period and therefore measures the relative stock supplies of outside assets denominated in dollar and mark currencies.

We begin with the expectations equation (7), reported in Tables 1A,B and 4A,B. When equation (7) is estimated by OLS allowing for a serial correlation correction (Tables 1A,B), the coefficient on the difference between the lagged and contemporaneous spot rate is generally negative, as in the extrapolative model.[26] The estimated extrapolative coefficient tends to be larger in magnitude when the regression is estimated using instrumental variables to correct for endogeneity of the spot rate (Table 4B) and when the one-week-ahead expectations are used (Appendix Table A2).

The more interesting finding is that the coefficient on the NEWS variable usually appears statistically significant for the one- and three-month horizon expectations, and of the correct sign: newspaper reports of

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[26] These are similar to estimates in Frankel and Froot (1988).

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prospective intervention in support of the dollar and related stories tend to lower expectations of the future dollar/mark exchange rate. The average news effect on the 1-month ahead expectations of the dollar mark exchange rate is on the order of .005 to .006 per cent. This is true both for the OLS estimates (Table 1) and for the instrumental variables estimates (Table 4).[27]

We now turn to the risk-premium, the portfolio equation (6). We present OLS regression results for (6) in Tables 2A,B and 3A,B and instrumental variable results in Tables 5A,B and 6A,B. The intervention variable (defined as x in the text) is expressed in each of two alternative possible ways: in terms of millions of dollars' in Tables 2A,B and 5A,B, and as a percent of total wealth W in Tables 3A,B and 6A,B. (Wealth, W, is measured as the total supply of U.S. and German federal government debt that has been issued and so must be held in investors' portfolios.) The first alternative is the approach of Loopesko (1984) and Dominguez (1987,1989). In the case when the intervention variable is simply expressed in number of dollars bought on the foreign exchange market (times the variance), its coefficient should be interpreted as r/W, rather than simply as r. The second alternative -- which is the approach of Dooley and Isard (1982,1983), Frankel (1982a,1982b), and Boothe, Clinton, Cote and Longworth (1985) -- is more in accordance with the asset-market theory of exchange rate determination; but it has in the past turned out less likely to give "good" results: intervention is in practice dwarfed by government

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[27] The reported intervention variable is less successful in the regressions than the more broadly defined NEWS variable in the early sample period (Tables 1A and 4A).

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deficits and other sources of changes in asset supplies. Finally, in the regressions where intervention is expressed as percent of wealth, we further disaggregate the data by including Bundesbank and Fed intervention separately. The three separate sets of regressions, therefore, include intervention measured as the sum of Bundesbank and Fed intervention I_t, intervention by the Bundesbank IBB_t, and intervention by the Fed $IFED_t$.[28]

Begin with the OLS estimates [tables 2 and 3]. When intervention is measured either between surveys or on the day before the survey in the latter sample period, the effect of the variance of spot changes on the risk premium is generally statistically significant at the 95 per cent level. This finding is itself of interest.[29] But our primary focus here is on the effect of intervention, and it is not statistically significant for the October 1982 - October 1984 sample period. Again, this is not surprising, as the sample size is small and this was the period when there was no official U.S. support for intervention.[30] But even for the later sample period, the OLS regressions show significance only for the effects of 1-day intervention on the 1-month-term risk premium.

As discussed earlier, the single equation estimates of the portfolio

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[28] While the magnitudes of the coefficient estimates on the intervention variable (however defined) of course change dramatically depending on whether intervention is expressed in millions of dollars or as a percent of wealth, the statistical significance of the coefficient is consistent across the two definitions. We therefore, in the interest of space, do not include regression results for Fed and Bundesbank intervention, separately, expressed in millions of dollars.

[29] Domowitz and Hakkio (1985) test for a relationship between the variance and the risk premium, with the latter defined using the conventional rational expectations methodology.

