

Board of Governors of the Federal Reserve System

International Finance Discussion Papers

Number 380

May 1990

Foreign Currency Operations: An Annotated Bibliography

Hali J. Edison

NOTE: International Finance Discussion Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to International Finance Discussion Papers (other than an acknowledgment that the writer has had access to unpublished material) should be cleared with the author or authors.

ABSTRACT

This paper is an annotated bibliography of recent research on foreign exchange market intervention. Most of the paper is devoted to empirical studies of the effectiveness of intervention.

The paper describes the analytical framework within which most of this research has been conducted. Researchers have identified two principal channels through which sterilized intervention has its effects: the portfolio balance channel and the expectations or signalling channel. The great bulk of formal statistical tests of the effectiveness of sterilized intervention operating through the portfolio balance channel (influencing the relative supplies of bonds denominated in different currencies) have not found a quantitatively significant effect for sterilized intervention. In all of the much smaller number of studies of the expectations channel (influencing the expected future exchange rate), intervention has been found to have at least some statistically significant effect; most of these studies do not assess the quantitative significance of the effects that researchers found.

Foreign Currency Operations: An Annotated Bibliography

I.	Introduction	1
II.	Definition of Intervention	7
III.	Portfolio Balance Models	7
IV.	Studies of the Expectations or Signalling Channel and of the Differential Effects of Coordinated and Noncoordinated Intervention	28
V.	Descriptive Studies of Particular Episodes of Intervention	34
VI.	Studies of the Profitability of Intervention	37
VII.	Studies of Factors Promoting Intervention and of the Extent of Sterilization of Intervention	41
VIII.	Studies That Do Not Make Use of Data on Bond Supplies or Intervention.....	43
	A. Studies of the Joint Hypothesis	43
	B. Studies of Maximizing Models with Imperfect Substitutability	45

Foreign Currency Operations: An Annotated Bibliography

Hali J. Edison¹

I. Introduction

This document is an annotated bibliography of recent research on foreign currency operations or exchange market intervention. It includes studies undertaken for the G-7 Working Group on Exchange Market Intervention (1982-83); subsequent studies on intervention, primarily key empirical contributions; and some related studies.²

There are two types of exchange market intervention: nonsterilized and sterilized. Nonsterilized intervention affects the monetary base, but sterilized intervention does not. Most of the studies included in this bibliography address the central question regarding intervention: Does sterilized intervention have a quantitatively significant effect on the

1. The author is an economist in the Division of International Finance. This paper represents the views of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff. I would like to thank Dale Henderson for his invaluable guidance and input. I would also like to thank William Helkie, Mike Leahy, Bonnie Loopesko, Dianne Pauls, Ralph Smith, Ted Truman, and Ralph Tryon for their helpful comments and suggestions.

2. The G-7 Working Group completed its report in January 1983. It was released in April 1983. The report is officially entitled the Report of the Working Group on Exchange Market Intervention and is commonly referred to as the "Jurgensen Report". The Report itself draws no explicit conclusions. The official press release of the G-7 Finance Ministries and Central Bank Governors, who received and reviewed the report, states that the analysis in the report seems to suggest that (1) sterilized intervention has a much smaller impact on exchange rates than does nonsterilized intervention; (2) sterilized intervention can have some short-run impact on exchange rates and may therefore be effective in achieving some short-run exchange market objectives; (3) sterilized intervention does not appear to have much long-run impact, and its effects are often swamped by those of other macroeconomic policies; and (4) coordinated intervention is more effective than intervention by a single country, although the conditions for successful coordination are exacting.

exchange rate?³ A few studies address other important questions regarding intervention: First, does coordinated intervention have a different effect than noncoordinated intervention?⁴ Second, has intervention been profitable? Third, what factors have prompted intervention? Fourth, to what extent has intervention been sterilized?

Researchers have identified two channels through which sterilized intervention might affect exchange rates: (1) a portfolio balance channel and (2) an expectations or signalling channel. Sterilized intervention can affect spot exchange rates through a portfolio balance channel if domestic currency bonds and foreign currency bonds are imperfect substitutes, even if the expected future exchange rate is fixed.^{5 6} Sterilized intervention changes the relative supplies of domestic and foreign bonds. A change in relative bond supplies necessitates a change in relative quantities of bonds demanded. Relative bond demands depend on expected returns and financial wealths. The expected return on domestic bonds is just the domestic interest rate and the expected return on foreign bonds is the foreign

3. A quantitatively significant effect is one that is predictable, sizeable, and lasting.

4. Coordinated intervention occurs when two central banks intervene in the same direction. Noncoordinated intervention occurs either when only one central bank intervenes or when two central banks intervene in opposite directions. Noncoordinated intervention has sometimes been referred to as unilateral intervention.

5. The case in which the expected future exchange rate is fixed is considered in order to keep the explanation of the portfolio balance channel as simple as possible. The expected future exchange rate would be unaffected by a change in the relative supplies of domestic and foreign bonds if this change were temporary.

6. In addition, it must be assumed that private agents do not regard the bond holdings of the authorities as their own. If private agents do regard the bond holdings of the authorities as their own, then a change in relative bond supplies resulting from a sterilized intervention operation is matched by an equal change in private relative bond demands, so there is no need for any change in expected returns and financial wealths.

interest rate plus the expected rate of depreciation of the domestic currency. Sterilized intervention leaves monetary bases and, thus, interest rates unchanged.⁷ Therefore, the spot exchange rate must change in order to bring about the required change in relative quantities of bonds demanded through changes in the expected return on foreign bonds and financial wealths.

Sterilized intervention can affect the spot exchange rate through an expectations channel if a change in relative bond supplies conveys any kind of information that causes agents to change their estimate of the expected future exchange rate, even if domestic and foreign bonds are perfect substitutes when their expected returns are equal. A change in the expected future exchange rate changes the expected return on foreign bonds. If domestic and foreign bonds are perfect substitutes, both types of bonds are held only if the domestic interest rate equals the expected return on foreign bonds. As stated above, sterilized intervention leaves interest rates unchanged. Therefore, the spot exchange rate must change by as much as the expected future exchange rate changes in order to reestablish equality between the domestic interest rate and the expected return on foreign bonds.

The rest of this bibliography is divided into seven more sections. Section II contains more detailed definitions of nonsterilized and sterilized intervention. In each remaining section, a brief overview

7. This conclusion is based on some implicit assumptions about the variables that affect the demand for a country's monetary base and the behavior of those variables in the short run. It is assumed, for example, that the demand for the domestic country's monetary base depends only on a domestic price index, a measure of domestic real economic activity, and the domestic interest rate and that only the domestic interest rate is free to vary in the short run.

precedes a listing of papers. In all but the last section, the listing is annotated.

Sections III - V include empirical studies that address the central question of whether sterilized intervention has a quantitatively significant effect on the exchange rate. Section III is devoted to formal statistical studies of the portfolio balance channel. In the great bulk of these studies, the researchers did not find a quantitatively significant effect for sterilized intervention. In most of the studies, the researchers did not find a statistically significant effect for sterilized intervention. In a few, the researchers found an effect that was statistically but not quantitatively significant. In one study, the researchers found a quantitatively significant effect.

Section IV includes the few available formal statistical studies of the expectations or signalling channel and the relative effects of coordinated and noncoordinated intervention. Some of these studies are preliminary. Daily data are used in all but one study. In some of the studies, it is assumed that sterilized intervention can affect the exchange rate through both the expectations channel and the portfolio balance channel, but in others it is assumed that sterilized intervention can affect the exchange rate only through the expectations channel. In all of the studies, the researchers found that sterilized intervention has some statistically significant effect through the expectations channel, but in one study the researcher found that the effect was very short-lived. In two studies, the researchers found that the difference between the effects of coordinated and noncoordinated intervention was statistically significant, but in one study, the researcher found that it was not. In most of the

studies, the researchers did not assess the quantitative significance of the effects that they found.

Just because a quantitatively significant effect for sterilized intervention has not been found in most of the research studies reviewed in Sections III and IV does not mean that such an effect definitely does not exist. The researchers used particular assumptions, data, and techniques, and other researchers using different assumptions, data, and techniques might reach different conclusions.

The studies in Section V are descriptive studies of particular episodes of intervention. Most of the descriptive studies included in this bibliography were undertaken for the G-7 Working Group. In these studies, it was concluded that sterilized intervention had a temporary impact on the exchange rate and that it was useful as a short-run tool to stabilize trading conditions and provide time to make policy adjustments.

Section VI is devoted to studies that address the question of whether intervention has been profitable. In most of these studies, the researchers found that intervention was profitable for a majority of the time intervals considered.

Section VII includes studies that address the questions of what factors have prompted intervention and to what extent intervention has been sterilized. In these studies, the researchers estimated policy reaction functions for intervention operations and for conventional open market operations. The researchers who analyzed intervention behavior found that intervention was undertaken to smooth nominal and real exchange rates, to achieve a target level of the nominal exchange rate, and for some other reasons. Most of the researchers who analyzed sterilization behavior found that a large part of intervention has been sterilized.

Section VIII includes two types of empirical studies which do not make use of data on bond supplies or intervention: (1) studies of the joint hypothesis that domestic and foreign bonds are perfect substitutes and that exchange rate expectations are rational and (2) studies of maximizing models with imperfect substitutability between domestic and foreign bonds.⁸ These studies are listed because they are closely related to the other studies in the bibliography. They are not annotated because they do not directly address questions regarding intervention.

8. In the theoretical models used in some of these studies to derive the relations that are used in the empirical work, sterilized intervention has no effect because it is assumed that private agents treat the bond holdings of the authorities as their own. See footnote 6.

II. Definition of Intervention

Intervention has the direct effect of altering the balance sheet of the monetary authority. When a central bank intervenes in the foreign exchange market it, in effect, exchanges bonds denominated in foreign currency for its own domestic currency reserve liabilities to commercial banks. This action has two immediate effects: both the stock of bonds denominated in foreign currency held by the public (at home and abroad) and the domestic monetary base change. This type of intervention is conventionally referred to as nonsterilized. When foreign exchange intervention is nonsterilized it can affect exchange rates by changing the stock of base money -- a change that leads to adjustments in broader monetary aggregates, in interest rates, and in market expectations.

