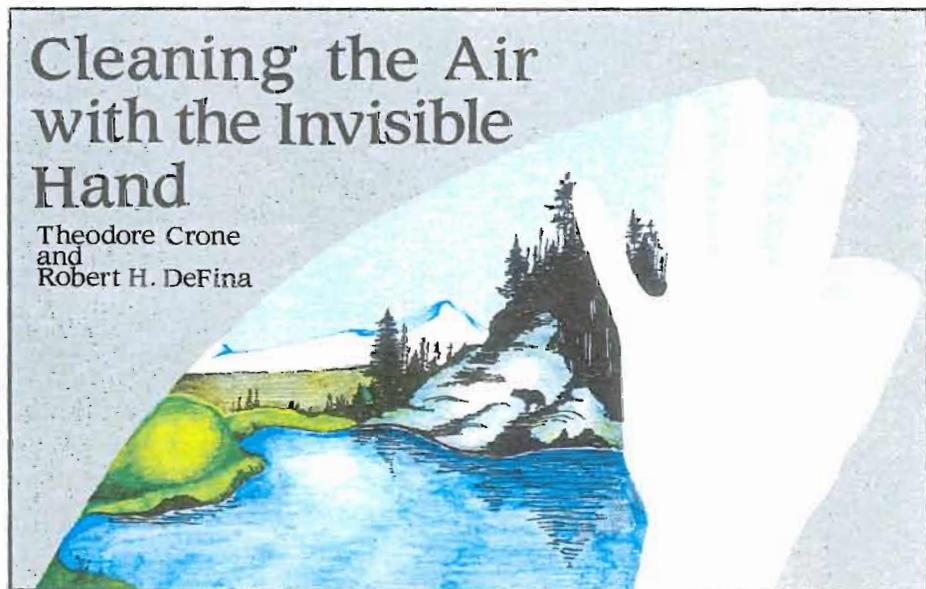
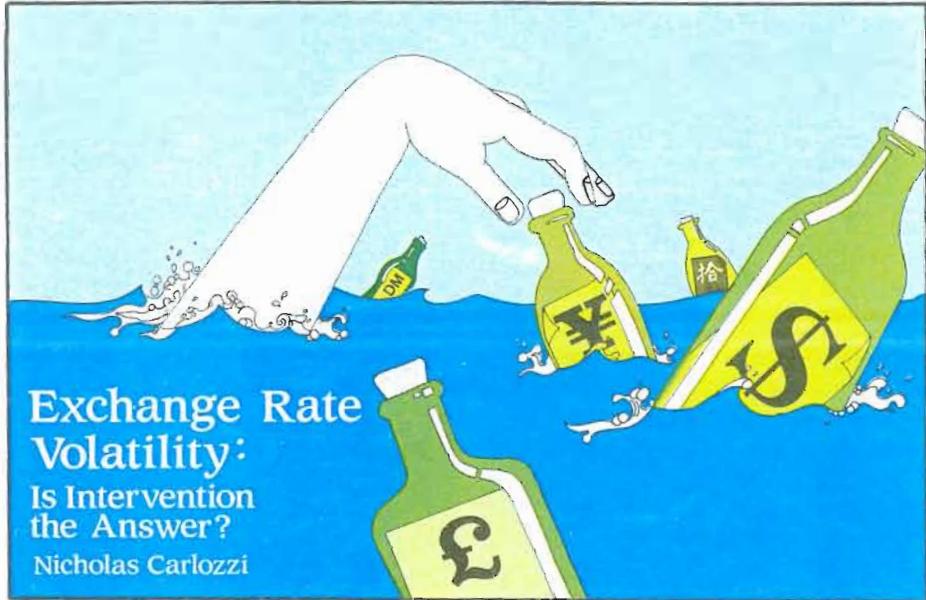


# BUSINESS REVIEW

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**EXCHANGE RATE VOLATILITY:  
IS INTERVENTION THE ANSWER?**

*Nicholas Carlozzi* . . . . . 3

Whether exchange rates are too volatile or not is a topic of debate among market analysts, as well as politicians. Each side agrees, however, that the crucial point is whether the volatility means the market is efficient or inefficient. At present, tests of efficiency in this market have not produced conclusive results. But this inconclusiveness itself underscores the need to deepen our analysis of the workings of the market before passing judgment.