[30] Indeed, what little U.S. intervention there was shows up with a high standard error and the wrong sign when Bundesbank and Fed intervention are included separately in the regressions.

regression are vulnerable to concerns of simultaneity bias due to the endogeneity of the spot exchange rate, used to translate the marks sold in intervention into dollar terms so as to be able to divide by wealth expressed in dollars. That is why we report simultaneous-equation estimates of equation (6) in tables 5A,B and 6A,B, using as instruments: last week's spot rate, the NEWS variable, and the reported component of Bundesbank and Fed intervention. During the later period, October 1984 to December 1987, the coefficient on intervention estimated by instrumental variables is usually statistically significant at the 95 per cent level, regardless of whether it is expressed in millions of dollars (Table 5B) or as a percent of wealth (Table 6B).[31] To be specific, intervention is statistically significant when measured either between surveys or just on the day before the survey; only in the case when intervention is cumulated from the beginning of the sample so as to reflect relative stock supplies of outside dollar and mark assets is it not statistically significant.[32]

The finding that the instrumented coefficients on the intervention

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[31] Recall that, in theory, the coefficient of the product of the intervention variable and the variance is the coefficient of relative risk-aversion. When intervention is defined as percent of wealth the estimates of the coefficient of risk aversion implicit in the Tables are extremely large. This result is an artifact, not of the particular estimation technique, but of the optimal-diversification theory, as has been noted before: e.g., Krugman (1981) and Frankel (1986). It follows from equation (4) that for intervention to have a non-negligible effect on the risk premium, either the coefficient of risk-aversion r must be much higher than 2, or the proper denominator for x must be much smaller than the total stock supply of marks and dollars.

[32] The findings that recent intervention is significant, but the stock of assets sold in intervention cumulated from the beginning of the sample period is not, are the same findings as in the two kinds of past studies cited above.

variable are generally statistically significant in equation (6) [for the later sample period] implies that intervention has an effect, even if sterilized. The reason is that if mark and dollar assets were perfect substitutes, then the coefficient should be zero: changes in asset supplies would have no effect on the risk premium.

VI. A Summary of the Quantitative Effects

For purposes of illustration, we now try out some sample parameter estimates in calculations of the effect of intervention on the exchange rate. We assume in these experiments that interest rates in Germany and the United States are held constant (which, for some readers, might mean that we are talking about sterilized intervention). If interest rates were allowed to vary, then the effects in a general portfolio-balance model might be either smaller or larger than those reported here, depending on whether the intervention were sterilized or not sterilized.

First, consider the effect of intervention on the exchange rate if it is not known publically. [Recall that this experiment precludes any effects that run via expectations of future asset supplies.] Because the extrapolative parameter in the expectations equation (7) is always statistically insignificant, we take it to be zero in the baseline case. If one wants to take the extrapolative parameter to be non-zero, the baseline case is still relevant as a description of the long-run equilibrium (where $s_t - s_{t-1}$ is zero). Under these assumptions, the intervention has no effect at all on the risk premium.

It follows from equation (6) that the effect of the intervention on the spot exchange rate is simply in proportion to the change in the supply of mark assets. What is the proportion represented by, say, $100 million

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dollars of intervention? If we are thinking of non-sterilized intervention, then the denominator is relatively clear: total reserve money supplied to the banking system by the Bundesbank, which, as of the end of 1987, was $ 126.3 billion [= DM 199.7 billion / 1.5815]. Thus the effect is only .079 per cent. If we are thinking of sterilized intervention, then the effect of $ 100 million will be even smaller, because the denominator is the total supply of mark-denominated bonds, rather than just money. (But it is worth recalling again that this effect, even if small, is nonetheless not zero, according to our rejection of perfect substitutability between mark and dollar bonds.)

To get large effects on the exchange rate, we need the public to hear the news of the intervention. Our second experiment considers the effect of such information in isolation, as reflected in the coefficient on our NEWS variable, even if such intervention is in fact not taking place. [If intervention actually takes place and is publically reported, then its total effect would be the sum of the (small) effect reported in the preceding paragraph, plus the (much larger) effect reported in this paragraph, plus the effect implied by the coefficient on the REPI variable when significant.] Under our baseline case [no change in interest rates and no extrapolative expectations], the risk premium simply changes by the coefficient of NEWS in the expectation equation: .004, to take an INST estimate for one-month-ahead expectations in Table 4B. Such a change in the risk premium will have a large effect on the demand for mark versus dollar assets.

The effect of the change on the exchange rate is simply proportional to the effect on $x_t/1-x_t$, the ratio of the portfolio demand for marks to

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the portfolio demand for dollars. Our preferred estimate of the coefficient on $v_t x_t$ from equation (6), for Federal Reserve 1-day intervention, is 164,561 (this is from the last row of Table 6B: for the period October 1984 to December 1987, using the one-month risk premium and the simultaneous-equation estimate). The average value of v_t during this period was .0000115. It follows that the average effect of the news was to lower the portfolio demand for marks x_t by .0021 [=.004/(164,561 x .0000115)], and to raise $1-x_t$ by the same amount. The average value of x_t during the period (measured as total debt issued by the German government, divided by the total of German and U.S. debt) was .0994, and so the average value of $1-x_t$ was .9006. Thus the average effect of a news report was to change $x_t/1-x_t$, the ratio of the portfolio demand for marks to the portfolio demand for dollars, from .110 [=.099/.901] to .108 [= .097/.903]. This represents a 2.4 per cent decline in $x_t/1-x_t$, and therefore in the exchange rate.

