The Nature and Management of Foreign Exchange Risk

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Since the 1970s, exchange rate volatility has increased markedly and, with it, the levels of foreign exchange risk. In fact, fluctuations in financial variables such as exchange rates and interest rates have produced capital gains and losses so large as to swamp many companies' operating results. In response, many financial managers have turned to hedging as well as to more active risk management strategies in the foreign exchange markets. In this article, I review the theoretical and practical issues involved, while citing actual market experience since 1973. With this as background, I then go on to discuss current forecasting techniques and risk management strategies.

Before the main issues are addressed, however, let me offer a few definitions of key terms. First, care should be exercised when using the term "risk." In popular usage, risk is the possibility of an outcome that is less favorable than expected. This is not the definition used either in the finance literature or in this article. Here risk is defined as the dispersion of possible values, favorable or not, around those values that are expected. Foreign exchange risk is the chance that fluctuations in the exchange rate will change the profitability of a transaction from its expected value.

Second, *real* exchange rate risk should be considered apart from *nominal* exchange rate risk. Fluctuations in exchange rates that are not matched by offsetting changes in price levels at home and abroad are changes in the real exchange rate (or, alternatively, deviations from purchasing power parity (PPP)). It is only changes in real exchange rates that affect a country's international competitive position and the underlying profitability of its businesses. As such, they are crucial in both corporate and governmental decisions.

The Recent Foreign Exchange Experience

Many economists have been surprised by the recent volatility of foreign exchange rates and by the persistence of deviations from purchasing power parity (which they call "misalignment"). Milton Friedman, for example, has argued that exchange rates should be unstable only if fundamental economic variables—most notably, national monetary policies, economic growth rates, interest and inflation rate differentials, and current account imbalances—are also unstable. But such arguments have overlooked the extent to which exchange rates behave like asset prices. The prices of financial assets are extremely sensitive to news; they adjust very quickly to reflect new information about the intrinsic value of the underlying asset. The variability of this news by itself increases the volatility of financial asset prices. Moreover, because financial assets, unlike goods, can be almost costlessly stored or traded, their prices are more volatile than those of goods. Exchange rates, accordingly, have been more volatile than goods prices.

This section summarizes well-documented

*I would like to acknowledge the support of the Chase Manhattan Bank, where this research was carried out. I also wish to thank R.L. Slighton, C.W. Slighton, J.R. Zecher for helpful comments, criticisms, and suggestions; D. Chew and C.B. Pantuliano for editorial assistance, and K. Holmes for research support.

Past monthly changes [in exchange rates] are not useful in forecasting future monthly changes, and the expected change in the monthly exchange rate is thus zero.

observations of exchange rate movements, most of which are consistent with this "asset market" view of exchange rate determination.

Volatility Has Been High Compared to Market Fundamentals and Is Increasing.

The most striking observation about exchange rates since 1973 is that monthly exchange rate changes have been more volatile than changes in the observed values of the fundamental determinants. Monthly changes in exchange rates have been within ± 6 percent, with a few approaching ± 12 percent, while reported inflation differentials have not exceeded ± 2 percent.[1]

Moreover, the daily volatility of most currencies, with the exception of the Japanese yen, had increased until the September 1985 "Group of Five" meeting. Due to coordinated intervention, there has been a marked decline in volatility since then—with a few exceptions.[2] Though the reasons for this increase in volatility are not completely clear, part of the explanation may be the increasing deregulation and integration of the financial markets, along with increased uncertainty about the international financial system. By contrast, the daily volatility of the Japanese yen seems to have declined since 1984, especially when compared to the volatilities of other currencies. This is probably due to day-to-day smoothing operations by the Japanese authorities.

There is Almost No Correlation Between Successive Changes in Exchange Rates.

Along with the increased volatility since 1973, monthly changes in exchange rates have been uncorrelated over time and have tended to average zero. This absence of statistically detectable trends suggests that past monthly changes are not useful in forecasting future monthly changes, and that the expected change in the monthly exchange rate is thus zero. The econometric evidence also shows that weekly changes are uncorrelated. Daily changes, however, appear to be weakly correlated. This could happen if news that affects exchange rates takes a few days to be fully absorbed by the markets (or if central banks intervene to attempt to reverse market trends).

Spot and Forward Rates Move Together.

Spot and forward rates tend to move together. In fact, a regression of the change in the DM/$ forward rate on the change in the DM/$ spot rate results in a coefficient estimate of 0.98, with a standard error of 0.01 and an adjusted R^2 of 0.98.[3] The statistical properties of changes in spot rates, the fact that these changes cannot be predicted by lagged forward rates or discounts, and the high correlation of these changes with changes in forward rates support the hypothesis that most exchange rate changes are unexpected and are thus the result of market adjustments to new information.[4]

Deviations From Purchasing Power Parity Persist For Long Periods.

Along with a weaker short-run link with the fundamentals since 1973, there have been persistent deviations from purchasing power parity (PPP) that have lasted, on average, about five years. One possible explanation is that exchange rates react to shocks quickly while price levels adjust slowly. In the long run, however, both exchange rates and price levels will tend to adjust to absorb shocks. The best available estimate of this rate of adjustment is 2 to 4 percent per month.