**CLEANING THE AIR  
WITH THE INVISIBLE HAND**

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Recent efforts to improve air pollution control have enlisted the power of market mechanisms to complement or replace long-standing regulations aimed at specific pollution sources. Programs providing economic incentives for firms themselves to control pollution may prove not only more cost-effective than direct regulation, but also more successful at achieving the goal of cleaner air.

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## Exchange Rate Volatility: Is Intervention the Answer?

Nicholas Carlozzi\*

In early 1973, coordinated efforts to peg exchange rates were abandoned, and a new era of international monetary relations began. Currently, countries are free to choose the degree of exchange market intervention that best suits their overall economic objectives. Most of the major developed countries no longer rigidly support internationally agreed upon parities.<sup>1</sup> Thus, market forces play a

greater role, and official intervention a lesser role, in the determination of exchange rates today than they did before 1973.

Whether consequence or coincidence, the move toward less government intervention in the exchange market has been accompanied by more volatility in exchange rates. Both day-to-day fluctuations and longer-term swings of exchange rates have been larger. Furthermore, this increased volatility has been observed not only in the exchange rates of less frequently traded currencies, but also in the exchange rates of those currencies used most frequently in international trade and finance. (See: THE DOLLAR'S BEHAVIOR.)

Should governments intervene extensively in the foreign exchange market in an attempt to reduce this volatility? Some market analysts say yes, arguing that increased exchange rate volatility is evidence that the market overreacts to per-

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<sup>1</sup>Most members of the European Economic Community (EEC) maintain their currencies within a prearranged range vis-a-vis other EEC currencies, but not vis-a-vis the dollar. For a description of the range of current exchange policies, see Nicholas Carlozzi, "Pegs and Floats: The Changing Face of the Foreign Exchange Market," this *Business Review*, (May/June, 1980), 13-23.

### THE DOLLAR'S BEHAVIOR

The Trade Weighted Index (TWI) of the dollar's exchange value exemplifies the increased volatility that has accompanied the reduction in exchange market intervention by the major developed nations. It is evident not only in day-to-day fluctuations of the TWI but also in its longer-term movements.

Longer-term cycles in the TWI were nearly imperceptible during the final years of active government exchange market intervention, 1967 through 1972, but longer-term cycles became more pronounced with the reduction in official intervention in March 1973. Moderate swings in the TWI occurred from March 1973 through July 1977. Then, in mid-1977, the dollar began a more dramatic decline in exchange value.<sup>a</sup> Between July 1977 and October 1978, the TWI declined by 18 percent. In mid-1980, several factors stimulated a rebound in the dollar's exchange value; for example, interest rates in the U.S. rose relative to those abroad, and the U.S. current account balance moved into surplus. Between October 1980 and December 1982, the TWI increased by 32 percent.

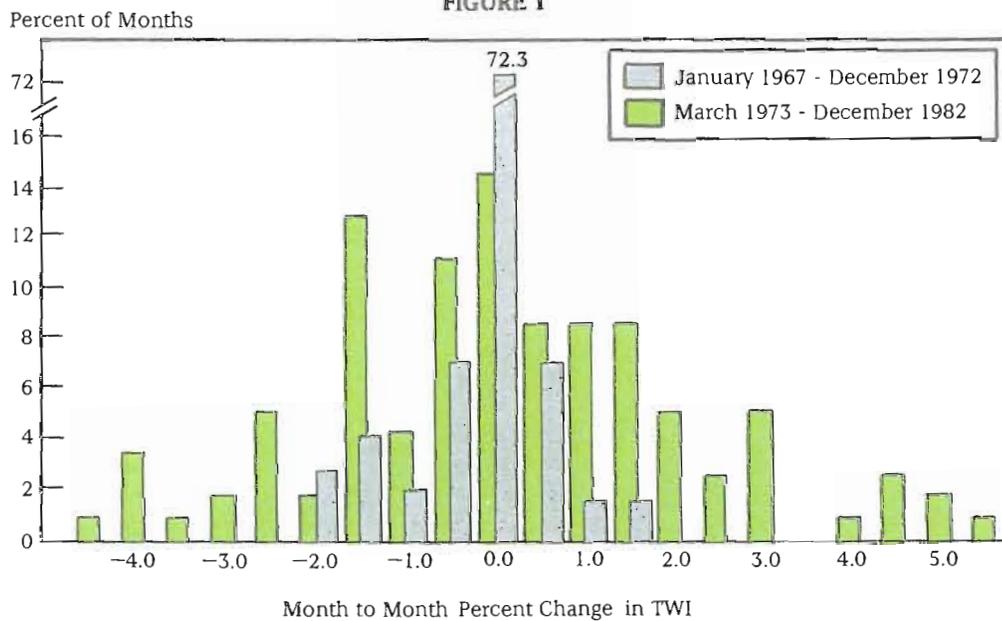
The month-to-month variability of exchange rates also increased with the reduction in official exchange market intervention in 1973. The increase in variability with the move from pegged to floating exchange rates is illustrated in Figure 1. Figure 1 plots the distribution of frequencies of monthly percentage changes in the TWI during the final years of pegged exchange rates, January 1967 through December 1972, together with monthly percentage changes during the period of floating exchange rates, March 1973 through December 1982.<sup>b</sup> Large month-to-month changes in the TWI clearly have become more frequent under floating rates.<sup>c</sup>