If the monetary authority also sells or purchases domestic-currency bonds in exchange for its own domestic currency reserve liabilities so that the monetary base remains unchanged, the initial exchange market intervention is said to be sterilized. In this sense, sterilized intervention is a 'pure' change in the relative stocks of national-currency bonds held by the public that is not accompanied by a change in the monetary base. In discussing the macroeconomic effects of intervention the focus in this paper is on sterilized intervention. In particular, the review addresses the important question of whether intervention can have significant effects on exchange rates independent of the effects of monetary policy.

III. Portfolio Balance Models

As was stated in the introduction, it is postulated that sterilized intervention may influence the exchange rate through two possible

channels: (1) the portfolio balance channel and (2) the expectations (signalling) channel. These two channels would not be operative if (1) assets denominated in different currencies were perfect substitutes and/or (2) if current market prices perfectly reflect future prices as the theory of rational expectations suggests. Many researchers have used ex post rates-of-return to test this joint hypothesis -- that assets are perfect substitutes and rational expectations holds -- not necessarily with the intention of testing for the effectiveness of intervention.⁹ In these tests, one cannot differentiate between the two hypotheses, but can only test jointly for their validity. There is considerable evidence, using many different types of tests on different data sets, that strongly rejects this joint hypothesis.

Attempts at explaining the rejection of the joint hypothesis abound in the literature. It is possible to divide the explanation of this rejection into models that have macroeconomic foundations, which tend to focus on the issue of the effectiveness of intervention, and those that have microeconomic (finance) foundations, which tend to focus on the various aspects of risk. The portfolio balance approach is an important member of the macroeconomic group. A salient feature of the portfolio balance approach is that it is based on a set of *postulated* (or *ad hoc*) asset demand equations where rates-of-return are endogenous and asset supplies are policy determined. Typically, the ex post rate-of-return is expressed as a function of outstanding stocks of foreign and domestic securities and

9. The ex post rate-of-return is the difference between the rate-of-return on domestic assets and the expected rate-of-return on foreign assets in domestic terms, where the expected rate of depreciation of the domestic currency is replaced by the actual rate of depreciation by assuming rational expectations.

wealth. This approach tends to be motivated by policy considerations and focuses on the effectiveness of sterilized intervention.

The main thrust of the *postulated* demand literature is that a necessary and sufficient condition for sterilized intervention to affect the exchange rate and interest rates is that securities denominated in different currencies are imperfect substitutes. This condition requires certain qualifications. This proposition may not hold if a government exchange of foreign for domestic assets with domestic residents has no effect because private agents fully take account of all future net taxes levied by the government. In this extreme case of *Ricardian equivalence* between debt issue and taxes, the government cannot systematically affect the relevant "outside" bond supplies -- the net supply of claims on governments that the public must hold. Therefore, in a Ricardian world imperfect substitutability of assets is not a sufficient condition for sterilized intervention to affect exchange rates.

Most of the empirical studies summarized in this section use some form of a *postulated* portfolio balance model to analyze the effects of intervention in exchange markets. In such models, asset holders allocate their wealth among different assets in shares that are increasing functions of the expected returns on each asset. If investors are averse to risk and if rates-of-return are uncertain, investors will diversify their portfolios instead of holding only the one asset with the highest expected return.

The portfolio balance model consists of demand equations for domestic and foreign assets. It explains the demand for each asset as a function of expected returns, wealth, and a variable representing transactions demand. Equilibrium occurs when the demand for each asset is equal to its supply; relative rates-of-return on each asset adjust to

maintain equilibrium. In this framework, adjusting the spot exchange rate can change the value in domestic currency of assets denominated in foreign currency and alter the expected rate-of-return on foreign assets.¹⁰

Three basic approaches have been adopted in the estimation of this type of model. The first approach, the direct approach, is simply to estimate the structural asset demand equations of portfolio balance models. Asset demands are specified as linear functions of expected returns. This approach tends to be straightforward for money demand equations, but is more complicated for bond-demand equations because data are unavailable for the typical level of aggregation that is needed. To circumvent this problem, the model is frequently estimated by aggregating the asset demands to derive total demand functions for domestic and foreign-currency bonds -- data that are readily available. The coefficients on the rate-of-return variable in the asset demand function reflect the degree of asset substitutability. A small coefficient indicates assets are imperfect substitutes; while a large coefficient implies assets are close substitutes.

The second approach, the inverted asset demand approach, estimates inverted *postulated* asset-demand functions, whether aggregated or not, so

10. The general specification of the postulated asset demand models assumes that the residents of both countries hold four assets: home money, foreign money, home (currency) securities, and foreign (currency) securities. Many of the models summarized in this bibliography have used models that have made several simplifying assumptions, such as: (1) Residents do not hold foreign currency (no currency substitution). (2) Each country's demand for money is independent of the return on the security denominated in the foreign currency. (3) All changes in residents' demand for money resulting from changes in nominal income and prices are matched by changes in demand for securities denominated in their country's currency. (4) Demand for money is independent of nominal wealth in each country. Further details about the specification of the postulated asset demand functions are described in Branson and Henderson (1985).

that the rate-of-return variable appears on the left-hand-side. The rate-of-return variable is typically the ex post rate-of-return, the difference between the expected returns on domestic and foreign currency bonds after having invoked the rational expectations hypothesis. Under the null hypothesis of perfect substitutes the coefficients on the right-hand-side are all zero. Under the alternative hypothesis of imperfect substitutability, the coefficients are finite but not zero. To reject the joint hypothesis of rational expectations and perfect substitutability, all the coefficients on the right-hand-side should be jointly significant. In particular, if the portfolio balance channel holds, then the coefficients on the asset supplies also will be statistically significantly different from zero. The empirical estimates could reject the joint hypothesis and also reject the perfect substitutes hypothesis. This would occur if the right-hand-side coefficients are all zero, but the error follows some process other than white noise.

Two econometric problems can arise in connection with the estimation of asset demand functions in either direct or inverted form. First, several endogenous variables appear on the right-hand-side of the equation. Second, assuming that expectations are rational implies that the overall equation error has unusual properties. Under the assumption of rational expectations, the ex post return is used as a proxy for the expected return. The difference between the ex post return and the expected return is a forecast error. The overall equation error depends both on this forecast error and on an ordinary equation error. The presence of the forecast error gives rise to the unusual properties in the overall equation error. Both of these econometric problems can be solved by using some form

of instrumental variables estimation that allows for errors with unusual properties. (See Hodrick (1987) for a description of these techniques.)

A third approach, the individual optimization approach, derives the asset demand equations from an individual's optimization problem, as in the micro-finance literature, rather than simply postulating them. In particular, it is assumed that investors choose their portfolios so as to maximize a function of the mean and variance of their real wealth. In this way the parameters of the asset demand equations are explicit functions of the mean and variance of rates of return and investors attitudes toward risk. These restrictions can be tested. In addition, this approach provides more structure than just testing for non zero coefficients. What distinguishes this approach from the general micro-finance literature is that relative asset supplies are postulated as influencing the rate-of-return variable.

In the literature there are examples using each of these three different approaches. Some studies examine these issues using a bilateral exchange rate (and data); some studies, especially those using the individual optimization approach, use several exchange rates. The frequency, the definition, and the quality of the data vary across studies. When data on actual asset supplies are employed, either weekly, monthly, or quarterly data have been used. Those studies using daily data have tended to use cumulated intervention as a proxy for asset supplies.

A common feature of this entire body of literature is that the joint hypothesis -- that assets are perfect substitutes and that expectations are rational -- is consistently rejected statistically. The rejection of the joint hypothesis is persistent over data frequency, sample size, and asset definitions. In the great bulk of these studies, the

researchers did not find a quantitatively significant effect for sterilized intervention. In most of the studies, the researchers did not find a statistically significant effect for sterilized intervention. In a few, the researchers found an effect that was statistically but not quantitatively significant. In one study, the researchers found a quantitatively significant effect.

Three studies, Obstfeld (1983), Kearney and MacDonald (1986), and Blundall-Wignall and Masson (1985), not only estimate portfolio balance equations but also simulate different forms of intervention using a small macroeconomic model. The evaluation of the efficacy of the different types of intervention is based on how much these policies influence the exchange rate.

The Obstfeld and the Kearney and MacDonald studies follow very similar methods. The latter study examines the United Kingdom and the former Germany. Both of these studies use the forward exchange rate as a proxy for the expected future exchange rate. The study for the United Kingdom provides some evidence from the simulation exercise that sterilized intervention could have a quantitatively significant influence on the exchange rate; this evidence was not forthcoming in the German case. The Blundall-Wignall and Masson study which focuses on Germany follows a slightly different research strategy. Nevertheless, they find that the estimates of a portfolio balance equation indicate sterilized intervention has a statistically significant effect. In the simulation section of their study, they show that this effect is not quantitatively significant.

Blundell-Wignall, A., and P. R. Masson. "Exchange Rate Dynamics and Intervention Rules," *International Monetary Fund Staff Papers*, vol. 32 (March 1985), pp. 132 - 59.

This paper considers the effect of sterilized intervention in a model where it is assumed that changes in monetary policy can produce misalignments. The model also assumes imperfect substitutability between domestic and foreign assets. It uses the well-known Dornbusch overshooting model extending it by including a role for asset supplies through a risk premium variable and by including an intervention rule whereby the authorities attempt to resist movements in the real exchange rate. This model is then examined empirically for Germany from 1973 Q3 through 1982 Q2.

A small macroeconomic model for Germany is estimated under the assumption that expectations are unbiased so that next period's realized values for both the exchange rate and the price deflator can be taken as measures of the expectations, subject to white-noise errors. The risk premium parameter is estimated to be small but statistically significant. It suggests that a one percent change in the cumulated current account will lead to a .05 percent change in the spot exchange rate, other factors given.