At the <u>end</u> of the sample period, the value of x_t was .121 (because the value of the mark was much higher [$.613 as compared to $.437]), and so $1-x_t$ was .879. Thus the effect of a news report at that time would have been to change $x_t/1-x_t$, the ratio of the portfolio demand for marks to the portfolio demand for dollars, from .138 [=.121/.879] to .135 [=.119/.881], an effect of 2.2 per cent on the exchange rate.[33]

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[33] The [OLS] estimate for the effect of news on one-month-ahead expectations ´ı Table 1B is more highly significant statistically. If we use this estimate, .006, the average effect of the news was to lower the portfolio demand for marks x_t by .0032 [=.006/(164,561 x .0000115)], and to raise $1-x_t$ by the same amount. Thus the average effect of a news report was to change $x_t/1-x_t$, the ratio of the portfolio demand for marks to the portfolio demand for dollars, from .110 [=.099/.901] to .106 [= .096/.904]. This represents a 4 per cent decline in the exchange rate. At the <u>end</u> of the sample period, the decline in the exchange rate would have been 3 per

These effects seem rather high (and they would be considerably higher if the estimate was taken from the coefficient on Bundesbank intervention, rather than that on Federal Reserve intervention). One's intuition that the effect should in reality be smaller can easily be fit into any of several categories. First, it is possible, even if we are talking about intervention that is sterilized in the sense that there is no change in the money supply, that the interest rates will absorb some of the impact of the decreased demand for mark assets (the German interest rate rising and the U.S. interest rate falling), so that the depreciation of the mark will be smaller. One would need to specify a complete portfolio balance model to answer how big the changes in the interest rates would be. But the effect on the nominal interest differential would only have to be 30 basis points to wipe out half of the reported effect on the spot rate.

Second, if one wishes to deviate from the baseline case to consider the possibility of extrapolative expectations, then the effects reported above obtain only in the long-run equilibrium in which $s_t - s_{t-1}$ is zero. The short-run impact effect would be considerably smaller.[34] For some readers an intuitively appealing implication of extrapolative expectations is that, after the first-week impact of the news, market forecasters react further to the observed change in the exchange rate by jumping on the bandwagon, so

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cent.

[34] On the other hand, if market participants are believed to have regressive expectations, then the impact in short-run equilibrium will be higher than in long-run equilibrium, the familiar overshooting hypothesis. Estimates in Frankel and Froot (1988) show that expectations are extrapolative at the short-term horizons, as they are in the present estimates, but turn regressive at 6-month and 1-year horizons. [We did not try these horizons in our estimates here, partly because they are only available (from the Economist's Financial Report) at six-week intervals.]

that the effect grows in subsequent weeks.[35] Others may prefer to believe that expectations are regressive rather than extrapolative; or that newspaper reports or other random disturbances to the level of the spot rate, to the extent that they are not confirmed subsequently by actual observed changes in macroeconomic fundamentals, will gradually lose their effect on the spot rate as time passes, and that this "unwinding factor" is not adequately captured in our equations. This last possibility would constitute a third factor that could reduce the effect on the spot rate in long-run equilibrium below that reported above.[36]

Our own inclination is to believe that expectations only tend to be extrapolative, as opposed to regressive, in occasional periods: "speculative bubble" environments, when the foreign exchange market "loses its moorings" and forecasters forget about fundamentals. Of course, these are precisely the periods in which Central Bankers might be most interested in using the tool of intervention.[37]

The last circumstance in which the effect on the spot rate would be less than that estimated here is if the event occurs during a period when the variance is higher than it is on average. Again, these might be the

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[35] C.Fred Bergsten, for example, has urged that Central Banks intervene by "leaning into the wind," which could be interpreted as getting a bandwagon or snow-balling effect going.

[36] A related point concerns the famous "Lucas critique." If the Central Bank adopted a policy of routinely making public announcements of its intervention -- which is not its practice now -- each announcement would not continue to have the same impact as in our estimates (unless, perhaps, it was sufficiently backed up by a correspondingly greater degree of actual changes in asset supplies). Our estimates only purport to say what the effect was during the regime actually in effect during the sample period.