<sup>a</sup>"Storm in a Dollar Teacup," *The Economist*, (July 9, 1977), p. 111; and "Treasury and Federal Reserve Foreign Exchange Operations," *Federal Reserve Bulletin*, 63 (September 1978), pp. 793-810, particularly pages 794-795.

<sup>b</sup>The average monthly change in the TWI from January 1967 through December 1972, 71 observations, was -.12 percent. From March 1973 through December 1982, 118 observations, this change averaged .15 percent.

<sup>c</sup>Stronger evidence of increased exchange rate variability is provided by Janice M. Westerfield, "An Examination of Foreign Exchange Risk Under Fixed and Floating Rate Regimes," *Journal of International Economics*, 7 (1977), 181-200.

FIGURE 1



SOURCE: Computed from the monthly levels of the TWI reported in various issues of the *Federal Reserve Bulletin*.

ceived changes in economic conditions, and that this volatility is harmful. They urge a much bigger role for official intervention in order to temper the market's response and to reduce volatility. Other analysts disagree, arguing that increased exchange rate volatility is the correct response to more uncertain economic conditions. Such uncertainty could be due to natural disasters, such as a storm that destroys part of a country's wheat crop, or to unanticipated changes in economic conditions and in economic policies here and abroad. These analysts claim that, in those circumstances, exchange market intervention would itself be harmful, because it would delay the market's adjustment to the "correct" exchange rate.

From an economic point of view, the variability of exchange rates does not in itself condemn the current policy of limited exchange market intervention. The case for greater intervention to reduce exchange rate variability turns instead on knowing whether the market reacts appropriately to economic news. Economic well-being is promoted when exchange rates fully reflect all information that has a bearing on present and future economic conditions. If market participants ignore relevant information or if they overreact or underreact to economic news, then economic well-being suffers. Economists refer to a market where prices correctly reflect all currently available information at all times as an "efficient" market.

If the exchange market under floating rates is efficient, then intervention is likely to be counterproductive; that is, it is likely to reduce economic well-being, regardless of how variable exchange rates happen to be.<sup>2</sup> If, however, the exchange market under floating rates is inefficient, then there may be a valid case for some sort of corrective government intervention.

### WHAT IS AN EFFICIENT MARKET?

The theory of market efficiency revolves around

<sup>2</sup>As a general principle, it may be possible to improve economic welfare by intervening in a market that is efficient, as long as there are other inefficiencies elsewhere in the economy. In a sense, introducing a distortion in an efficient and undistorted market may offset a distortion somewhere else, and improve welfare. Though this is a possibility in theory, it is very difficult to apply this principle in practice. This possibility is discounted in the discussion that follows.

the relation between prices and information. In an efficient market the price "accurately reflects all the relevant information." In other words, all the factors that matter to buyers and sellers in the market, including their expectations of future events, are built into the market price. In a sense, the price is always right in an efficient market.

Economists can set up conditions that practically guarantee a market will be efficient. If it costs nothing to buy or sell, if information is free, if there are many market participants, and if people strive to maximize their welfare, then prices must accurately convey relevant information.

Does this mean that prices are stable in an efficient market? Far from it—prices will adjust promptly every time new information becomes available. For example, news of crop failures, technological innovations, or unexpected changes in government policies will cause prices to change.