Deviations from PPP, as mentioned earlier, are changes in real exchange rates. The real exchange rate can be defined as:

$$E = SP^*/P \qquad (1)$$

where S is the nominal exchange rate in terms of home currency per foreign currency, P* is the foreign price level and P is the home price level. If PPP

1. In fact, some analysts argue that exchange rate changes have more frequent outliers than changes in their fundamental determinants. Formally, academics characterize exchange rate changes as having "fat tails," that is, as compared to the normal distribution function.

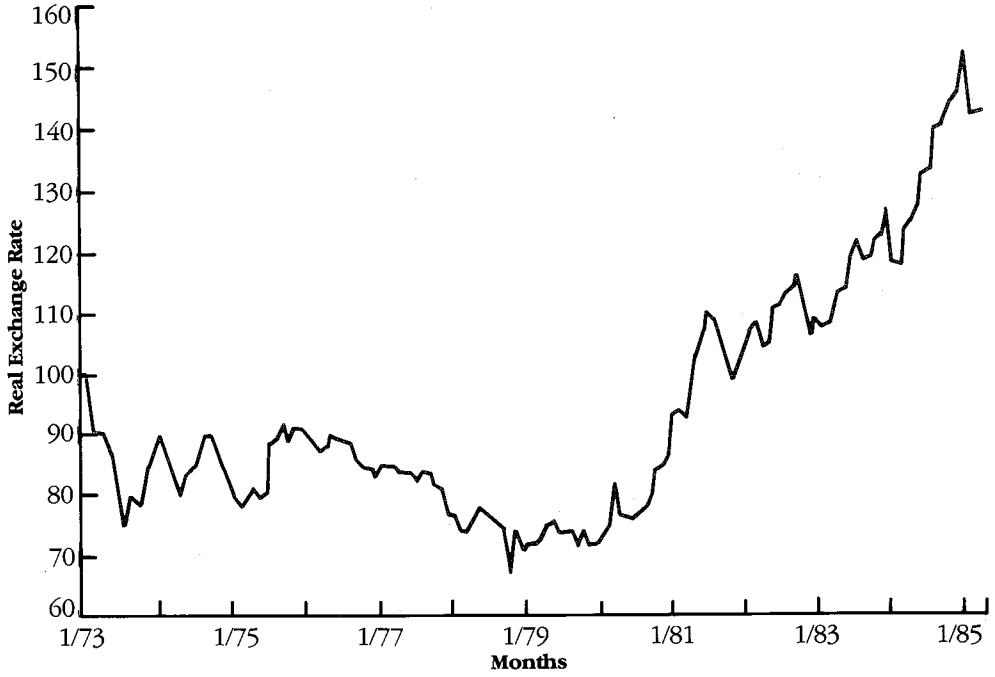
2. Volatility may be defined in various ways. Here, it is simply defined as the absolute value of the daily percentage changes times 15.8, the square root of 250, which is the approximate number of trading days in a year. The constant 15.8 annualizes the daily volatility calculations.

3. The residuals do not signal any autocorrelation or other econometric problems. The data are monthly from February 1975 to March 1985.

4. If changes in spot rates had been expected, then such changes would be highly correlated with lagged forward premiums and discounts, and uncorrelated with contemporaneous changes in forward rates. Since this is not so, we infer that spot and forward rates jointly respond to the same news.

It is clear that substantial deviations from PPP do happen; further, they have lasted, on average, five years during the period of floating rates.

FIGURE 1
Real Exchange Rate: DM vs. $
(Base Period = 100)



holds, then a change in P*/P should be exactly offset by a change in S, yielding a constant E.

In the short run, movements in real exchange rates reflect primarily changes in the nominal exchange rate rather than changes in relative inflation differentials. Hence, real exchange rate risk in the short run is difficult to distinguish from the risk of changes in nominal exchange rates.

To demonstrate this relationship between real and nominal exchange rate changes, Figure 1 plots the real exchange value of the mark against the dollar. By definition, an upward movement in the index implies that the mark is depreciating in real terms, and a downward move implies a real appreciation. If the years between 1973 and 1977 are taken as the base period, the dollar has been clearly overvalued with respect to PPP in the early 1980s.

In PPP calculations, however, the choice of the base period is always difficult. In this case, for example, if the 1950s were instead chosen as the base period, then the dollar in the early 1980s would not be considered overvalued. To illustrate this point, Figure 2 plots the trade-weighted real exchange value of currencies of the major U.S. trading partners *vis-a-vis* the dollar. (Note that an upward movement in this graph implies a real *depreciation* of the dollar.)