[37] References include Krugman (1985), Frankel (1985), Marris (1985), Frankel and Froot (1988), and Williamson and Miller (1987).

precisely periods in which Central Bankers would be most interested in using intervention as a short-term tool, to smooth "disorderly markets."[38]

Our results cannot be viewed as definitive. We plan to extend the framework in several directions, such as including other currencies. Nevertheless, to sum up, the findings for the dollar/mark rate during our mid-1980s sample period are generally favorable for the effectiveness of intervention. There appear to be statistically significant effects both through the expectations channel and through the portfolio channel. The quantitative effects can vary, depending both on the particular estimates chosen for the key parameters and on the precise experiment that one wishes to consider. But we hope that the statistical significance of the effects that we find will contribute to the debate.

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[38] On the other hand, the financial press often talks of central bankers' intervention operations as seeking to have an effect on market behavior precisely by creating extra volatility, and thereby "punishing" nasty speculators. Our estimates imply that a change in volatility can indeed have a significant impact on investors' asset demands. But, aside from the difficulty of driving out nasty destabilizing speculators without also driving out good stabilizing speculators, and aside from the general undesirability of creating needless volatility, there is another problem with this theory. If the supply of dollar assets in the market exceeds the share in the minimum-variance portfolio, then an increase in the variance will work to depreciate the dollar (for a given risk premium), which may not be the direction desired by the authorities. (Of course, the Lucas critique is again relevant, if we begin to talk about changes in the intervention regime, to change the variance on a permanent basis.)

DATA SOURCES AND VARIABLE DEFINITIONS

s_t: log of the \$/DM spot exchange rate (DRI)

$\hat{s}^e_{t,k}$:   log of Money Market Services (MMS) median k-period-ahead expectation for the \$/DM rate.

$NEWS_t$:   +1 for reports of central bank purchases, etc., in support of dollar
-1 for reports of central bank purchases, etc., in support of mark
0 for no relevant newspaper reports
(Newspapers: <u>Wall Street Journal</u>, <u>London Financial Times</u>)

$REPI^*_t$:   actual Bundesbank and Fed intervention, in millions of \$s, when reports of intervention appeared in the newspaper

v_t: daily variance of \$/DM exchange rate changes over the preceding week

$i^{DM}_{t,k}$:   euroDM k-period-ahead interest rate (DRI)

$i^{\$}_{t,k}$:   euro\$ k-period-ahead interest rate (DRI)

$\Delta \hat{s}^e_{t,k}$:   log of the MMS k-period-ahead \$/DM exchange rate minus the log of the time t \$/DM exchange rate.

I_t: sum of Bundesbank and Fed intervention, in millions of \$

IDM_t: sum of Bundesbank and Fed intervention, in millions of DM

IBB_t: Bundesbank intervention, in millions of \$

$IFED_t$:   Fed intervention, in millions of \$

* All intervention variables are known at time t (purchases and sales through the end of day t-1) and are defined in terms of number of dollars purchased.

ESTIMATION TECHNIQUE: OLS

SAMPLE: November 1982 - October 1984

$$\hat{s}^e_{t+k} - s_t = \alpha_0 + \alpha_1(s_{t-j} - s_t) + \alpha_2 NEWS_t + \alpha_3 REPI_t + u_t$$

BI-WEEKLY THREE-MONTH-AHEAD SURVEY EXPECTATION EQUATION

(OBS=51, k=90, j=14)

INTERV-ENTION	α_0	α_1	α_2	α_3	RHO	R^2	D.W.
1-DAY[a]	.018** (.003)	-.017 (.089)	-.006** (.003)	-.115-04 (.474-04)	.404** (.163)	.20	2.06
14-DAY[b]	.018** (.003)	-.021 (.088)	-.005* (.003)	-.282-05 (.501-05)	.452** (.158)	.21	2.12
TOTAL[c]	.020** (.003)	.020 (.095)	-.006** (.003)	.588-06 (.572-06)	.294 (.175)	.21	1.90

Table 1B

SAMPLE: October 1984 - December 1987

WEEKLY ONE-MONTH-AHEAD SURVEY EXPECTATION EQUATION

(OBS=133, k=30, j=7)