The price changes generated by new information are viewed as beneficial by economists. They signal to everyone who looks at the price that something has occurred that calls for people to rethink their decisions on how to allocate resources.<sup>3</sup> When all markets are efficient the reactions of individuals to price changes will produce the best possible economy-wide allocation of resources—no one could be made better off without injuring someone else. This is why economists use efficiency as a yardstick when they evaluate the operation of a market.

How do we know whether a particular market is efficient? Unfortunately, the conditions that guarantee efficiency—costless transactions, free information, etc.—simply don't exist in the real world. Economists therefore rely on hypothesis-testing to tell them something about efficiency.

### TESTS OF EXCHANGE MARKET EFFICIENCY

In principle, economists might test the notion

<sup>3</sup>The oil crises of the 1970s bring to mind a vivid example of how people reallocate their resources when prices change. Oil prices soared, and what was once a cheap commodity became a precious one. In response, motorists and homeowners, for example, cut their consumption of oil drastically, and instead spent their money on energy-efficient cars, insulation and solar devices for homes.

that the foreign exchange market is efficient by checking to see whether exchange rates reflect all the relevant information. But they don't, because, in practice, they can't. For one thing, they can never know what "all the relevant information" really is. Instead, economists look for signs of inefficiency—cases where markets do not seem to be making good use of information. And they rely on indirect evidence to tell them how well a market works. This procedure is not unique to economics. Physicists cannot "see" elementary particles such as quarks, but they infer something about their behavior from what they *can* see. And theory tells them what to look for. In other words, rather than testing a theory directly, scientists sometimes focus on the *implications* of a theory. This is how economists address the issue of whether exchange markets are efficient.

What implication do economists use to test whether exchange markets are efficient? If exchange rates accurately reflect all information, then it follows that people should not be able to exploit existing information to earn abnormally large profits from speculating. In particular, if exchange markets are efficient, then it should be hard to make lots of money by "buying low" and "selling high." The reason is that any information that might have been used to implement such a strategy would *already* have been acted upon, and it would therefore be reflected in current exchange rates. Making large profits in an efficient market is, therefore, a matter of luck or a result of extraordinary skill. So economists can indirectly test whether the exchange markets are efficient by looking at the behavior of profits associated with speculation. If profits appear to be random, then the evidence is consistent with the view that the exchange market is efficient.

But suppose it appears that some people do earn above-average profits from speculation. Does this mean the exchange market is inefficient? The answer is, not necessarily. There may be other reasons why large profits accrue to speculation. In particular, it may be the case that speculators require a premium to compensate them for the risk that they may lose rather than make money. If so, finding above-normal profits from speculation may simply reflect the fact that the market, in effect, "pays" such a risk premium.

If economists knew the size of the risk premium,

they could simply subtract the payment for bearing risk from any profits associated with speculation. Unfortunately, little, if anything, is known about the size of the risk premium in the exchange market. The best economists can do, therefore, is *assume there isn't any risk premium*.<sup>4</sup> In technical jargon, economists assume speculators are "risk-neutral," that is, speculators do not require a premium to compensate them for the risk that they may lose money. Then nothing needs to be subtracted from the profits from speculation. But, in this context, if above average profits are discovered, it could mean either that (1) the market indeed is inefficient, or (2) speculators are not risk-neutral, contrary to the assumption, or both. All this suggests that testing for exchange market efficiency is a fairly tortuous process, complicated not just by the lack of useful measurements, but also by the necessity of examining two hypotheses (market efficiency and risk-neutrality) *at the same time*.

Economists go about testing for efficiency in the foreign exchange market by focusing their attention on the forward market.<sup>5</sup> In the forward market, foreign exchange is traded for *future delivery* at prices agreed upon today. Since a price pertaining to a future date can be "locked in" today, there is an obvious opportunity to speculate in the forward market. For example, a speculator could purchase German marks today at a known price for delivery three months from now. She would plan to sell them at that date (in the spot market) when she expects the price to be higher than today's forward rate ("buy low, sell high"). If the speculator believed the future price would be lower than today's forward rate, she would, of course, sell

<sup>4</sup>The factors that are thought to determine the risk premium required by speculators are described in the Appendix. Other assumptions made in these market efficiency tests generally concern the amount of information that is available to speculators when they transact in the exchange market. The effects of changing this information set are discussed briefly in the Appendix.