In order to examine the full effects of intervention the model was simulated with and without intervention in the foreign exchange market assuming that market participants know the structure of the model and the future values of the exogenous variables. It is shown that in response to a 10 percent domestic monetary shock that the effect of intervention is small, especially over the initial few periods. In general, if the purpose of intervention is to limit nominal exchange rate overshooting, then the simulation results suggest that the evidence provides little justification.

Boothe, Paul, and others. *International Asset Substitutability: Theory and Evidence for Canada*. Ottawa: Bank of Canada, 1985.

This work contains a chapter that examines the effectiveness of sterilized intervention using the Canadian dollar-U.S. dollar exchange rate. It reports original estimates and surveys other empirical estimates of the portfolio balance model. It examines several different models using monthly data from January 1971 to November 1982. Two definitions for outside assets are used: (1) the federal debt and (2) the sum of federal, provincial and municipal debt.

The authors show that the empirical work for Canada consistently rejects the joint hypothesis that assets are perfect substitutes and

expectations are rational. However, movements in the ex post rate-of-return are not related to asset stocks, and they conclude that intervention can only be effective if it can influence expectations.

Branson, William H., and Dale W. Henderson. "The Specification and Influence of Asset Markets," in Ronald Jones and Peter Kenen, eds., *Handbook of International Economics*, Volume II. Amsterdam: North Holland, 1985, pp. 749 - 805.

This article provides a complete survey of portfolio based approaches. It discusses two complementary approaches to the analysis of asset markets in open economies. The first approach is based on *ad hoc* (*postulated*) asset demand functions. These asset demand functions are broadly consistent with, but not directly implied by, microeconomic theory.

The second approach derives asset demands that are based on the solution to a maximization problem faced by an individual investor. The consumer arrives at its asset demands by maximizing its utility given interest rates and the parameters of the distribution of prices and exchange rates.

Danker, Deborah J., and others. "Small Empirical Models of Exchange Market Intervention: Applications to Germany, Japan, and Canada," *Journal of Policy Modeling*, (Spring 1987), pp. 143 - 73.

This is one of the studies for the G-7 Working Group. The authors use a standard portfolio balance model with the distinguishing feature that the private sector in each country is disaggregated into nonbank and bank sectors. Attention is focused on the demand for bonds denominated in the home currency. The home country is represented in succession by three different countries: Germany, Japan, and Canada. The sample periods in this study are February 1975 to December 1981 for Germany, February 1974 to December 1980 for Japan, and quarterly for Canada from 1971:Q2 to 1981:Q4.

The authors first estimate inverted asset demand functions assuming both static expectations and rational expectations. Two econometric problems arise in estimating their portfolio balance equation. First is the appearance of several endogenous variables on the right-hand-side of the equation. The second, if rational expectations are assumed, the error term becomes a composite error with an autoregressive and a moving average component. To deal with these problems they transform the data and estimate the equations using the Hayashi-Sims two-step, two-stage least squares method.

The right-hand-side variables in each equation for each country include part or all of the available quantity of home bonds. For two of the three countries studied, Germany and Canada, the authors reject the joint hypothesis that assets are perfect substitutes and that exchange rate expectations are rational. They also find some evidence that the ex post rate-of-return tended to be correlated with the supply of bonds in the case of Germany. In the Japanese case they were unable to reject the joint hypothesis.

The authors do some further testing by examining actual asset demand equations and by searching over various inverted demand functions, but are unable to estimate a model that confirms that sterilized intervention is effective.

Engel, Charles M., and Anthony P. Rodrigues. "Tests of International CAPM with Time-Varying Covariances," *Journal of Applied Econometrics*, vol. 4 (April/June 1989), pp. 119 - 38.

This article attempts to explain, by relaxing some assumptions, why the models described and tested in Frankel (1982), Frankel (1986), and Engel and Frankel (1984) -- all summarized below -- have not been supported by the data. These previous studies assume that the regression coefficients of the inverted demand equations for asset supplies are proportional to the covariance matrix of the regression errors and that the conditional variance is constant.

The country coverage is the same as the earlier studies -- the United States, Germany, the United Kingdom, Japan, France, and Canada. The data have been updated from the earlier studies and are monthly from June 1973 to December 1984.

In this study, the authors examine different ways of modeling the variance. They test a six-country ex post rate-of-return model, first by relating the variances to macroeconomic data (U.S. money supply and oil prices) and second by modelling the time varying variances as ARCH processes. In addition, they allow for a generalization of the Frankel-type model by introducing the possibility that the asset demand equation does not hold exactly.

The empirical section first estimates the standard Frankel equation and imposes and tests the restriction that coefficients on asset supplies are proportional to the variance term, which is assumed constant. This restriction is rejected.

The basic formulation of the 'Frankel' model does not require the assumption that the variance is constant, therefore the authors relax this assumption by allowing the variance to move with other macroeconomic data. The estimates of this model, using either economic variable, show that the assumption of a time-varying constant is a significant improvement, however the coefficient restrictions placed on the model are still rejected. The ARCH model does not require

knowledge of the economy, but allows the variances to vary. The estimates of this formulation of the model also show that the explanatory power of the model is increased by letting the conditional variances follow an ARCH process. Yet, the suggested restrictions of the derived demand functions are once again rejected.

One explanation for the rejection of these restrictions may be that the initial formulation of the model assumes that the asset demands hold exactly. Consequently, the authors relax this assumption and create a composite error term, which is often pursued in the more standard empirical literature on *postulated* portfolio demand models. In general, the estimates of the measurement error models do not significantly improve the explanatory power of the models.

This paper extends the frontiers of estimation of these models to consider some of the most important possibilities that have been suggested for the empirical failure of that model; yet the model is not supported by the data.

Frankel, Jeffrey A. "In Search of the Exchange Rate Premium: A Six Currency Test Assuming Mean-Variance Optimization," *Journal of International Money and Finance*, vol. 1 (December 1982), pp. 255 - 274.

This study tests a portfolio balance model where asset demand functions are based on mean-variance optimization using monthly data from June 1973 to August 1980 for six countries: the United States, Germany, the United Kingdom, Japan, Canada, and France. Rates of return are based on the difference of the log of the forward rate and the log of next month's spot rate. Asset supplies are calculated as the outstanding government debt corrected for three factors: (1) debt issued in foreign currency, (2) cumulated central bank intervention and (3) foreign exchange intervention in the domestic currency by other countries' central banks. Net wealth is calculated as the cumulation of the government deficit and the current account surplus.

One of the major contributions of the paper is the estimation of the system of equations subject to the restrictions imposed by the mean-variance optimization. Frankel estimates his equations under the assumption of rational expectations. The estimates are imprecise. Nevertheless, the estimates appear to be consistent with risk neutral investors in which case investors would only hold the asset with the highest rate of return, so that domestic and foreign assets are perfect substitutes.

Frankel suggests that the failure to reject the null hypothesis does not imply that the null is true, but that the test may not be very powerful. He also notes that several auxiliary assumptions are made when testing this hypothesis. Therefore the test is more than just a joint test. In this vein the assumption that consumption shares are identical across countries is relaxed. As before the estimates are

very imprecise and the hypothesis that the risk aversion term is zero could not be rejected.

This study is able to reject the joint hypothesis, but is unable to establish a link between asset supplies and relative rates-of-return.

_____ . "The Implications of Mean-Variance Optimization for Four Questions in International Macroeconomics," *Journal of International Money and Finance*, vol. 5 (March 1986), pp. S53 - S75.

This paper shows that the hypothesis of mean-variance optimization has important implications for some standard questions of interest in macroeconomics. It presents a limited number of new estimates and draws upon the database of Frankel (1982).

One of the main points of the paper, relevant for the current discussion, shows that changes in relative asset supplies tend to imply very small changes in the ex post rate-of-return. The author argues that this result does not, however, imply that intervention will have negligible effects on the level of the spot rate, because intervention may affect expectations which, in turn will affect the exchange rate. The argument is that the hypothesis of mean-variance optimization implies that the current exchange rate is very sensitive to expectations of future changes. The paper gives an estimate that if the expected permanent rate of growth of domestic asset supply is raised by .1 percent per annum, the mean-variance model would predict a 20 percent increase in the current exchange rate.

_____ and Charles M. Engel. "Do Asset Demand Functions Optimize Over the Mean and Variance of Real Returns? A Six-Currency Test", *Journal of International Economics*, vol 17 (November 1984), pp. 309 - 323.

This study is similar to the Frankel (1982) study discussed above. Instead of studying the relationship between *nominal* ex post rate-of-returns and outside asset supplies they study the relationship between *real* ex post rate-of-returns and outside *real* asset supplies, thereby relaxing the assumption that inflation is predetermined. The same data set (June 1973 to August 1980) and same country coverage is used.

The first part of the paper estimates a standard real ex post rate-of-return equation. Each equation is estimated unconstrained by OLS using all six outside real asset supplies as right-hand-side variables. Although each equation contains only one or two coefficient estimates that are statistically significantly different from zero, they report that the test of the constraint that all coefficients are zero is rejected. From this part of the paper, they conclude that the low degree of precision plagues the estimation of general portfolio-balance

equations. This provides motivation for considering the constraints placed on the parameters by the mean-variance optimization.

The second part of the paper estimates the constrained model with and without the estimation of the relative risk aversion parameter. When the relative risk aversion parameter is constrained to be equal to 2, the model fits considerably worse than the unconstrained model. The authors choose to interpret this as a rejection of the optimization hypothesis. When the relative risk aversion is allowed to be a free parameter, its maximum likelihood estimate is -67. Since their model of a risk-averse investor only makes sense with the relative risk parameter constrained to be greater than zero, this finding is a clear rejection of the model.

This study, like most of these studies, is able to reject the joint hypothesis, but is unable to establish a link between asset supplies and relative rates-of-return.

Ghosh, Atish, R. "Is it Signalling? Exchange Intervention and the Dollar-Deutschemark Rate," Unpublished paper, Princeton University, September 1989.