	α_0	α_1	α_2	α_3	RHO	R^2	D.W.
1-DAY	.008** (.002)	-.011 (.087)	-.006** (.003)	-.487-06 (.137-04)	.354** (.085)	.12	2.07
7-DAY	.008** (.002)	-.046 (.085)	-.006** (.003)	.913-05** (.351-05)	.294** (.090)	.17	2.02
TOTAL	.009** (.002)	-.025 (.086)	-.005** (.003)	.205-06 (.241-06)	.347** (.085)	.13	2.06

a) Intervention variable (REPI) is an end-of-day before the survey measure.

b) Intervention variable is an accumulated measure between survey forecasts.

c) Intervention variable is an accumulated measure from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

Table 2A

ESTIMATION TECHNIQUE: OLS

SAMPLE: November 1982 - October 1984

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta \hat{s}^{e}_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * I_t + u_{t+k}$$

BI-WEEKLY THREE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS-51, k-90)

(Intervention in millions of $)

INTERV-ENTION	β_0	β_1	β_2	RHO	R^2	D.W.
1-DAY[a]	.006 (.005)	116.90 (132.90)	-.0139 (3.0396)	.754** (.122)	.44	2.24
14-DAY[b]	.005 (.006)	93.26 (131.19)	-.1664 (.2277)	.774** (.118)	.45	2.29
TOTAL[c]	.006 (.005)	88.59 (161.81)	-.0087 (.0300)	.769** (.122)	.44	2.26

Table 2B

SAMPLE: October 1984 - December 1987

WEEKLY ONE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS-153, k-7)

1-DAY	.002 (.002)	204.99** (74.91)	.6229* (.3317)	.429** (.080)	.24	2.16
7-DAY	.002 (.002)	159.10** (73.19)	.0645 (.1205)	.436** (.081)	.22	2.17
TOTAL	.002 (.002)	-346.83 (465.62)	-.0287 (.0251)	.436** (.080)	.23	2.16

a) Intervention variable (I) is an end-of-day before the survey measure.

b) Intervention variable is an accumulated measure between survey forecasts.

c) Intervention variable is an accumulated measure from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

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Table 3A

ESTIMATION TECHNIQUE: OLS

SAMPLE: November 1982 - October 1984

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta\hat{s}^e_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * x_t + u_{t+k}$$

BI-WEEKLY THREE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS= 51, k=90)

(Intervention expressed as percent of wealth.)

INTERV-ENTION	β_0	β_1	β_2(x=I)	β_2(x=IBB)	β_2(x=IFED)	RHO	R^2	D.W.
1-DAY[a]	.006 (.005)	118.17 (132.08)	1459.91 (38646.69)			.755** (.122)	.45	2.25
	.006 (.005)	113.42 (134.04)		-4666.69 (48288.90)		.756** (.122)	.45	2.25
	.006 (.005)	116.70 (128.21)			56559.85 (137063.70)	.759** (.122)	.45	2.25
14-DAY[b]	.006 (.006)	92.46 (130.61)	-2400.69 (3011.58)			.774** (.118)	.45	2.30
	.006 (.006)	91.57 (130.87)		-2691.11 (3384.62)		.775** (.117)	.45	2.30
	.006 (.005)	106.79 (128.91)			-13169.65 (21040.87)	.760** (.122)	.45	2.29
TOTAL[c]	.006 (.006)	83.74 (163.52)	-141.02 (425.31)			.771** (.121)	.45	2.27

a) Intervention variables (I, IBB, IFED) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

Table 3B

ESTIMATION TECHNIQUE: OLS

SAMPLE: October 1984 - December 1987

$$i^{DM}_{t+k} - i^{S}_{t+k} + \Delta\hat{s}^{e}_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * x_t + u_{t+k}$$

WEEKLY ONE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS= 133, k=30)

(Intervention expressed as percent of wealth.)

INTERV-ENTION	β_0	β_1	β_2(x=I)	β_2(x=IBB)	β_2(x=IFED)	RHO	R^2	D.W.
1-DAY[a]	.002 (.002)	202.81** (74.68)	9351.99* (5067.35)			.431** (.080)	.24	2.16
	.002 (.002)	201.34** (75.07)		9154.76* (5410.92)		.433** (.080)	.24	2.16
	.002 (.002)	175.42** (70.88)			134188.70** (51228.66)	.433** (.080)	.26	2.15
14-DAY[b]	.002 (.002)	161.79** (72.67)	1282.98 (2367.96)			.435** (.081)	.22	2.17
	.002 (.002)	138.59* (77.64)		3891.16 (4184.79)		.420** (.083)	.23	2.16
	.002 (.002)	166.63** (75.25)			376.55 (4664.66)	.448** (.080)	.22	2.17
TOTAL[c]	.002 (.002)	262.80 (385.00)	96.75 (373.51)			.445** (.079)	.22	2.16

a) Intervention variables (I, IBB, IFED) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