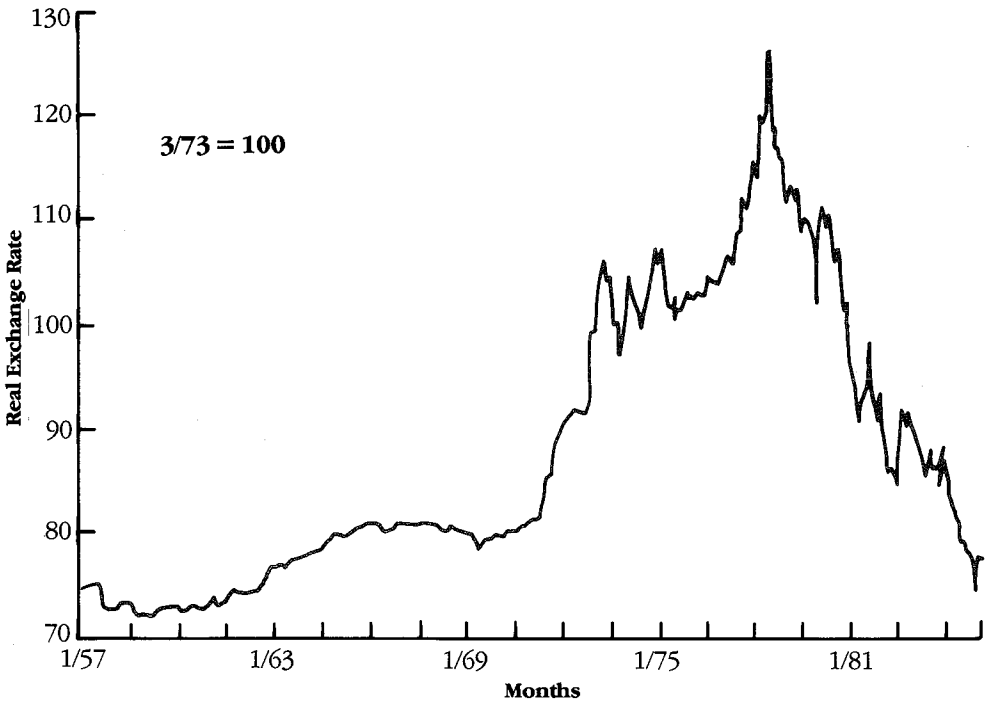
Regardless of the choice of the base period, however, it is clear that substantial deviations from PPP do happen; further, they have lasted, on average, five years during the period of floating rates. That is, as can be seen in a graphical analysis of various real exchange rates, the real exchange rate tends to wander away from some agreed-upon base level for approximately five years on average. This average embodies both the magnitude of past shocks and the speed of adjustment towards PPP. As such, the predictive ability of this average is quite limited.

There are several reasons for deviations from PPP. Actual or expected changes in central bank reactions and monetary and fiscal policies are predominant. Differential productivity growth in various countries also result in deviations from PPP. And under certain conditions, such as the imposition of capital controls, these deviations can become permanent.

Correlations with Market Fundamentals Are Unstable and Sometimes Curious.

Explanations for movements in exchange rates are hampered by the extremely weak and unstable relationship over the past decade between changes in exchange rates and the major macroeconomic

FIGURE 2
U.S. Trade-Weighted Real Exchange Rate Index



variables. Some of this may be due to the inconsistency of economic relationships over time; some may be due to the role of swiftly changing expectations.

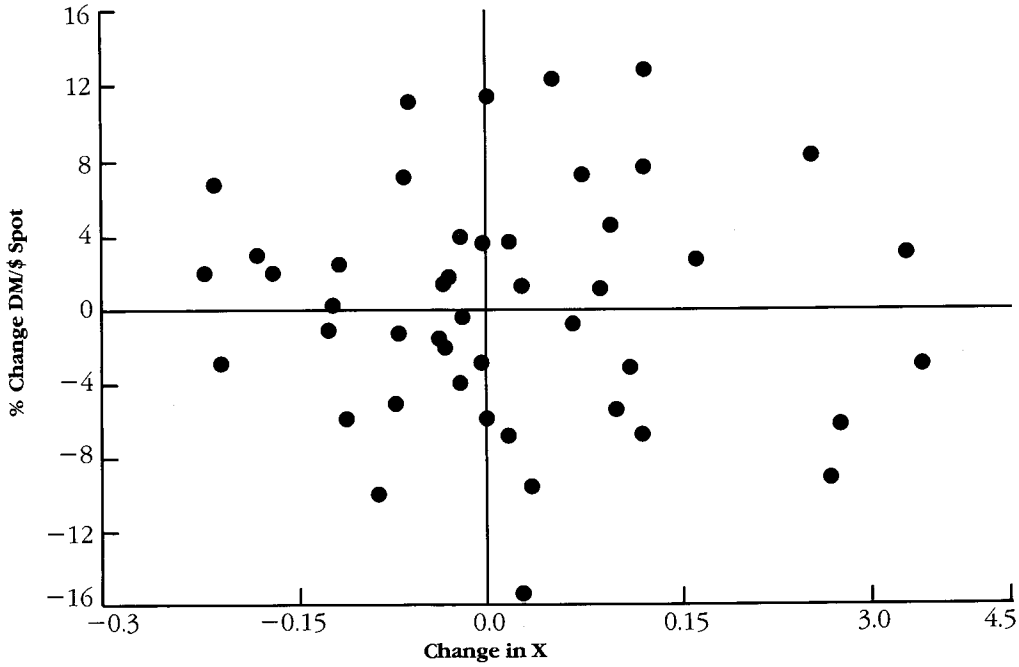
For example, contrary to theoretical arguments by monetarist economists, the actual correlation between relative changes in the money supply and in exchange rates has been almost nonexistent in the monthly data of the industrialized countries. The correlation does seem to hold, however, for countries subject to extremely high inflation. In such cases, high monetary growth seems to be a reliable predictor of a sharply depreciating currency.