This paper tests the portfolio balance channel, while controlling for the signalling channel using a sticky price-monetary model to characterize the movements in the exchange rate. The null hypothesis of the paper is that the monetary model is the true model, so that sterilized intervention can, at best, influence the current exchange rate by signalling future changes in monetary policy. The alternative model, is the monetary model augmented to include the portfolio balance channel. The two models are examined empirically from December 1979 to December 1988 using monthly data.

The monetary model is statistically rejected, but is shown to perform well both in its in-sample forecasting and out-of-sample prediction. The portfolio balance model when using the supply of assets denominated in dollars and marks account for significant deviation of the exchange rate from its value implied by the monetary model. However, changes in reserve assets, an alternative measure of outside assets, appear to have little effect on the exchange rate.

The conclusion that emerges from this study is that sterilized intervention through the portfolio balance channel is statistically significant. However, the author finds that it is not quantitatively significant, since it requires substantial intervention to influence the exchange rate through the portfolio balance channel.

Henderson, Dale W. and Stephanie Sampson. "Intervention in Foreign Exchange Markets: A Summary of Ten Staff Studies," *Federal Reserve Bulletin*, vol. 69 (November 1983), pp. 830 - 36.

This paper summarizes the ten staff studies of the Federal Reserve System and the U.S. Department of Treasury written for the G-7 Working Group. These studies covered a wide range of topics including: (1) the definition of intervention, (2) the studies of historical episodes of intervention, (3) the calculation of the profitability of intervention, (4) the review of the research literature, and (5) the presentation of formal econometric analysis. Most of these studies are summarized in this annotated bibliography.

Kearney, Colm, and Ronald MacDonald. "Intervention and Sterilisation under Floating Exchange Rates: the UK 1973 - 1983," *European Economic Review*, vol. 30 (April 1986), pp. 345 - 64.

This article is divided into two parts. The first part addresses the question: Does the Bank of England intervene in the foreign exchange market, and, if so, how? The second part considers whether sterilized intervention is effective at influencing the exchange rate. It estimates a central bank reaction function and a small portfolio balance model for the British pound-dollar exchange rate using quarterly data over the period 1973 Q2 to 1983 Q4. The resulting estimates of the reaction function show that the Bank of England has tended to intervene in the foreign exchange market in a 'leaning against the wind' fashion. The authors also test and confirm that the Bank of England usually sterilizes its intervention.

To assess the efficacy of sterilized intervention the authors estimate and simulate a small macro model of the U.K. economy. The authors estimate equations for money demand, money supply, domestic demand for bonds, and foreign demand for such bonds. Foreign wealth, proxied by U.S. wealth, is measured as portfolio wealth for the United States and domestic wealth as financial wealth for the United Kingdom. They use the three-month forward premium as a proxy for the expected change in the exchange rate following an earlier Obstfeld paper -- summarized below. As noted in our review of that study this proxy assumes assets are perfect substitutes and clouds the interpretation of the results. The coefficient estimates of the demand for U.K. bonds by both U.K. and U.S. residents are correctly signed, but few are statistically significant.

To evaluate the effectiveness of sterilized intervention the authors conduct two policy simulations. A nonsterilized intervention is considered first, in which the authorities sell foreign exchange reserves and allow the monetary base to contract by 10 percent. A sterilized intervention is subsequently considered in which the monetary consequences of an equal sale of foreign exchange are offset by a reduction in the stock of privately held domestic assets. Both policies are considered transitory. The effect of the nonsterilized intervention causes an immediate appreciation of the exchange rate of almost eight percent. The sterilized intervention causes the value of sterling to appreciate by just over three percent on impact.

The conclusion of this study is that sterilized intervention does appear to have an effect on the exchange rate though not as great as nonsterilized intervention, but nevertheless substantial.

Lewis, Karen K. "Testing the Portfolio Balance Model: A Multi-lateral Approach," *Journal of International Economics*, vol 24 (February 1988), pp. 109 - 27.

This paper estimates directly, as opposed to the inverse form, outside *multilateral* as opposed to *bilateral* asset demand equations for the portfolio balance model for the currencies of five countries: the United States, the United Kingdom, Germany, Japan, and Canada. The data cover the period from January 1975 through December 1981. Data for Canadian, German, and Japanese assets and wealth are from the Danker et al study with some modification in timing.

As in most studies, this author assumes rational expectations, therefore the error becomes a composite error. The author uses the two-step, two stage least squares estimator. This enables her to estimate the equations consistently. She also exploits some of the cross equation restrictions on the covariance matrix.

The coefficients on the relative rates of return are insignificant for the most part. The only exception is the positive relationship between yen returns and Canadian bonds. The effect of wealth upon asset demands provides some evidence for the portfolio model. In general the empirical results indicate little relationship between asset supplies and rates of return. The domestic variables -- income and interest rates -- were generally insignificant.

Despite attempts to use improved and more efficient empirical techniques, the results of this study indicate that estimates of the portfolio balance model are imprecise.

_____. "Inflation Risk and Asset Market Disturbances: The Mean-Variance Model Revisited," *Journal of International Money and Finance*, vol. 7 (September 1988), pp. 273 - 88.

This paper studies the ex post rate-of-return using a mean-variance optimizing model. It is an extension of the earlier work by Frankel (1982) and Frankel and Engel (1984). It explicitly introduces inflation risk without requiring purchasing power parity. In addition, it allows for the possibility of there being asset market disturbances. To allow for these additional sources of uncertainty, an alternative estimation method is derived to identify the covariance constraints.

The estimation uses data for six different countries -- Canada, France, Germany, Japan, the United Kingdom, and the United States. The model

is estimated using monthly data from January 1975 through December 1981. Interest rates on one-month Eurocurrency deposits are used as measures of the rate of return on the assets.

The results in this paper are similar to the earlier studies despite differences in estimation methods. The covariance parameter estimates are like those in Frankel and Engel. In fact, the point estimates of the risk aversion parameter in this paper are closer to zero. These estimates may be imprecise, but the results are consistent with risk neutral investors. This result in turn implies that intervention which would alter asset supplies will have no effect on the expected rates-of-return. In other words, this study does not report findings that suggest intervention may be effective.

Loopesko, Bonnie E. "Relationships Among Exchange Rates, Intervention, and Interest Rates: An Empirical Investigation," *Journal of International Money and Finance*, vol. 3 (December 1984), pp. 257 - 77.

This is one of the studies for the G-7 Working Group. It analyzes the effect of sterilized intervention using daily data on the exchange rate of the U.S. dollar vis-a-vis the currencies of the other G-7 countries. The data are carefully compiled and constructed taking into consideration the institutional structure of the various markets.

It uses an ex post rate-of-return equation to test the joint hypothesis that assets are perfect substitutes and expectations are rational. To test this joint hypothesis, Loopesko estimates an equation for the ex post returns that uses lags of itself, lagged exchange rates, and cumulated intervention as a proxy for the stock of domestic outside assets.

The joint hypothesis is rejected for all currencies and subsamples examined. For at least one subsample period for five out of the six exchange rates examined sterilized intervention may have affected the exchange rate through the portfolio channel. In about half of the total cases considered the data do not support the existence of a portfolio balance channel. Thus, sterilized intervention could have a short-term impact on exchange rates for all the countries in the study, but through a variety of channels.

Loopesko also tests the proposition that coordinated intervention is more effective than noncoordinated intervention for the case of the United States and Germany. The test that is actually implemented compares whether these two types of intervention have different effects. The results of this test are dependent on the definition of intervention used. When using a broad definition of intervention (including a component categorized as "other") it appears that coordinated and noncoordinated intervention have the same effect. But when a narrower definition (one that excludes "other" intervention transactions by the Bundesbank) is used, coordinated intervention has

in general an effect on the exchange rate that differs significantly from that of noncoordinated.

Micossi, S. and S. Rebecchini. "A Case Study on the Effectiveness of Foreign Exchange Market Intervention: The Italian Lira (September 1975 - March 1977)," *Journal of Banking and Finance*, vol. 8 (December 1984), pp. 535 - 55.

This paper discusses the effects of Italian intervention during an episode of major depreciation of the Italian lire, September 1975 to March 1977. Daily time series of official intervention, the exchange rate, and interest rates are estimated in a general vector autoregressive framework that does not depend on any particular structural model. Interest rates and intervention do not explain changes in the exchange rate, but the interest differential seems to influence intervention significantly.

The study also estimates the effects of intervention on the ex post rate of return following the work of Loopesko (1984). However, unlike Loopesko, the estimation shows that intervention itself was not significant. Nevertheless, they report rejecting the perfect substitutability hypothesis because lagged values of the ex post returns were significant.

Obstfeld, Maurice. "Exchange Rates, Inflation and The Sterilization Problem: Germany 1975 - 1981," *European Economic Review*, vol. 21 (March 1983) pp. 161 - 89.

This paper examines the Bundesbank's foreign exchange intervention policy from February 1975 to October 1981. It asks whether the Bundesbank pursued a sterilized intervention policy or not. Since it finds that German intervention was predominately sterilized, it then asks whether sterilized foreign exchange intervention is effective in the German case.

The first question is addressed by estimating a domestic credit reaction function, which tests whether the Bundesbank responded positively to cyclical shortfalls in output, but negatively to increases in foreign exchange reserves. The econometric evidence supports the hypothesis that the Bundesbank used domestic credit policy to attain domestic policy objectives while engaging in sterilized intervention.

To assess the efficacy of sterilized intervention the author estimates and simulates a small macro model of the German economy, which contains structural asset demand equations. Obstfeld estimates equations for money demand, money supply, domestic demand for bonds denominated in

deutsche marks, and foreign demand for such bonds. In the two domestic demand equations, he includes income as a transaction variable, and a lagged dependent variable to allow for stock adjustments. In the estimation Obstfeld uses the forward premium for the expected exchange rate depreciation. This procedure implies the absence of an exchange risk premium and clouds interpretation of his results.