<sup>5</sup>Earlier investigations also consider the efficiency of the spot exchange market. The results are similar to those for the forward market and are not discussed here. For a survey of the exchange market efficiency literature, see Richard M. Levich, "On the Efficiency of Markets for Foreign Exchange," in Rudiger Dornbusch and Jacob A. Frenkel (eds.), *International Economic Policy: Theory and Evidence*, (Baltimore: Johns Hopkins Press, 1979), 246-267

marks in the forward market and buy in the spot market ("sell high, buy low"). In an efficient market, any such strategies should yield, at best, a normal profit. In other words, if market participants are risk-neutral our speculator should do about as well buying a safe-asset, like a Treasury bill, as she would trading in forward exchange.<sup>6</sup> This implication makes it possible to examine the market efficiency hypothesis by calculating the profitability of forward trading over time.

**Statistical Evidence.** Statistical tests of forward exchange market efficiency under floating exchange rates try to determine whether market prices are set so as to eliminate extraordinary profits available through forward speculation, on average. If the efficiency theory is correct it should not be possible to make extraordinary profits (more than the rate of return on Treasury bills) from predictable fluctuations in exchange rates.

Typical tests of forward market efficiency examine historical returns from forward speculation to see whether future speculative profits are predictable or random (average out to zero). One way to predict future returns is to use past speculative returns as information. If past speculative returns fail to predict future returns, this suggests that profits from forward speculation are random, which supports the joint hypothesis of market efficiency and risk-neutrality. Any success in predicting profits from forward speculation suggests that those profits are not purely random, which contradicts the joint hypothesis. The results available to date (discussed in the Appendix) indicate that profits do include a significant predictable component. During the 10-year period of floating exchange rates, the market did not set rates so as to eliminate profits from predictable exchange rate fluctuations. Statistical tests, then, reject the joint hypothesis that the market is efficient and speculators are risk-neutral.

**Technical Trading Rules.** Researchers also have analyzed the profitability of using technical trading rules as an alternative measure of exchange market efficiency. Technical rules are designed to

identify troughs and peaks in exchange rates.<sup>7</sup> If exchange rates are cyclical, then a speculator would make a profit by buying just after the cyclical trough and by selling just after the cyclical peak.

Speculators who identify a trough using a technical rule will shift their assets into the currency whose value they expect to increase.<sup>8</sup> But if the efficiency theory holds, it should not be possible to profit from buying and selling foreign exchange by using technical rules.

Researchers can statistically examine how profitable different rules would have been by varying the size of the percent change required to identify troughs and peaks. But rejecting efficiency in the market requires more than showing that a particular trading rule *could have been* exploited profitably. The point of the test is to see whether the profits from using such a rule persist long enough that speculators have time both to learn of the rule's profitability *and* to exploit it.

The results of these tests suggest that, while using trading rules based on large percentage changes would not have been profitable, using those rules based on changes between 1 and 5 percent would have been profitable. Moreover, the tests indicate that these trading rules have consistently yielded profits.<sup>9</sup> Tests of efficiency based on technical trading rules, like those based on the predictability of profitable speculation, reject the joint hypothesis that the market is efficient and that speculators are risk-neutral.

**Other Evidence.** The conclusions from these

<sup>7</sup>A simple percentage trading rule compares the current spot rate to its past history. A percentage rule identifies a trough by comparing the current exchange rate to the *lowest* rate recorded after the most recent peak. If the current exchange rate exceeds the lowest rate by a predetermined percentage, then the *lowest* exchange rate is identified as the trough rate, and the exchange rate is predicted to appreciate until it reaches its next peak. The procedure is reversed for identifying peaks.

<sup>8</sup>For example, if the exchange value of the dollar against the German mark appears to have reached its trough, then the trading rule suggests that speculators sell marks and buy dollars in order to profit from an anticipated rebound in the dollar's exchange value.

<sup>9</sup>Michael P. Dooley and Jeffrey R. Shafer, "Analysis of Short-Run Exchange Rate Behavior: March, 1973 to November, 1981," in David Bigman and Teizo Taya (eds.), *Exchange Rate and Trade Instability* (Cambridge, Mass: Ballinger, 1983).