Another weak, though often asserted, correlation is that between relative current account balances and exchange rate changes. Most models maintain that an improvement in the home current account implies an appreciation of the home currency and, conversely, that large trade deficits cause depreciations. The gist of the argument is that a current account surplus increases domestic holdings of foreign exchange reserves, thereby raising the price of the home currency. That is, for domestic residents willingly to own a greater proportion of foreign assets, the relative price of those assets must fall.

Figure 3 plots the quarterly percentage changes in the DM/$ rate against changes in the difference between the ratio of the current account to GNP for the U.S. and the same ratio for Germany over the period 1973-1985. If the theory posited above were true, we would expect larger relative current account surpluses (deficits) to be reflected in an appreciating (depreciating) currency. This expectation is not borne out in Figure 3.

Similarly, attempts to find a stable relationship between interest rates (whether daily, weekly or monthly), oil prices, and exchange rate changes have failed. Table 1, which lists the elasticities of various exchange rates with respect to oil price changes, illustrates the instability of some econometric relationships. Except in the case of Britain, signs of oil prices changes driving exchange rate movements are visible in 1983, not at all in 1982, and only faintly detectable in 1984 and 1985. In 1982, the stability of oil prices may explain the inability of statistical tests to pick up a relationship. As for 1984, it is possible that most countries learned how to hedge their oil exposures while Britain did not because of the size of its oil endowment. Countries that are oil poor relative to the U.S. should experience an appreciation of their currencies when oil prices decrease. (In Table 1, this relationship would appear as a positive

FIGURE 3
Change in the DM/$ Rate vs. Change in Current-Account Proxy



X = German (current account/GNP) − U.S. (current account/GNP)

TABLE 1
Foreign Exchange Rate Elasticities with Respect to Oil Price Changes

Sample	1982	1983	1984–85
DM/$	.0166	−.0874[c]	−.0809
	(.0915)	(.0428)	(.0739)
YEN/$	.0459	−.0754[b]	−.0524
	(.1172)	(.0434)	(.0467)
SF/$	.0489	−.1563[c]	−.0931[a]
	(.1171)	(.0479)	(.0671)
BP/$	−.0144	−.1268[c]	−.1190[b]
	(.0888)	(.0449)	(.0699)
FF/$	−.0165	−.0672[a]	−.0980[a]
	(.0876)	(.0452)	(.0720)
LIT/$	.0535	−.0825[c]	−.0639
	(.1753)	(.0407)	(.0666)

Standard errors are in parentheses.
Data are daily. The 1985 sample ends on February 6.
DM, YEN, SF, BP, FF and LIT, respectively, stand for the German mark, Japanese yen, Swiss franc, British pound, French franc and Italian lira.
[a,b,c] Denote significance at the 10, 5 and 2.5% levels for a two-tailed t-test.

number because of the way exchange rates are defined.) The converse is true for the U.K. because it is endowed with oil (and would be shown as a negative number in Table 1). Let us call this the "oil-to-currency" effect.

Yet, the fact that oil is priced in dollars introduces a complication. When the dollar appreciates (and, thus, foreign currencies depreciate relative to the dollar), oil producers may be prompted to reduce their dollar oil prices to foreign buyers to keep local currency oil prices more or less constant (thus giving rise to a negative number in Table 1). This relation-

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TABLE 2
Estimates of Currency Betas

Sample	1982	1983	1984–85
YEN/$	1.027	.8044	.0436
	(.0496)	(.0390)	(.0241)
SF/$	1.134	.9727	.8544
	(.0356)	(.0385)	(.0191)
BP/$	.7272	.5179	.9012
	(.0412)	(.0589)	(.0321)
FF/$	.9533	.9525	.9650
	(.0412)	(.0657)	(.0090)
LIT/$	.9629	.8519	.9015
	(.0790)	(.0264)	(.0170)

Data are daily: The 1985 data end on March 28.
All coefficients are significant at least at the 2.5% level (two-tailed test).
See Table 1 for additional notes.

ship can be called the "dollar-to-currency" effect.

The oil-to-currency effect implies a positive relationship for all except the British pound. The dollar-to-oil effect implies a negative relationship for all. Table 1 suggests that, contrary to conventional wisdom, the dollar-to-oil effect dominates. Even for the pound, it might be argued that were it not for the dollar-to-oil effect, the pound would not be as sensitive to oil price changes as it seems to be. Note that both the first and second effects for the pound are in the negative direction. For the other currencies, the effects tend to cancel out.

Correlations Across Rates Are Often Unstable.