ESTIMATION TECHNIQUE: INSTRUMENTAL VARIABLES

SAMPLE: November 1982 - October 1984

$$\hat{s}^e_{t+k} - s_t = \alpha_0 + \alpha_1(s_{t-j} - s_t) + \alpha_2 NEWS_t + \alpha_3 REPI_t + u_t$$

BI-WEEKLY THREE-MONTH-AHEAD SURVEY EXPECTATION EQUATION

(OBS= 51, k=90, j=14)

INSTRUMENTS: v_t, IDM_t

INTERV-ENTION	α_0	α_1	α_2	α_3	RHO	R^2	D.W.
1-DAY[a]	.018**	-.019	-.007**	-.322-04	.391	.20	2.05
	(.003)	(.096)	(.003)	(.509-04)	(2.993)		
14-DAY[b]	.019**	.005	-.007**	.293-05	.361	.19	1.99
	(.003)	(.097)	(.003)	(.548-05)	(.969)		
TOTAL[c]	.021**	.059	-.007**	.105-05*	.193	.21	1.78
	(.002)	(.098)	(.003)	(.570-06)	(2.329)		

Table 4B

SAMPLE: October 1984 - December 1987

WEEKLY ONE-MONTH-AHEAD SURVEY EXPECTATION EQUATION

(OBS= 133, k=30, j=7)

INTERV-ENTION	α_0	α_1	α_2	α_3	RHO	R^2	D.W.
1-DAY	.008**	-.033	-.004	.634-05	.321	.12	2.06
	(.002)	(.092)	(.003)	(.145-04)	(2.055)		
7-DAY	.008**	-.056	-.005*	.985-05**	.280	.16	2.02
	(.002)	(.089)	(.003)	(.365-05)	(1.134)		
TOTAL	.009**	-.057	-.003	.224-06	.324	.12	2.05
	(.002)	(.091)	(.003)	(.255-06)	(.680)		

a) Intervention variables (REPI, IDM) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

Table 5A

ESTIMATION TECHNIQUE: INSTRUMENTAL VARIABLES

SAMPLE: November 1982 - October 1984

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta\hat{s}^e_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * I_t + u_{t+k}$$

BI-WEEKLY THREE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS= 51, k=90)

INSTRUMENTS: s_{t-j}, $NEWS_t$, $REPI_t$

(Intervention in millions of $)

INTERV-ENTION	β_0	β_1	β_2	RHO	R^2	D.W.
1-DAY[a]	.006 (.005)	-29.19 (177.31)	-3.7774 (4.1051)	.742** (.234)	.42	2.32
14-DAY[b]	.007 (.006)	-83.69 (178.06)	-.3502 (.3060)	.774** (.188)	.42	2.38
TOTAL[c]	.011** (.003)	369.85 (240.34)	.1383** (.0530)	.348 (.272)	.25	1.86

Table 5B

SAMPLE: October 1984 - December 1987

WEEKLY ONE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS= 133, k=30)

	β_0	β_1	β_2	RHO	R^2	D.W.
1-DAY	.002 (.002)	181.39** (82.23)	.7631** (.3666)	.421** (.181)	.24	2.15
7-DAY	.002 (.002)	72.49 (88.11)	.6822** (.2639)	.288 (.226)	.08	2.08
TOTAL	.002 (.002)	-1466.38 (1022.72)	-.0877 (.0556)	.413** (.156)	.20	2.12

a) Intervention variables (I, REPI) are end-of-da⸱ ⸱⸱fore the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

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Table 6A

ESTIMATION TECHNIQUE: INSTRUMENTAL VARIABLES

SAMPLE: November 1982 - October 1984

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta\hat{s}^e_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * I_t + u_{t+k}$$

BI-WEEKLY THREE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS= 51, k=90)

INSTRUMENTS: s_{t-j}, $NEWS_t$, $REPI_t$

(Intervention expressed as percent of wealth.)