The coefficient on interest rates in the equation for foreign demand for bonds is significant, but this is the only equation in which the rate-of-return variable has a significant effect. The explanatory power of the bond-demand equations is almost entirely due to the wealth and lagged dependent variable terms. These results offer only slight support for the portfolio-balance model.

Obstfeld adds a price equation to the model which allows changes in the exchange rate to affect prices and feed back into the model via money demand. To evaluate the effectiveness of sterilized intervention three simulations are considered. First, the benchmark simulation, the model is simulated assuming perfect foresight for the exchange rate, so that the forward rate in one period is equal to the solution for the spot rate in the next period. The next simulation considers the effect of a 10 percent temporary (three-quarter) decline in the monetary base. This monetary perturbation causes an immediate 3.0 percent appreciation of the currency relative to its benchmark value. The last simulation considers the effect of a sterilized sale of DM 13.25 billion. This policy change causes an impact a .04 percent appreciation of the exchange rate relative to the benchmark.

The conclusion reached in the simulation experiments suggest that the Bundesbank's ability to influence the exchange rate using sterilized intervention is very limited.

_____ . "The Effectiveness of Foreign-Exchange Intervention:
Recent Experience," NBER Working Paper 2796, (December 1988).

This paper focuses on the recent practices and effects of foreign exchange intervention by the G-3 countries - Germany, Japan, and the United States. It contains casual observation rather than presenting any formal statistical analysis. It reviews the recent evolution of key macroeconomic fundamentals, other than intervention, that are likely to have influenced exchange rates. It sets out the mechanics of both sterilized and nonsterilized intervention, and emphasizes the effects on asset supplies of alternative intervention strategies. It also considers an alternative to the portfolio balance rationale for sterilized intervention, the signalling theory. According to this view, official portfolio shifts between nonmoney assets can influence exchange rates, independent of any necessity for private portfolio rebalancing, by credibly signalling future policy intentions or information not widely appreciated by the market. It also raises several fundamental questions about the effectiveness of this channel.

The paper concludes that the international currency experience since 1985 lends little support to the idea that sterilized intervention has been an important determinant of exchange rates. Anecdotal evidence suggests that intervention has been useful as a device for signalling official views on currency prices to the exchange market.

Rogoff, Kenneth. *Time-Series Studies of the Relationship between Exchange Rates and Intervention: A Review of the Techniques and Literature*. Staff Studies 132. Washington: Board of Governors of the Federal Reserve System, September 1983.

This is one of the studies for the G-7 Working Group. This review article explores whether the nonstructural time-series techniques, especially vector autoregressions, can be used to examine the impact of intervention in the short run. It concludes that the gains in using this approach are more apparent than real, especially when modelling effects of intervention on exchange rates with daily data. This technique is not a way of escaping the severe problem of omitted variables presented by daily data. The money supply is not available daily, and one can reasonably assume that changes in the money supply are correlated with sterilized intervention and changes in the exchange rate.

It also surveys three time-series investigations of the effectiveness of exchange rate intervention. Two use daily data on exchange rates and intervention to analyze the Canadian experience with floating exchange rates from 1952 to 1960. Neither of these studies distinguish between sterilized and nonsterilized intervention. The two studies reach opposite conclusions on whether intervention helped stabilize the Canadian dollar against the U.S. dollar. The third study differentiates between sterilized and nonsterilized intervention and estimates a six variable vector autoregressions for the United States, the United Kingdom, Germany and Japan. There are a number of econometric problems making the interpretation of the results in this paper rather cloudy.

_____. "On the Effects of Sterilized Intervention: An Analysis of Weekly Data," *Journal of Monetary Economics*, vol. 14 (September 1984), pp. 133 - 50.

This study tests for the existence of the "portfolio balance effect" by using high frequency data and by implementing an instrumental variable technique. Weekly data, the shortest interval for which money supply and net new government bond sales data are available, for the Canadian dollar-U.S. dollar are used for the period March 1973 - December 1980.

An ex post rate-of-return equation that depends on the ratio of Canadian dollar government bonds to the Canadian dollar value of U.S. government bonds is estimated. Expectations are assumed to be rational so that the actual exchange rate and a forecast error are substituted for the expected exchange rate. The equation contains both the serially correlated portfolio balance error as well as the rational expectations error. Therefore the equation is estimated using OLS and two-step, two-stage least squares. The advantage of such an instrumental variable technique is that it gives consistent estimates under both hypotheses. Relative asset supplies are constructed alternatively using interest bearing assets only, and interest-bearing assets plus the monetary base. The coefficients on these two different measures of relative asset supplies are insignificant and of the wrong sign. These results are invariant to a number of alternative specifications and estimation procedures. In addition, different interest rate data are considered but similar results emerge.

The study concludes that it is difficult to demonstrate that the ex post return responds as predicted by theory to changes in the relative supplies of outside assets denominated in different currencies.

Taya, Teizo. "Effectiveness of Exchange Market Intervention in Moderating the Speed of Exchange Rate Movements: An Empirical Study of the Case Of Japan," in David Bigman and Teizo Taya, eds., *Exchange Rate and Trade Instability: Causes, Consequences and Remedies*. Cambridge, Mass.: Harper and Row, Ballinger, 1983, pp. 217 - 55.

This paper examines the effectiveness of intervention on moderating exchange rate movements utilizing Japanese data. It uses daily and weekly data by observing the yen-dollar exchange rate from both the London and Tokyo market from October 1977 to December 1979. These two markets are sampled to examine possible intra-day effects of intervention. Two separate subperiods are analyzed: a period of dollar support (October 1977 - December 1978) and a period of yen support (January - December 1979). The intervention figures are those estimated by market sources for the Bank of Japan in Tokyo and quoted by the Reuters wire service.

Simple linear regressions of the change of the exchange rate on interest rate differentials and intervention are used. Over the two subsamples intervention and lagged intervention are not significant. The conclusion reached in this study is that intervention does not appear to have a significant effect on the market.

Tryon, Ralph W. *Small Empirical Models of Exchange Market Intervention: A Review of the Literature*. Staff Studies 134. Washington: Board of Governors of the Federal Reserve System, September 1983.

This is one of the studies for the G-7 Working Group. It reviews the literature on the empirical estimation of small structural models, which shows the effects of intervention in foreign exchange markets. It begins with a theoretical framework for examining these effects using a standard portfolio balance model and goes on to discuss ways to estimate the model econometrically. It notes that two problems are encountered in the estimation of these models: (1) data on bond holdings of residents of each country are not generally available and need to be estimated, and (2) expected future exchange rates are unobservable therefore one must make an assumption about how expectations are formed. It then reviews existing empirical studies in this area. None of the studies reviewed provide a definitive answer to the question of whether sterilized intervention is an effective means of altering exchange rates.

Weber, Warren E. "Do Sterilized Interventions Affect Exchange Rates?" *Federal Reserve Bank of Minneapolis Quarterly Review*. vol. 10 (Summer 1986), pp. 14 - 23.

This article reviews the mechanics of a sterilized foreign exchange market intervention and presents a theoretical model that shows how intervention may affect the exchange rates. It also reviews the empirical literature. The empirical evidence cited, most of which is surveyed here, does not show that sterilized intervention has an effect on exchange rates, at least over time intervals of a month or more.

IV. Studies of the Expectations or Signalling Channel and of the Differential Effects of Coordinated and Noncoordinated Intervention

Sterilized intervention might affect exchange rates through an expectations or signalling channel, whether or not domestic and foreign bonds are imperfect substitutes. Sterilized intervention operates through this channel if it causes private agents to change their exchange rate expectations. Private agents might change their exchange rate expectations for one of two reasons. First, they might change their views about the likely future actions of the monetary or fiscal authorities or of other private agents. Second, although they do not change their views about likely future actions, they might change their views about the likely implications of these actions for the future exchange rate.

Analysts who are skeptical of the argument that sterilized intervention has affected exchange rates through an expectations channel raise two obvious questions. The first question is, Why do the authorities not always announce their intervention when they are doing it, and why do they not disclose more data on intervention? If intervention is to affect the exchange rate expectations of private agents, they must know about it. In the studies of the expectations channel, the researchers have not to date answered the skeptics' first question directly. However, some of them have recognized that the question must be taken seriously. Dominguez (forthcoming) used actual intervention data for Germany which are not available to the public and newspaper reports of intervention for the United States. She argued that her comparisons of the newspaper reports of intervention with actual intervention data covering longer periods that were released in connection with published reports on Treasury and Federal Reserve foreign exchange operations suggest that the newspaper reports were

accurate. Dominguez and Frankel (1989) used one variable based on newspaper reports of both intervention and related developments and another based only on newspaper reports of intervention and actual intervention data.

The skeptics have a second question: What do the authorities have to gain by using intervention instead of, or in addition to, simple announcements when attempting to affect the exchange rate expectations of private agents? In the studies of the expectations channel, the researchers do answer the skeptics' second question directly. They argue that the authorities care about the domestic currency value of their balance sheet. If the authorities sell foreign bonds for domestic bonds and the domestic currency ultimately depreciates, the domestic currency value of their balance sheet is lower than it otherwise would be. That is, if the authorities intervene in order to affect exchange rate expectations, attempts to mislead the public result in a loss of more than just face. Therefore, if the authorities use intervention instead of, or in addition to, simple announcements to affect exchange rate expectations, they are more likely to be taken seriously.

There are only a few studies of the expectations channel. All except one use daily data. The two most promising studies, Dominguez and Frankel (1989) and Humpage (1989), are preliminary. Dominguez and Frankel assume that sterilized intervention can have effects through both the portfolio balance channel and the expectations channel while Humpage assumes that sterilized intervention can have effects only through the expectations channel. Dominguez and Frankel use data on exchange rate expectations obtained from surveys instead of imposing the assumption of rational expectations. All the studies of the expectations channel found that sterilized intervention had some statistically significant effect through

the expectations channel. Dominguez and Frankel found that sterilized intervention had a statistically significant effect through the portfolio balance channel when estimating the equation using instrumental variable estimators. This result was not forthcoming for the OLS regression except for 1-day interventions during the latter part of their sample period. Dominguez and Frankel report that their results appear to be quantitatively significant under alternative parameter values. Humpage found that the statistically significant effect of sterilized intervention was very short-lived. Except for the Dominguez and Frankel study, the researchers did not assess the quantitative significance of the effects that they found.