Movements in one exchange rate are not independent of movements in another. Such relationships, however, are not stable. Correlations among currency movements can be measured using the concept of "beta (β)," a regression coefficient, which is formulated as follows:

$$\Delta S = \beta \Delta S_{DM/\$}$$

where Δ is the percentage change, S is the exchange rate in foreign currency units per dollar, $S_{DM/\$}$ is the DM/$ exchange rate and β is a constant. Note that the DM/$ rate is chosen as the anchor only for convenience. Table 2 presents estimates of various currency betas over several periods.

As exhibited in the cases of SF and yen, betas are unstable over time. In particular, the Japanese authorities in 1984-85 seem to have been trying to dampen currency movements. It appears that the yen has not been allowed to depreciate against the dollar as much as European currencies, possibly to prevent trade sanctions against Japan by the U.S. or even Europe. The mildness of this depreciation is made up when the dollar depreciates, for then the yen is not allowed to appreciate against the dollar by as much as the European (EMS) currencies. Casual observation suggests that the betas of other EMS currencies are roughly around 1.0 for DM/$ changes of no more than 10 percent in absolute value. For larger changes, EMS betas drop below 1.0.[5]

Forward Rates May Have Stable or Fluctuating Biases.

Forward rates may continuously under- or overpredict future spot rates. These biases may be due to the risk characteristics of the underlying economies. For instance, there is good reason to believe that U.S. monetary policy is more unstable than its German counterpart. Hence, the dollar might be a riskier asset than the DM. This suggests that the DM/$ forward rate would overvalue the DM compared to the expected future spot rate. In fact, most recent econometric evidence, discussed in more detail later, suggests that forward rates are actually biased predictors of future spot rates. If the riskiness of the

5. It is interesting that the Swiss beta is lower in 1984-85 than in 1982. The explanation for the previously larger Swiss beta was that the SF market was not as deep as the DM market and produced larger swings. Apparently, this is no longer true, either because of central bank intervention or deeper markets.

It is important to remember that the volatility of exchange rates, even though high, is not significantly different from that of the prices of other financial assets.

underlying economies fluctuates, so would the bias in the forward rate.

There is an additional source of fluctuating biases. Currencies that are not allowed to float freely, such as the Mexican peso, exhibit a special statistical characteristic that has come to be known as the "peso problem." When the market expects the peso to be sharply devalued, but does not know the exact date of the devaluation, the forward discount on pesos is not as large as the expected devaluation. Hence, the forward peso continuously undervalues the peso through a series of negative forecast errors for dates preceding the devaluation. And for dates subsequent to the devaluation, the forward rate overvalues the peso through a large positive forecast error. Thus, a series of small negative forecast errors followed by a large positive forecast error, or its converse, has come to be called the peso problem.

Biases similar to the peso problem may also exist for the exchange rates of more or less freely floating currencies. This is especially true when there is uncertainty about both the timing and actual occurence of major economic or political events—for example, the unexpected election of a political candidate likely to change a country's monetary and fiscal policies.

The Implications

Just as in the stock market, foreign exchange analysts use various techniques alleged to provide an edge in forecasting financial prices such as exchange rates and stock prices. If such techniques did prove to be effective forecasting tools, it would imply that the users of such techniques could generate profits above the fair market rate of return. While this sometimes may occur, it generally does not. And there is good reason to be skeptical about apparent free lunches: it is not rational to share successful forecasting methods with others because doing so would reduce per-capita profits.

In this section we discuss the efficient markets hypothesis (EMH)—loosely, the notion that there is no free lunch—and its implications for foreign exchange forecasting. In the critical light of EMH, we then assess the usefulness of the technical and econometric analyses that are currently used to forecast exchange rates.

There Is No Free Lunch: The Efficient Markets Hypothesis

The dismal forecasting performance of econometric models, as well as the very limited horizon of technical models, add further credence to the efficient markets hypothesis. In its so-called "strong" form, the EMH states that financial asset prices, such as exchange rates, fully reflect *all* information. Investors therefore cannot consistently earn extraordinary profits by exploiting any sources of information, even that of insiders. Less extreme versions of the hypothesis state that only *publicly* available information, including all past price performance, is already reflected in the current price.

The strong form of the hypothesis is based on the observation that financial assets can be easily traded by numerous well-informed traders who make decisions continuously.[6] For this reason, financial prices are extremely sensitive to news and immediately adjust to reflect all available information about the major determinants of an asset's value. In turn, the strength of these expectations affects the volatility of the financial asset's price.

In the long run, financial prices do turn out to be consistent with market fundamentals. In the short run, however, financial prices are rather "noisy," whether because of shifts in expectations, institutional movements in and out of the market, or other unsystematic factors. Nevertheless, it is important to remember that the volatility of exchange rates, even though high, is not significantly different from that of the prices of other financial assets.

For reasons discussed previously, efficient market theorists contend that the apparent departures from market fundamentals do not necessarily imply that the market is inefficient. Such departures do not offer consistent opportunities to earn extraordinary profits (on a risk-adjusted basis).