INTERV-ENTION	β_0	β_1	$\beta_2(x=I)$	$\beta_2(x=IBB)$	$\beta_2(x=IFED)$	RHO	R^2	D.W.
1-DAY[a]	.007 (.005)	-26.59 (176.43)	-47995.06 (51772.59)			.739** (.236)	.42	2.32
	.007 (.005)	-44.30 (181.17)		-66774.58 (67367.29)		.744** (.230)	.42	2.34
	.007 (.005)	17.04 (169.34)			-94185.31 (170303.10)	.735** (.252)	.43	2.26
14-DAY[b]	.007 (.006)	-81.21 (176.74)	-4752.69 (4012.84)			.772** (.189)	.43	2.38
	.007 (.006)	-81.15 (177.21)		-5139.13 (4547.90)		.774** (.188)	.43	2.38
	.007 (.005)	-57.21 (172.54)			-33020.97 (26579.35)	.743** (.209)	.42	2.37
TOTAL[c]	.011** (.003)	367.05 (248.29)	1889.46** (782.57)			.377 (.264)	.25	1.87

a) Intervention variables (I, IBB, IFED, REPI) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

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Table 6B

ESTIMATION TECHNIQUE: INSTRUMENTAL VARIABLES

SAMPLE: October 1984 - December 1987

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta\hat{s}^{e}_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * I_t + u_{t+k}$$

WEEKLY ONE-MONTH-AHEAD RISK PREMIUM EQUATION

(OBS= 133, k=30)

INSTRUMENTS: s_{t-j}, $NEWS_t$, $REPI_t$

(Intervention expressed as percent of wealth.)

INTERV-ENTION	β_0	β_1	$\beta_2(x=I)$	$\beta_2(x=IBB)$	$\beta_2(x=IFED)$	RHO	R^2	D.W.
1-DAY[a]	.002 (.002)	178.12** (81.99)	11358.59** (5577.35)			.422** (.180)	.24	2.16
	.002 (.002)	178.04** (82.48)		11600.19* (5962.68)		.424** (.178)	.24	2.16
	.002 (.002)	146.13* (78.09)			164561.40** (65998.75)	.425** (.188)	.26	2.15
14-DAY[b]	.002 (.002)	108.14 (83.51)	11799.42** (4665.94)			.293 (.227)	.12	2.08
	.003 (.002)	37.16 (92.16)		15615.49** (7153.92)		.320 (.216)	.19	2.11
	.001 (.002)	215.69** (92.43)			20456.96** (10097.24)	.352* (.188)	.12	2.11
TOTAL[c]	.002 (.002)	877.18 (862.13)	726.43 (848.06)			.413** (.157)	.21	2.16

a) Intervention variables (I, IBB, IFED, REPI) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

Table A1

ESTIMATION TECHNIQUE: OLS

SAMPLE: October 1984 - December 1987

$$\hat{s}^e_{t+k} - s_t = \alpha_0 + \alpha_1(s_{t-j} - s_t) + \alpha_2 NEWS_t + \alpha_3 REPI_t + u_t$$

WEEKLY ONE-WEEK-AHEAD SURVEY EXPECTATION EQUATION

(OBS=153, k=7, j=7)

INTERV-ENTION	α_0	α_1	α_2	α_3	RHO	R^2	D.W.
1-DAY[a]	.004** (.001)	-.111 (.076)	-.002 (.002)	-.139-04 (.123-04)	.077 (.085)	.04	1.99
7-DAY[b]	.004** (.001)	-.084 (.075)	-.004* (.002)	.639-05** (.296-05)	.050 (.085)	.06	1.99
TOTAL[c]	.004** (.001)	-.103 (.075)	-.003 (.002)	.405-06 (.582-06)	.072 (.086)	.03	1.99

Table A2

ESTIMATION TECHNIQUE: INSTRUMENTAL VARIABLES

INSTRUMENTS: v_t, IDM_t

	α_0	α_1	α_2	α_3	RHO	R^2	D.W.
1-DAY	.004** (.001)	-.114 (.076)	-.002 (.002)	-.132-04 (.124-04)	.073 (1.599)	.04	1.99
7-DAY	.004** (.001)	-.085 (.075)	-.004* (.002)	.644-05** (.296-05)	.049 (.675)	.06	1.99
TOTAL	.004** (.001)	-.108 (.076)	-.003 (.002)	.395-06 (.582-06)	.069 (1.136)	.03	1.99

a) Intervention variables (REPI, IDM) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

Table A3

ESTIMATION TECHNIQUE: OLS

SAMPLE: October 1984 - December 1987

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta \hat{s}^e_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * I_t + u_{t+k}$$

WEEKLY ONE-WEEK-AHEAD RISK PREMIUM EQUATION

(OBS=153, k=7)

(Intervention in millions of $)