There are also only a few studies of the differential effects of coordinated and noncoordinated intervention. Loopesko (1984) and Dominguez (forthcoming) found that the difference between the effects of coordinated and noncoordinated intervention was statistically significant, but Humpage found that it was not. Loopesko and Dominguez did not assess the quantitative significance of the difference in effects.

Dominguez, Kathryn Mary. "Does Sterilized Intervention Influence Exchange Rates? A Test of the Signalling Hypothesis." Unpublished paper, Harvard University, 1986.

This paper presents a set of empirical tests of the signalling hypothesis using the mark-dollar exchange rate from February 1977 to February 1981. These tests utilize daily data on intervention from the Bundesbank and the Federal Reserve.

A distinction is made between subperiods where the Federal Reserve appeared credible (November 1978 - May 1979, October 1979 - March 1980) and periods in which it appeared non-credible (September 1977 - October 1978, May 1979 - October 1979, April 1980 - February 1981). This credibility criterion is based on whether the Federal Reserve announces major shifts in monetary policy designed to accomplish anti-inflationary goals and simultaneously backed this change with major policy changes.

A set of empirical tests of the signalling hypothesis are presented. One test examines whether a relationship exists between intervention and weekly money surprises, using publicly available pre-announcement money supply forecasts. This test provides some evidence that during high-reputation periods money supply surprises are positively correlated with intervention. Another test examines the effects of intervention during high-reputation periods. On days that the Federal Reserve intervenes heavily in the market, and has high credibility, the exchange rate change is in the direction implied by intervention. This relationship is not forthcoming in either the low-reputation period or for a given random sample. A further test considers whether intervention helps to explain changes in the spot rate. The results show that without isolating subperiods based on credibility, it is impossible to determine the effects of intervention.

The conclusion reached in the paper is that the results provide some suggestive evidence in support of the signalling hypothesis.

_____ . "Market Responses to Coordinated Central Bank Intervention." Forthcoming in *Carnegie-Rochester Series on Public Policy*, Volume 32.

This paper tests whether sterilized intervention influences exchange rates through the expectations or signalling channel by providing information about future monetary policy. It also attempts to determine whether the effects of coordinated and noncoordinated intervention differ.

It examines the dollar-mark and the dollar-yen exchange rate. An inverted asset demand function is used. Ex post returns are calculated daily for dollar-mark and dollar-yen over the same period using overnight, one-month, and three-month eurocurrency interest rates. These returns are regressed on a constant and the previous day's intervention. Intervention is broken into coordinated intervention, defined as the sum of Federal Reserve and Bundesbank intervention on days when at least two of the G-3 central banks were in the market, and noncoordinated intervention by the Bundesbank and by the Federal Reserve, which only pertains to days in which each of these respective authorities was the only G-3 central bank in the market. (Bank of Japan intervention is not included explicitly in the regression.)

The regressions were run over the entire three-year period January 1985 through December 1987, and over five subperiods: January - March 1985, September - December 1985, September 1986 - January 1987, February - June 1987, and October - December 1987. The results are mixed. In the first two episodes -- periods of dollar sales -- the coefficients on both coordinated and noncoordinated intervention are generally statistically significant and of the correct sign, though the two periods differ in terms of whether noncoordinated or coordinated intervention has a larger effect. Noncoordinated Bundesbank intervention is statistically insignificant in the post-Plaza period

when it played a relatively minor role. During the three later periods of dollar purchases, the coefficient on intervention -- when statistically significant -- is generally of the wrong sign, except for coordinated intervention in the post-Louvre period over the one and three-month horizons. For the three year period as a whole, coordinated intervention is generally statistically significant and of the correct sign, but the magnitude seems implausibly large. In general, coordinated intervention is reported to have a different effect than noncoordinated intervention.

_____, and Jeffrey Frankel. "Does Foreign Exchange Intervention Matter? Disentangling the Portfolio and Expectations Effect for the Mark." NBER Working Paper 3299, (March 1990).

This study tests both the signalling channel and the portfolio balance channel without invoking rational expectations. They use survey data on market forecasts of exchange rates for the expected future exchange rate. One of the innovations of this study is that they estimate both a portfolio balance equation and an equation for the formation of exchange rate expectations.

The study covers two subperiods: November 17, 1982 - October 10, 1984 and October 24, 1984 - December 18, 1987. The equations are estimated by ordinary least squares (OLS) and instrumental variables. The focus is on the mark-dollar exchange rate.

The first equation of their two equation system, the portfolio balance equation, is an inverted asset demand equation and imposes the mean-variance optimization constraint. Asset supplies are modelled as intervention or intervention as a percentage of total wealth, which is defined to be the outstanding stock of government debt. In each case, intervention is measured in three different ways: (1) intervention which occurred the end of the day before the survey; (2) intervention which is accumulated between survey forecasts; and (3) intervention which is accumulated from the beginning of the sample period.

The other equation models the formation of expectations. The dependent variable is the investor's forecast of the change in the expected future spot rate, as measured by survey data. The regressors include the difference between the lagged and contemporaneous spot rate, and three different intervention variables: a dummy to reflect information on intervention appearing in the newspaper, and actual intervention by the Bundesbank and the Federal Reserve, respectively, when reported in the newspapers.

The authors find intervention has a significant effect both through the expectations channel and through the portfolio channel. In addition, they show that these effects can also be quantitatively significant. This result, however, varies depending both on the particular estimates chosen for the key parameters and on the precise experiment that one considers.

Humpage, Owen F. "On the Effectiveness of Exchange-Market Intervention."

Unpublished paper, Federal Reserve Bank of Cleveland, June 1989.

This study examines the relationship between day-to-day official intervention and day-to-day exchange rate movements. It examines intervention for the yen-dollar and the mark-dollar rate between August 3, 1984 and October 30, 1987. It uses exchange rates quoted in French francs and therefore calculates the dollar rates using the French franc-dollar rate. Intervention is classified in three ways: actual total daily intervention, coordinated/noncoordinated intervention, and initial/subsequent intervention.

The analysis assumes that intervention works only through the expectational channel. To test this hypothesis the author regresses the spot exchange rate on lagged intervention, lagged interest rate differentials and the two-day lag of the spot rate.

This equation is estimated over five subperiods: August 3, 1984 - May 31, 1985; June 3, 1985 - December 30, 1985; October 1, 1986 - February 10, 1987; February 11, 1987 - October 30, 1987. The author draws three conclusions from his results: (1) that systematic intervention has no apparent impact on exchange rates, (2) intervention can have a short-term effect if it provides new information to the market, and (3) that the distinction between coordinated and noncoordinated intervention is not important. This latter conclusion is the opposite reached by Loopesko (1984) and Dominguez (forthcoming).

Loopesko, Bonnie E. "Relationships Among Exchange Rates, Intervention, and Interest Rates: An Empirical Investigation," *Journal of International Money and Finance*, vol. 3 (December 1984), pp. 257 - 77.

This paper is summarized in Section III.

Mussa, Michael. "The Role of Official Intervention," Group of Thirty Occasional Papers 6. New York: Group of Thirty, 1981.

This article surveys the role of intervention. It contains one of the earlier arguments that sterilized intervention may be effective through signalling future monetary policy. It argues that a case can be made for intervention on the grounds that central banks possess resources and knowledge not available to private market participants. In particular, a central bank has the ultimate control over the supply of domestic money and knows about future monetary policy that is not available to market participants. Thus a central bank can use its knowledge of its own future policy to guide its speculations in foreign exchange and if the need arises can use its control over monetary policy to guarantee the success of its speculations.

V. Descriptive Studies of Particular Episodes of Intervention

This section includes descriptive studies of particular episodes of intervention. Three of these studies were written for the G-7 Working Group. These studies discuss the objectives and effects of U.S. intervention operations for several important episodes during the period of floating dollar rates before 1982 both from the perspective of the U.S. monetary authorities at the time the operations were undertaken and from the perspective of the U.S. authorities at the time of the G-7 Working Group.

The other two studies have a different focus. The Funabashi study gives a behind-the-scenes account of Plaza Agreement of September 1985 through the Louvre Accord of February 1987. The Obstfeld study, on the other hand, examines the intervention policies and macroeconomic policies of the United States in order to explain the movement of the dollar during the 1980s.

Funabashi, Yoichi. *Managing the Dollar: From the Plaza to the Louvre*, Washington D.C.: Institute for International Economics, 1988.

This book is a case study of the policy coordination involved in the G-5 Plaza strategy, focusing primarily on the United States, Germany, and Japan. The time frame is roughly the period from the Plaza agreement in September 1985 to the Louvre Accord, in February 1987. The book has three objectives. The first objective is to account for the Plaza strategy as it evolved, using interviews and reports with the leading people involved. The second objective is to explain the events in the context of both domestic and international politics. The third objective is to analyze the Plaza agreement in terms of its implications for international economic policy coordination.

Greene, Margaret L. *U.S. Experience with Exchange Market Intervention: January - March 1975*. Staff Studies 127. Washington: Board of Governors of the Federal Reserve System, September 1983.

This is one of the studies for the G-7 Working Group. This study covers the first major episode of the U.S. exchange market intervention

in the period of floating rates. The United States, Germany and Switzerland intervened in late 1974 and early 1975 to moderate the dollar's depreciation against European currencies and to counter disorderly market conditions. In February 1975, the first large-scale concerted intervention began. These operations appear to have achieved the objective of the U.S. authorities because the pattern of daily declines ended. However, the trend of dollar movements appears not to have been reversed until the market became convinced that the U.S. economic performance was improving relative to those of other countries.

_____. *U.S. Experience with Exchange Market Intervention: September 1977 - December 1979.* Staff Studies 128. Washington: Board of Governors of the Federal Reserve System, September 1983.