In judging the efficient markets hypothesis, it is perhaps better to think of market efficiency as the description of a process rather than a static condition of the market at each point in time. It is, in fact, almost impossible for investors to make extraordinary profits using only publicly available information. Those who do make such profits possess superior forecasting skills and their economic return may be viewed as a "monopoly rent." Aside from these ex-

6. It also assumes that these assets can be stored without cost.

In the absence of capital controls, arbitrage dictates that the home currency must be at a forward discount that is approximately equal to the difference between home and foreign interest rates.

ceptions, many other traders invest in information gathering and processing; and they make economic profits on their positions if their judgments are borne out. Such traders help ensure that the market reflects all available information.

A corollary of the EMH is the validity of the random walk model (or some variant thereof). The model holds that the best predictor of future asset prices is the current asset price, perhaps with some adjustment for the expected growth of the asset. There are two types of random walk models: those with and those without "drift." Drift stands for the expected growth of the asset in question.

Are Current Rates Adjusted for Interest Differentials the Best Forecasters of Future Spot Rates?

Price changes have two components: the expected and the unexpected. In the case of equities, stock prices move at a rate appropriate to their risk class (the expected component) together with a random term (the unexpected component). The unexpected component can only be random because new information, by definition, arrives randomly. From this, it follows that stock prices behave according to the random walk model with a drift term (which reflects, again, an expected rate of growth in the asset's price).[7]

This model is also applicable to the foreign exchange market. One can either invest a dollar at home or, alternatively, convert it to foreign currency, invest it abroad, and repatriate it at the end of the investment period. The functioning of arbitrageurs who are indifferent between holding domestic and foreign assets ensures that the above two investment strategies produce the same rate of return. That is, we would expect the home currency to depreciate by an amount approximately equal to the difference between domestic and foreign interest rates.[8] For example, if home interest rates are 200 basis points below foreign rates, then one expects the home currency to appreciate by 2 percent.

This relationship is known as the *uncovered interest rate parity* theorem. In essence, it is the random walk model with drift, in which the drift (or expected) term is the differential between home and foreign interest rates. The unexpected term is the arbitrageurs' judgmental error.[8]

Aha, the Corresponding Forward Rate Is the Best Forecaster of Future Spot Rates!

One twist in the foreign exchange markets that must be accounted for is the forward market. In the absence of capital controls, arbitrage dictates that the home currency must be at a forward discount that is approximately equal to the difference between home and foreign interest rates.[9] For instance, if foreign annual interest rates are 300 basis points above home rates, then the foreign currency must be at a 3 percent annual forward discount. Otherwise, there would be arbitrage opportunities through the forward market.

Because speculators take forward positions which reflect their views, it can be argued that forward rates should be unbiased predictors of future spot rates.[10] In fact, some authors have coined the term "forecasting efficiency" to indicate that forward exchange rates are the best available forecasters of the future spot rate.

Or Maybe the Best Forecaster of Future Spot Rates Is the Current Rate.

Unfortunately, the most satisfying simple model of exchange rate movement turns out to be the random walk model without drift, which implies that the best forecaster of all future spot rates is the current spot rate. The forecasting superiority of the spot rate over the forward rate is especially prominent in the short run, but gradually disappears as the forecasting horizon is lengthened.

What Really Forecasts Future Spot Rates Best?

There is increasing evidence that forward rates, and hence the random walk model with drift, are not unbiased predictors of future spot rates. This may be due to the existence of a risk premium that arises from restrictions on the free substitution of home

7. Expressed in the form of an equation, the random walk model with drift is as follows: $s_t = u + s_{t-1} + e_t$, where s is the natural log of the underlying asset price, subscripts t and t-1 denote the time at which a variable is measured, u is the drift term (expected component) and e (unexpected component) is a normally, independently distributed error term with mean zero and constant variance. Note that since s_t and s_{t-1} are in logs, their difference is the expected growth rate of the asset, u. And e represents the unexpected growth of the asset.

8. The uncovered interest rate parity theorem, which is simply a reworking of the equation for the random walk model with drift, can be formulated as follows: $s_{t+1} = (i - i^*) + s_t + e_{t+1}$, where s_{t+1} and s_t are the logs of the exchange rate in terms of home currency per unit of foreign currency at times t+1 and t, respectively; i and i^* are the home and foreign interest rates; and e_t, the unexpected component, is a normally, independently distributed error term with mean zero and constant variance.

9. In equation form, $f_{t+1} - s_t = i - i^*$, where f_{t+1} is the log of the forward rate set at time t for delivery at time t+1.

10. This assumes there is no risk premium in international capital markets—either because of risk neutrality or because assets can be readily substituted.

When central banks attempt to dampen price changes that would otherwise take place, they make exchange rate behavior look like the slow spread of new information.

and foreign assets, or from investors' demand for a higher expected return for holding more risky currencies. The evidence is that current exchange rates predict future spot rates better than do forward rates; forecast errors, as measured by the mean absolute errors for example, are smaller when current rates are used.

Further, there is evidence that the random walk model without drift has better forecasting performance than such models, even when econometric models use actual values for the independent variables. This is well documented for forecasting horizons of up to a year. Hence, the empirical evidence suggests that the best simple predictor of future spot prices is the driftless random walk model.