<sup>6</sup>Note, however, that in practice, dealing in the forward exchange market requires only a security deposit, so, strictly speaking, the risk-neutral speculator's return should be zero, on average.

tests are reinforced by studies of the effectiveness of professional foreign exchange rate forecasters. Professional forecasters use a broad range of procedures to generate their forecasts. Some rely on technical analysis similar to the trading rules, some rely on econometric models, and still others rely on subjective judgments of the economic, regulatory, and political factors that affect the exchange market. In independent studies, Goodman and Levich have tested the predictive abilities of these advisory services; their results indicate that, overall, speculators are able to earn profits by following the advice of foreign exchange rate forecasters.<sup>10</sup> The results also show that the technical services have outperformed the econometric and judgmental services up to now. The success of exchange rate forecasting services in predicting future fluctuations in exchange rates provides evidence of unexploited opportunities for profitable speculation. Once again, the joint hypothesis of exchange market efficiency and risk-neutrality is rejected.

In summary, the evidence contributed by statistical analyses, by the profitability of technical trading rules, and by the forecasting expertise of exchange rate services all points toward the same conclusion. The joint hypothesis of market efficiency and risk-neutrality is not consistent with the exchange rate behavior observed during the current regime of floating exchange rates.

#### WHAT CAN WE CONCLUDE?

The case for government intervention in exchange markets rests on the notion that exchange rates are "too volatile"—that the market swings too far in one direction or another in light of changes in economic conditions and events. This view obviously conflicts with the premise that exchange markets are efficient, that the price of foreign currency is "always right."

<sup>10</sup>The records of the advisory services are examined by: Richard M. Levich, "How to Compare Chance with Forecasting Expertise," *Euromoney* (August 1981), 61-78; and Stephen H. Goodman, "Foreign Exchange Rate Forecasting Techniques: Implications for Business and Policy," *Journal of Finance* 34 (1979), 415-427. Some analysts have suggested that the success of the technical services has resulted from a shortage of speculative capital. See Michael R. Rosenberg, "Is Technical Analysis Right for Currency Forecasting?" *Euromoney* (June 1981), 125-131.

Proponents of intervention therefore might see the empirical evidence on exchange market efficiency as mostly supporting their view. But that judgment would overlook the fact that existing tests involve a *joint hypothesis*—market efficiency and risk-neutrality. It would also discount some independent, but relevant, evidence on efficiency in other markets for financial assets.

While it may be true that the existing statistical evidence does not support the notion that exchange markets are efficient, the findings in these studies may just as well reflect the fact that market participants are not risk-neutral. Rather, market participants may require compensation for placing funds at risk in the exchange market. If so, the evidence of extra-normal profits from speculation in foreign exchange may simply reflect the existence of such a risk premium, rather than suggest that markets are not efficient. To discover which part of the joint hypothesis—market efficiency or risk-neutrality—accounts for these statistical findings, economists need to find out more about the size of risk premia in exchange markets and the factors that might influence their variability. At the moment, very little is known about either.

Until they can provide stronger evidence that exchange market participants do not care much about risk, advocates of intervention cannot rely on the body of existing evidence on efficiency to buttress their case. Indeed, there is reason to be skeptical on other grounds that exchange markets are inefficient. In particular, economists have studied the efficiency hypothesis in a number of other markets for financial assets, including stocks, bonds, and options. They have found it very difficult to reject the efficiency hypothesis in these other markets. Why should the exchange market be any different?

Even if tests could firmly establish that exchange markets were inefficient, government intervention may not be the best form of response. Identifying the cause of an observed inefficiency (high information costs, liquidity constraints, thin markets, regulation) would be a necessary ingredient in the design of a policy to cope with the problem.

Some observers thought the debate over intervention would be settled by the results of the study of the Working Group on Exchange Market Intervention established at the Versailles Economic Summit in June, 1982. The results of the group's

research were aired at the 1983 Summit in Williamsburg. Each side finds some support for its views from the study—which, of course, is another

way of saying the results remain inconclusive. What we can conclude is that we need to know a lot more than we do at the moment.

## TECHNICAL APPENDIX

# STATISTICAL TESTS OF EXCHANGE MARKET EFFICIENCY

A simple way to test forward exchange market efficiency is to estimate the relationship between current and lagged values of the return to forward speculation. This test assumes risk-neutrality, that is, the expected fair return to speculation in the forward market is assumed to equal zero. Therefore, rejection of the efficiency hypothesis can be attributed either to the inconsistency of the risk-neutrality assumption or to a fundamental market inefficiency.