This is one of the studies for the G-7 Working Group. This case study examines several episodes of U.S. intervention during the roughly two years between September 1977 and December 1979. At various times between September 1977 and December 1979 U.S. authorities shifted their intervention tactics and other policies to meet their changing exchange market objectives. In addition, the Federal Reserve's operating procedures were changed in October 1979 and there was a subsequent tightening of money market conditions. In general, the evidence from this period suggests that, while intervention was successfully used as a short-run tool to stabilize trading conditions and provide time to make policy adjustments, it did not have a lasting positive impact in the face of persistent, adverse fundamentals.

_____. *U.S. Experience with Exchange Market Intervention: October 1980 - September 1981.* Staff Studies 129. Washington: Board of Governors of the Federal Reserve System, September 1983.

This is one of the studies for the G-7 Working Group. This case study covers the year between October 1980 and September 1981. The period includes two subperiods: October 1980-February 1981 and April 1981 to mid-August 1981. During both of these subperiods the dollar appreciated by about 20 percent against the German mark. During the first rise in the dollar the U.S. authorities sought to take advantage by acquiring currencies to repay outstanding foreign-currency commitments. The second run-up of the dollar occurred after the U.S. Treasury decided not to intervene in the market. Evidence of the role of intervention in this period on volatility of exchange rates was ambiguous.

Obstfeld, Maurice. "The Effectiveness of Foreign-Exchange Intervention: Recent Experience," NBER Working Paper 2796, (December 1988).

This paper is summarized in Section III.

VI. Studies of the Profitability of Intervention

This section discusses the literature that analyzes profitability as a measure of the effectiveness of intervention in stabilizing exchange rates. This literature can be traced back to Milton Friedman. Friedman argues that intervention will not be destabilizing if officials sell currencies when the currency values are above their equilibrium levels and buy currencies when values are below their equilibrium level. When the authorities are correct about the equilibrium levels, buying low and selling high should earn them profits. When they are wrong, their intervention will be unprofitable.

Since Friedman first put forward this argument, further analysis of the profitability criterion has shown that the relationship is not so clear cut. Depending on the particular assumptions made, it is possible to show that stabilizing intervention may be unprofitable and that profitable intervention need not be stabilizing. For example, if the authorities were to purchase foreign exchange when its price was low and sell it when its price was high, then abstracting from interest-rate considerations, the intervention would be profitable even if the purchases and sales had no significant effect on exchange rates. If it is possible to earn profits on intervention that has no effect on exchange rates, then it is difficult to argue that those profits imply the intervention has had a stabilizing effect on exchange rates.

Because positive profits do not necessarily imply that intervention is stabilizing and negative profits do not necessarily imply that intervention is destabilizing, the usefulness of the profitability criterion has been called into question. Much of the early debate on the relationship of profitability and the effectiveness of intervention was inconclusive. Discussion about the profitability criterion generally shifted from the

ambiguous relationship between profitability and stability to the general welfare effects of the profits (or losses) that arise from speculation.

In addition to some unsolved theoretical questions, there are substantial practical problems in trying to calculate profits made from central banks intervening in the foreign exchange market. The emphasis of the reviews contained here will be on these practical issues rather than on the interpretation of the results in regard to the effectiveness of intervention. Most of these studies use different methods with which to choose the time period for their calculations and to deal with the related problem of valuing changes in the stock of foreign assets. Dramatically different results arise from altering various assumptions.

Jacobson, Laurence R. *Calculations of Profitability for U.S. Dollar-Deutsche Mark Intervention*. Staff Studies 131. Washington: Board of Governors of the Federal Reserve System, September 1983.

This is one of the studies for the G-7 Working Group. The paper reviews the literature that analyzes profitability and calculates the profits on dollar-mark intervention from 1973 to 1981.

The author calculates profits using different formulas. For some comparisons to the earlier literature, profits are calculated as the dollar value of foreign currency purchased since the initial period, evaluated at end-of-period exchange rates, less its initial dollar cost. For the entire period 1973-81, using this formula, net profits are \$289 million. However, the evaluation from 1973-79 shows a loss of \$500 million. This loss is a consequence of the revaluation of large net dollar purchases at the dollar's historic low. These differences in results indicate how profit calculations are sensitive to the choice of time period. This result also sheds some light on the results of earlier work by Taylor -- summarized below.

The author also calculates profits for eight subperiods in which net intervention is nearly zero. These calculations also include net interest earnings. Profits are positive for all but one subperiod when the differential between the U.S. Treasury bill rate and the German interbank rate is used to calculate net interest earnings. They are positive for all subperiods when the forward discounts are used.

Including net interest earnings increases measured profits significantly. Almost 90 percent of gross daily intervention occurred during one subperiod, October 1977 to January 1981. Profits calculated for this episode are close to the total calculated for the entire period. Moreover, net interest earnings in this subperiod constitute more than half the total profit figure: the United States gained by issuing mark debt at interest rates substantially lower than dollar interest rates.

Leahy, Michael P. "The Profitability of U.S. Intervention" International Discussion Papers 343. Washington: Board of Governors of the Federal Reserve System, February 1989.

This study evaluates the profitability of U.S. intervention. It offers a method of calculating profits that differs from earlier studies in that it computes net interest earnings using a general formula; other formulas are shown to be variants of a first order approximation.

In general, the results of these calculations show that since 1973 the monetary authorities in the United States have earned profits. It is estimated that the combined net worth of the Federal Reserve and the U.S. Treasury increased due to intervention by \$5.5 billion from 1973 to January 1988.

The results of these profit calculations indicate that the calculations are extremely sensitive to changes in sample periods and end-of-period exchange rates. For example, U.S. dollar-mark intervention from September 1985 to December 1985 yielded profits of \$161 million. Extending the calculation period to the end of the next year -- when no intervention was done -- yields a much larger estimate for profits, \$716 million. Profits increased because the dollar continued to decline in 1986, by more than the depreciation implicit in the dollar-mark interest rate differential, raising the dollar value of the long-mark position that had accumulated by the end of 1985 more than enough to offset the deterioration of the short dollar position.

The study also reports that dollar-yen intervention during the first 15 years of the floating rate period was profitable -- \$1,172 million. Studying the various subperiods are limited for the yen because the U.S. intervention in the yen was minimal until 1978. It is important to note that this study does report some periods where the central bank incurs losses. During the period January 1981 to January 1985, U.S. intervention in the yen showed losses of \$1,426 million.

Murray, John, and others. "Measuring the Profitability and Effectiveness of Foreign Exchange Market Intervention: Some Canadian Evidence," Unpublished paper, Ottawa: Bank of Canada, May 1989.

This paper presents empirical evidence on the profitability of Canadian intervention over the period 1975 to 1988. This study incorporates many of the refinements to the calculation of profits that are suggested in Leahy (1989).

The authors calculate profits over nine different sample periods. The first included the full sample, July 1, 1975 to June 30, 1988. The remaining eight were run over various subperiods. The results suggest the Canadian foreign exchange market intervention has been very profitable over the post Bretton Woods period. They show that total profits on trading and investment income generated C\$1,625 million in net profits. More than 78 per cent of these returns came from net interest earnings. Although large net profits were reported for the period as a whole, substantial trading losses were realized through most of the 1980s.

Taylor, Dean. "Official Intervention in the Foreign Exchange Market, or, Bet Against the Central Bank," *Journal of Political Economy*, vol. 90 (April 1982), pp. 256 - 68.

This is one of the earlier studies on profitability of central bank intervention. The paper examines nine major industrial countries -- Canada, France Germany, Italy, Japan, Spain, Switzerland, the United Kingdom, and the United States -- using monthly data to investigate the profitability of central bank intervention from the early 1970s, at the start of the floating exchange rate period, through the end of 1979.

The author defines profits of the foreign central banks as the sum of dollars purchased less the sum of the dollar value of domestic currency sold. It excluded valuation changes in the assets initially held, the losses incurred due to the inflow or outflow of reserves just prior to the unpegging of the exchange rate, and net interest income.

According to the estimates in the paper, central banks lost between \$11 billion and \$12 billion over the entire period. The paper also reports profits and losses for various subperiods. Generally, the central banks studied show a loss for subperiods of 4 to 5 years. The profits and losses for an individual country varied substantially depending on the dates that are used to begin and end the calculations.

These results lead the author to claim that intervention was necessarily costly to central banks and probably deceitful to foreign exchange markets, though there appears to be little empirical basis for the latter conclusion.

VII. Studies of Factors Prompting Intervention and of the Extent of Sterilization of Intervention

This section includes studies of the factors that have prompted intervention and of the extent to which intervention has been sterilized. In these studies, the researchers estimated policy reaction functions for intervention operations and for conventional open market operations. The researchers who analyzed intervention behavior found that intervention was undertaken to smooth nominal and real exchange rates, to achieve a target level of the nominal exchange rate, and for some other reasons. Most of the researchers who analyzed sterilization behavior found that a large part of intervention had been sterilized.

Blundell-Wignall, A., and P. R. Masson. "Exchange Rate Dynamics and Intervention Rules," *International Monetary Fund Staff Papers*, vol. 32 (March 1985), pp. 132 - 59.

This paper is summarized in Section III.

Gartner, Manfred. "Intervention Policy Under Floating Exchange Rates: An Analysis of the Swiss Case," *Economica*, vol. 54 (November 1987), pp. 439 - 53.

This study evaluates the Swiss National Bank's intervention. It considers two motivations: smoothing of short-run fluctuations of the exchange rate ('leaning against the wind') and exchange rate targeting. In this study no attempt is made to distinguish between sterilized and nonsterilized intervention. It instead attempts to explain Swiss National Bank foreign exchange market intervention by modelling a reaction function using the Swiss franc-U.S. dollar exchange rate from January 1974 to June 1984. The empirical estimates of the reaction function, using instrumental variables to take account of simultaneity, reveal that the Swiss National Bank leans not only against today's wind, but also uses intervention to target the exchange rate. In fact the results suggest that in situations of conflict, the Swiss National Bank has given priority to exchange rate targeting over exchange rate smoothing.