INTERV-ENTION	β_0	β_1	β_2	RHO	R^2	D.W.
1-DAY	.001 (.001)	139.20** (59.14)	.2978 (.4177)	.132 (.083)	.06	2.00
7-DAY	.001 (.001)	121.47** (57.15)	.0281 (.0922)	.141 (.085)	.06	2.00
TOTAL	.001 (.001)	155.68 (117.12)	.0054 (.0173)	.150* (.083)	.06	2.01

Table A4

ESTIMATION TECHNIQUE: INSTRUMENTAL VARIABLES

INSTRUMENTS: s_{t-j}, $NEWS_t$, $REPI_t$

	β_0	β_1	β_2	RHO	R^2	D.W.
1-DAY	.001 (.001)	150.53** (59.88)	.5316 (.4444)	.120 (.529)	.06	2.00
7-DAY	.001 (.001)	94.94 (62.45)	.3339* (.1942)	.085 (.476)	-.002	1.99
TOTAL	.001 (.001)	-110.76 (183.65)	-.0404 (.0295)	.143 (.346)	.02	2.01

a) Intervention variables (I, REPI) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

Table A5

ESTIMATION TECHNIQUE: OLS

SAMPLE: October 1984 - December 1987

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta \hat{s}^e_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * x_t + u_{t+k}$$

WEEKLY ONE-WEEK-AHEAD RISK PREMIUM EQUATION

(OBS= 153, k=7)

(Intervention expressed as percent of wealth.)

INTERV-ENTION	β_0	β_1	$\beta_2(x=I)$	$\beta_2(x=IBB)$	$\beta_2(x=IFED)$	RHO	R^2	D.W.
1-DAY[a]	.0007 (.001)	135.95** (58.93)	3795.20 (6463.70)			.135 (.083)	.07	2.00
	.0008 (.001)	128.67** (59.39)		1559.10 (6920.63)		.142* (.084)	.06	2.01
	.0006 (.001)	124.59** (55.13)			108418.90** (43646.26)	.149* (.083)	.10	2.00
7-DAY[b]	.0008 (.001)	122.86** (56.56)	520.10 (1855.86)			.141 (.085)	.06	2.00
	.0009 (.001)	112.08* (61.40)		1958.37 (3604.52)		.135 (.086)	.07	2.00
	.0008 (.001)	123.73** (57.65)			21.89 (3473.89)	.147* (.085)	.06	2.01
TOTAL[c]	.0008 (.001)	152.23 (120.18)	88.86 (329.60)			.148* (.083)	.06	2.01

a) Intervention variables (I, IBB, IFED) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

Table A6

ESTIMATION TECHNIQUE: INSTRUMENTAL VARIABLES

SAMPLE: October 1984 - December 1987

$$i^{DM}_{t+k} - i^{\$}_{t+k} + \Delta \hat{s}^{e}_{t+k} = \beta_0 + \beta_1 v_t + \beta_2 v_t * I_t + u_{t+k}$$

WEEKLY ONE-WEEK-AHEAD RISK PREMIUM EQUATION

(OBS= 153, k=7)

INSTRUMENTS: s_{t-j}, $NEWS_t$, $REPI_t$

(Intervention expressed as percent of wealth.)

INTERV-ENTION	β_0	β_1	$\beta_2(x=I)$	$\beta_2(x=IBB)$	$\beta_2(x=IFED)$	RHO	R^2	D.W.
1-DAY[a]	.0007 (.001)	145.31** (59.61)	6955.65 (6807.14)			.125 (.513)	.06	2.01
	.0007 (.001)	139.05** (60.15)		5068.78 (7302.60)		.131 (.492)	.06	2.00
	.0005 (.001)	124.15** (55.98)			152013.50** (52915.65)	.154 (.415)	.10	2.00
7-DAY[b]	.0007 (.001)	111.20* (59.46)	6565.03* (3652.25)			.080 (.486)	.001	1.99
	.001 (.001)	32.40 (77.91)		15283.79** (7505.97)		.056 (.473)	-.02	2.00
	.0004 (.001)	159.35** (61.10)			8327.80 (6157.68)	.108 (.454)	.03	2.00
TOTAL	.0007 (.001)	-71.99 (192.86)	-617.60 (571.93)			.157 (.339)	.04	2.01

a) Intervention variables (I, IBB, IFED, REPI) are end-of-day before the survey measures.

b) Intervention variables are accumulated measures between survey forecasts.

c) Intervention variables are accumulated measures from the beginning of the sample period.

* significant at the 90% level; ** significant at the 95% level.

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