Single market efficiency tests involve statistical estimation of the parameters in the relation

$$(1) \quad P_t = \beta_0 + \beta_1 \sum_{i=1}^n P_{t-i} + \varepsilon_t$$

in which  $P_t$  is the return to forward speculation,  $\varepsilon_t$  is an unobserved error, and  $\beta_0$  through  $\beta_n$  are parameters. The return to forward speculation is defined by

$$(2) \quad P_t = \frac{S_t - F_{t-1}}{F_{t-1}}$$

where  $S_t$  is the spot exchange rate in the current period and  $F_{t-1}$  is the one-period ahead forward rate observed in the previous period. When the current spot rate exceeds last month's 30-day forward rate, for example,

those who had the foresight to buy foreign currency for forward delivery profit by selling the currency in the spot market. The joint hypothesis of market efficiency and risk-neutrality is not rejected as long as parameters  $\beta_0$  through  $\beta_n$  do not differ significantly from zero. The joint hypothesis is rejected when any of these parameters is significantly positive or negative. Tests of this hypothesis for a number of foreign currencies provide weak evidence for the rejection of the joint hypothesis.<sup>a</sup>

Efficiency tests like those of equation (1) are not particularly powerful, and they only reject the joint hypothesis when exchange rate behavior differs markedly from what would be observed if the joint hypothesis were true. More sensitive tests have been constructed by increasing the amount of information used to test the randomness of speculative returns. These tests, referred to as multimarket efficiency tests, take the form

$$(3) \quad P_t^a = \gamma_0 + \gamma_i^a \sum_{i=1}^n P_{t-i}^a + \gamma_i^b \sum_{i=1}^n P_{t-i}^b + \eta_t$$

$$P_t^b = \delta_0 + \delta_i^a \sum_{i=1}^n P_{t-i}^a + \delta_i^b \sum_{i=1}^n P_{t-i}^b + \nu_t$$

in which  $P_t^a$  is the return to forward speculation in foreign currency *a*,  $P_t^b$  is the return to speculation in foreign currency *b*, and  $\eta_t$  and  $\nu_t$  are unobserved errors. Parameters  $\gamma_0$  through  $\gamma_n^b$  and  $\delta_0$  through  $\delta_n^b$  should equal zero if the forward markets for currencies *a* and *b* are jointly efficient and speculators are risk-neutral. Rather than focusing on the efficiency of the forward market for a particular foreign currency, multimarket tests examine the overall efficiency of the forward market. That approach makes multimarket efficiency tests more sensitive measures of forward market efficiency. Multimarket efficiency tests reject the joint hypothesis of market efficiency and risk-neutrality much more frequently than single market tests.<sup>b</sup>

Failure of the joint hypothesis has led many observers to suggest that the risk-neutrality assumption is at fault. This interpretation has generated interest in modeling the economic determinants of exchange risk. The value of the premium demanded by risk-averse speculators is determined in theory by a number of factors.<sup>c</sup> The premium is sensitive to the degree of risk-aversion among private investors, the variances and covariances among the economic disturbances occurring in different nations, and the supplies of assets outstanding. Early tests have failed to explain predictable exchange rate fluctuations (attributed to risk aversion) in terms of the theoretical determinants of the fair return to bearing exchange risk.<sup>d</sup> This failure can be attributed either to risk-neutrality (in which the fair return always equals zero) or to the simplicity of these models. As models of risk-bearing become more sophisticated, exchange market efficiency can then be retested while allowing a fair return to speculation.

<sup>a</sup>Results of single market efficiency tests are reported by John Geweke and Edgar Feige, "Some Joint Tests of the Efficiency of Markets for Forward Foreign Exchange," *Review of Economics and Statistics*, 61 (1979), 334-341, and Lars Peter Hansen and Robert J. Hodrick, "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis," *Journal of Political Economy*, 88 (1980), 829-853.

<sup>b</sup>Geweke and Feige report the results of multimarket efficiency tests involving the forward rates of Belgian francs, Canadian dollars, French francs, German marks, Netherlands guilders, Swiss francs and British pounds against the U.S. dollar. Hansen and Hodrick report the results of multimarket tests for the same currencies excluding the Belgian franc and Netherlands guilder.

<sup>c</sup>Jeffrey A. Frankel, "The Diversifiability of Exchange Risk," *Journal of International Economics*, 9 (1979), 379-393.

<sup>d</sup>Jeffrey A. Frankel, "In Search of the Exchange Risk Premium: A Six-Currency Test Assuming Mean-Variance Optimization," *Journal of International Money and Finance*, 1 (1982), 255-274.