Kearney, Colm, and Ronald MacDonald. "Intervention and Sterilisation under Floating Exchange Rates: the UK 1973 - 1983," *European Economic Review*, vol. 30 (April 1986), pp. 345 - 64.

This paper is summarized in Section III.

Neumann, Manfred J. M. "Intervention in the Mark/Dollar Market: the Authorities' Reaction Function," *Journal of International Money and Finance*, vol. 3 (August 1984), pp. 223 - 39.

This paper investigates the intervention behavior of the Bundesbank using a central bank reaction function for the dollar-mark exchange rate over the period March 1974 to December 1981. The intervention data are those provided by the Bundesbank. The reaction function depends on: (i) the difference in the actual dollar-mark exchange rate from its target rate (various alternative formulations of exchange rate targets are considered), (ii) the expected risk premium, (iii) current account surplus, and (iv) the difference in base money from its target.

Two findings reported in this study are striking. In contrast to the Obstfeld (1983) study, this paper reports evidence that the Bundesbank does not fully sterilize its exchange rate intervention. Secondly, it finds that the Bundesbank shifts in favor of achieving its monetary targets with perceived increases in exchange rate uncertainty.

Obstfeld, Maurice. "Exchange Rates, Inflation and the Sterilization Problem: Germany 1975 - 1981," *European Economic Review*, vol. 21 (March 1983) pp. 161 - 89.

This paper is summarized in Section III.

VIII. Studies That Do Not Make Use of Data on Bond Supplies or Intervention

This section includes two types of empirical studies that do not make use of data on bond supplies or intervention: (1) studies of the joint hypothesis that domestic and foreign bonds are perfect substitutes and that exchange rate expectations are rational and (2) studies of maximizing models with imperfect substitutability between domestic and foreign bonds.

The maximizing models with imperfect substitutability in the studies included in this section are asset pricing models. One example is the consumption-based asset pricing model in which the consumption-saving and portfolio allocation decisions are interdependent. In this model a key determinant of ex post asset returns is the conditional covariance between asset returns and the rate of change in consumption. Although domestic and foreign bonds are imperfect substitutes in this model, sterilized intervention has no effect. Changes in the bond holdings of the authorities do not alter the covariance of asset returns denominated in different currencies with consumption.

Empirically, tests for imperfect substitutability of domestic and foreign bonds conducted without using data on bond supplies have yielded as little evidence in favor of imperfect substitutability as tests conducted using such data.

A. Studies of the Joint Hypothesis

Baillie, Richard T., and others. "Testing Rational Expectations and Efficiency in the Foreign Exchange Market," *Econometrica*, vol. 51 (May 1983), pp. 553 - 63.

Cumby, Robert E., and Maurice Obstfeld. "A Note on Exchange-Rate Expectations and Nominal Interest Differentials: A Test of the Fisher Hypothesis," *Journal of Finance*, vol. 36 (June 1981), pp. 697 - 703.

Giovannini, Alberto, and Phillippe Jorion. "Interest Rates and Risk Premia in the Stock Market in the Foreign Exchange Markets," *Journal of International Money and Finance*, vol. 6 (March 1987), pp. 107 - 23.

Hansen, Lars P., and Robert J. Hodrick. "Forward Exchange Rates an Optimal Predictor of Future Spot Rates: An Econometric Analysis," *Journal of Political Economy*, vol. 88 (October 1980) pp. 829 - 53.

Hsieh, David. "Tests of Rational Expectations and No Risk Premium in Forward Exchange Markets," *Journal of International Economics*, vol. 19 (August 1984), pp. 173 - 84.

Korajczyk, Robert A. "The Pricing of Forward Contracts for Foreign Exchange," *Journal of Political Economy*, vol. 93 (April 1985), pp. 346 - 68.

Levich, Richard. "On the Efficiency of Markets for Foreign Exchange," in Rudiger Dornbusch and Jacob Frenkel, eds., *International Economic Policy: Theory and Evidence*, Baltimore: The Johns Hopkins University Press, 1979.

Tryon, Ralph W. "Testing Rational Expectations in Foreign Exchange Market," International Finance Discussion Paper 139, Washington: Federal Reserve Board, 1979.

B. Studies of Maximizing Models with Imperfect Substitutability

Campbell, John Y., and Richard H. Clarida. "The Term Structure of Euromarket Interest Rates: An Empirical Investigation," *Journal of Monetary Economics*, vol. 19, (January 1987), pp. 25 - 44.

Domowitz, Ian, and Craig Hakkio. "Conditional Variance and the Risk Premium in the Foreign Exchange Market," *Journal of International Economics*, vol. 19 (August 1985), pp. 47 - 66.

Giovannini, Alberto, and Phillipe Jorion. "The Time-Variation of Risk and Return in the Foreign Exchange and Stock Markets," *Journal of Finance*, vol. 64 (June 1989), pp. 307 - 325.

Hansen, Lars P., and Robert J. Hodrick. "Risk Averse Speculation in the Forward Foreign Exchange Market: An Econometric Analysis of Linear Models," in Jacob A. Frenkel, ed., *Exchange Rate and International Macroeconomics*. Chicago: University of Chicago Press for National Bureau of Economic Research, 1983.

Hodrick, Robert J. *The Empirical Evidence on the Efficiency of Forward and Futures Foreign Exchange Markets*. Fundamentals of Pure and Applied Economics 24. Chur, Switzerland: Harwood Academic Publishers, 1987.

Hodrick, Robert J., and Sanjay Srivastava. "The Covariation of Risk Premiums and Expected Future Spot Exchange Rate," *Journal of International Money and Finance*, vol. 3 (April 1984), pp. 1 - 29.

Mark, Nelson C. "Time Varying Betas and Risk Premia in the Pricing of Forward Exchange Contracts," *Journal of Financial Economics*, vol 22 (December 1988), pp. 335 - 354.

Robichek Alexander A., and Mark R. Eaker. "Foreign Exchange Hedging and the Capital Asset Pricing Model," *Journal of Finance*, vol. 33 (June 1978) pp. 1011 - 18.

Roll, Richard, and Bruno Solnik. "A Pure Foreign Exchange Asset Pricing Model," *Journal of International Economics*, vol 7 (May 1977), pp. 161 - 80.

International Finance Discussion Papers

<u>IFDP NUMBER</u>	<u>TITLES</u> <u>1990</u>	<u>AUTHOR(s)</u>
380	Foreign Currency Operations: An Annotated Bibliography	Hali J. Edison
379	The Global Economic Implications of German Unification	Lewis S. Alexander Joseph E. Gagnon
378	Computers and the Trade Deficit: The Case of the Falling Prices	Ellen E. Meade
377	Evaluating the Predictive Performance of Trade-Account Models	Jaime Marquez Neil R. Ericsson
376	Towards the Next Generation of Newly Industrializing Economies: The Roles for Macroeconomic Policy and the Manufacturing Sector	Catherine L. Mann
375	The Dynamics of Interest Rate and Tax Rules in a Stochastic Model	Eric M. Leeper
374	Stock Markets, Growth, and Policy	Ross Levine
373	Prospects for Sustained Improvement in U.S. External Balance: Structural Change versus Policy Change	Catherine L. Mann
372	International Financial Markets and the U.S. External Imbalance	Deborah Danker Peter Hooper
371	Why Hasn't Trade Grown Faster Than Income? Inter-Industry Trade Over the Past Century	Joseph E. Gagnon Andrew K. Rose
370	Contractionary Devaluation with Black Markets for Foreign Exchange	Steven B. Kamin
	<u>1989</u>	
369	Exchange Rate Variability and the Level of International Trade	Joseph E. Gagnon
368	A Substitute for the Capital Stock Variable in Investment Functions	Guy V.G. Stevens
367	An Empirical Assessment of Non-Linearities In Models of Exchange Rate Determination	Richard A. Meese Andrew K. Rose
366	Equilibrium in a Production Economy with an Income Tax	Wilbur John Coleman II

Please address requests for copies to International Finance Discussion Papers, Division of International Finance, Stop 24, Board of Governors of the Federal Reserve System, Washington, D.C. 20551.

International Finance Discussion Papers

<u>IFDP NUMBER</u>	<u>TITLES</u>	<u>AUTHOR(s)</u>
365	Tariffs and the Macroeconomy: Evidence from the USA	Andrew K. Rose Jonathan D. Ostry
364	European Integration, Exchange Rate Management, and Monetary Reform: A Review of the Major Issues	Garry J. Schinasi
363	Savings Rates and Output Variability in Industrial Countries	Garry J. Schinasi Joseph E. Gagnon
362	Determinants of Japanese Direct Investment in U.S. Manufacturing Industries	Catherine L. Mann
361	The U.S. and U.K. Activities of Japanese Banks: 1980-1988	Henry S. Terrell Robert S. Dohner Barbara R. Lowrey
360	Policy Rules, Information, and Fiscal Effects in a "Ricardian" Model	Eric M. Leeper
359	A Forward-Looking Multicountry Model: MX3	Joseph E. Gagnon
358	Implications for Future U.S. Net Investment Payments of Growing U.S Net International Indebtedness	Lois E. Stekler William L. Helkie
357	U.S. Policy on the Problems of International Debt	Edwin M. Truman
356	International Economic Policy: The Role of Exchange Rates	Edwin M. Truman
355	An Econometric Analysis of UK Money Demand in <i>Monetary Trends in the United States and the United Kingdom</i> by Milton Friedman and Anna J. Schwartz	David F. Hendry Neil R. Ericsson
354	Encompassing and Rational Expectations: How Sequential Corroboration Can Imply Refutation	Neil R. Ericsson David F. Hendry
353	The United States as a Heavily Indebted Country	David H. Howard
352	External Debt and Developing Country Growth	Steven B. Kamin Robert B. Kahn Ross Levine
351	An Algorithm to Solve Dynamic Models	Wilbur John Coleman II
350	Implications of the U.S. Current Account Deficit	David H. Howard
349	Financial Integration in the European Community	Sydney J. Key