This finding poses a problem because the driftless random walk model is extremely unsatisfactory from a theoretical perspective. In fact, this implies a money-making strategy (which I discuss later) and is inconsistent with long-term PPP.

Technical Analysis May Work in the Very Short Run.

Technical analysis is a vague term but is here defined as a body of analysis for forecasting the price of a financial asset solely on the basis of that asset's own price history. Common forms of technical analysis include models with names such as "momentum," "slope," "moving average," and "head and shoulders." Most of these models forecast only the direction of price movements.

A momentum model is based on the idea that a price, such as an exchange rate, will continue to move up if it has been rising in the past, and vice versa. Another theory defines a peak as a resistance area. If the market again approaches a peak, after having moved down from it, it is said to be "testing" the resistance area. If it "pierces" the resistance area, it is likely to move up for a while. If it backs away, it is likely to go down some more. Resistance areas are also formed on the downside.[11]

Technical analysis can be successful only if successive price changes are correlated. There is some support for technical analysis from a number of mechanisms that cause price changes to be positively autocorrelated. These include mass psychology, in the form of price changes feeding upon themselves, and the slow spread of new information. The existence of central banks that "lean against the wind" is another such mechanism. When central banks attempt to dampen price changes that would otherwise take place, they make exchange rate behavior look like the slow spread of new information.

For example, if there is market pressure for the exchange rate to move by 10 percent and the central bank instead allows only a series of 2 percent changes in stages, these small changes would be positively autocorrelated, whereas a once-and-for-all 10 percent jump does not have to be correlated with subsequent changes. Furthermore, technical analysis may pick up certain factors that escape classical statistical methods. For instance, technical analysis might be better at signaling certain discrete "jumps," such as a European Monetary System realignment.

Indeed, there is evidence that technical models have predictive power, especially in intra-day trading. However, their predictive power for periods of a month or longer does not seem strong. If information spreads in a few days, and if information in technical models is quickly disseminated, it is possible to have daily but not monthly autocorrelations.

If a technical model signals that a market will go up—and if enough people act on this signal—the market will go up by an amount corresponding to the information embodied in the technical signal. But because financial markets react quickly to news, it is unlikely that any worthy news will take a month or longer to be disseminated. Thus, the very use of technical models in the short run invalidates their use in the longer run.

Econometric Analysis Has Been Disappointing In The Short To Medium Run.

The exchange rate is an asset price that equilibrates various markets. When asset holders' expectations change with respect to the factors that affect those markets, the exchange rate also adjusts to reflect the new expectations. Attempts to uncover this process have produced several theoretical models of exchange rate determination, ranging from simple monetary theories to more complex portfolio bal-

11. There are also less common forms of technical analysis. Sophisticated econometric techniques such as Box-Jenkins analysis that use a price series' own history for forecasting are philosophically no different from the more traditional forms of technical analysis. However, Box-Jenkins-like autoregressive methods forecast the magnitude of change as well as the direction of change.

Given the current state of the art, econometric models are not very useful for forecasting exchange rates in the short to medium term—that is, up to five years—though forecasting performance improves with the length of the horizon.

ance formulations. Econometric analysis is generally used to substantiate the superiority of one model over another. Thereafter comes forecasting.

With econometric forecasting of exchange rates, however, a number of problems arise. First, we do not have a satisfactory theory to explain the formation of expectations. Moreover, we cannot accurately measure expectations—not surprisingly, since expectations are not directly observable (that is, when we are unable to measure accurately the variables that go into an econometric forecasting model, we cannot place much faith in the forecast itself). Second, any knowledge embodied in an econometric or technical model should already be embodied in the market price of a financial asset. Thus, the use of a model should not give its user an edge over other market participants. Third, the true underlying model that drives the world has not yet been uncovered. And fourth, the data needed to build econometric models of foreign exchange rates are inadequate. Statistics collected for this purpose usually are not timely or of the desired frequency. They are often inaccurate and generally do not reveal enough about institutional factors such as interventions and financial flows. Institutional factors may not be important in the determination of foreign exchange rates in the long run. Nevertheless, a large jump in the demand for foreign exchange by a large corporation on any given day will move the exchange rate on that day. And for traders whose profitability hinges on intra-day movements, that is important.

On balance, then, given the current state of the art, econometric models are not very useful for forecasting exchange rates in the short to medium term—that is, up to five years—though forecasting performance improves with the length of the horizon. Still, the longer-run forecasting capabilities of econometric modeling may be useful for other purposes, if only for focusing management's attention on the likely economic consequences of future exchange rate changes.

Risk Management Strategies

Though faced with ever greater exchange rate risk, financial managers can nevertheless reduce their exposure to such risk. Some of the available means for managing exchange risk are the consolidation of foreign exchange receivables and payments, hedging, and diversification.

Consolidate Receivables and Payables

The obvious first step in the management of foreign exchange exposure is to consolidate foreign currency receivables and payables. This gives management a clearer picture of foreign exchange exposures and avoids unnecessary covering costs.

In addition, correlations among currency movements can be exploited. Suppose, for example, that the current spot rates are 2.00 DM/$ and 150 yen/$, with receivables consisting of 200,000 DM and payables consisting of 15,000,000 yen in matched maturities. At current exchange rates, the yen payables are offset by the DM receivables. If management does not expect exchange rates to change, then no hedging transactions are necessary.

This would also be true if exchange rates change and the yen Beta equals one; that is, if changes in the yen were accompanied by the same percentage change in the value of the DM. If, however, the yen Beta is less than one, the DM receivables do not fully hedge the yen payables when the dollar appreciates because the depreciation of the DM exceeds the depreciation of the yen. Put differently, the yen has appreciated against the DM. Conversely, if the dollar depreciates, the mark receivables more than fully hedge the yen payables. In fact, it can be shown that one can be fully hedged by altering the DM position by the amount y, where:

$y = x\ (1 - \text{Beta})$ and where x is the expected change in the DM/$ exchange rate. That is, if x equals 0.10 (that is, the dollar appreciates by 10 percent), and Beta is 0.5, the DM position should be increased by 5 percent (y = .05).

Hedging Is Relevant.

The second step in foreign exchange exposure management is assessing and, if necessary, hedging the remaining exposure to exchange risk. The selection of an appropriate risk management strategy depends on management's view of what constitutes risk. The prevailing view, among practitioners at least, is that the primary purpose of exchange risk management is to reduce the variability of the firm's profits—whether measured by cash flows or conventionally reported dollar earnings—caused by changes in exchange rates. Financial academics, however, have long argued that reducing the variability of a company's returns, while leaving the expected level of those returns unchanged, should

Reducing the overall risk profile of the firm is relevant to shareholders if only because risk affects the perceptions and behavior of other corporate stakeholders such as employees, managers, lenders, and suppliers.

have little effect on the value of the firm. This view of risk management focuses on risk in the equity markets and considers a security or a firm's operations risky only to the extent that the firm's activities move in tandem with the market as a whole. Well-diversified international investors, so the argument goes, should not be willing to pay a premium for corporate hedging activities which they can easily duplicate for themselves simply by adjusting their portfolios. According to this view, although hedging to reduce overall variability of profits may be important to executives compensated on the basis of short-term earnings, it is largely a matter of "irrelevance" to shareholders.

I take issue with this argument, first of all, because it underestimates the importance of information, transaction costs, and other sources of friction in the operation of markets. These factors may make it costlier for market participants to hedge certain risks than for the firm to do so. In this article, I begin with the assumption that hedging does have value for shareholders (in part because it is so widely observed). Reducing the overall risk profile of the firm—stemming from fluctuations in commodity prices, high fixed costs, high financial leverage, as well as exchange rate swings—is relevant to shareholders if only because risk affects the perceptions and behavior of other corporate stakeholders such as employees, managers, lenders, and suppliers.[12] By reducing the total risk or variability of the firm, hedging transactions reduce the exposure of a range of corporate constituencies; and this in turn may increase the value of shareholders' claims.

Use Passive Strategies If You Cannot Forecast Nominal Rates.

For protection against the risk arising from currency volatility, there are a number of passive strategies that either totally or partially hedge a firm's foreign exchange exposure. These strategies are particularly useful when management has little confidence in its ability to forecast. In general, these strategies try to avoid risk at almost all cost. By contrast, active strategies—those which entail participation in the foreign exchange market based on a view of currency movements—require some appetite for risk.

Some passive strategies ensure a minimum level of profits and, at the same time, allow the opportunity for more. But at the least, passive strategies are beneficial because they insure positions and insulate the firm's income from undesirable foreign exchange moves. These strategies, with the exception of using futures, also avoid the costs involved in managing positions.

Passive strategies use a variety of financial instruments, including forwards, futures, swaps, and options. Other widely used techniques are leading and lagging, borrowing and lending, currency matching, and commodity hedging. (Only a few examples are illustrated below, but the pros and cons of each technique are outlined in the Appendix to this article.) Because the characteristics of foreign exchange risk tend to differ by time horizon, the appropriate strategies for the short, medium, and long term also vary.

Use Readily Available Instruments in the Short Term.

The evidence presented above suggests that in the short term (less than one year), most movements in nominal exchange rates are largely unanticipated. Moreover, prices at home and abroad do not adjust quickly to offset nominal exchange rate changes (thereby causing deviations from PPP). And finally, nominal interest rate differentials across countries are not matched by subsequent and offsetting exchange rate changes.

This evidence implies that there is *real* foreign exchange risk in the short term. In turn, this leads directly to business risk by affecting both unhedged monetary and nonmonetary positions arising out of commercial transactions and dividend flows. This type of currency risk is sometimes referred to as "transaction" risk.

Because foreign exchange forecasting is so unreliable in the short term, transaction risk should be (and is easily) hedged by using the available financial instruments and techniques mentioned above. Of course, there is a cost attached to these procedures. For example, the cost of forward covering is best represented as the difference between the bid-ask spread in the forward contract and in the spot markets.[13]

12. For an extensive discussion of this point, see Alan Shapiro and Sheridan Titman, "An Integrated Approach to Corporate Risk Management," *Midland Corporate Finance Journal*, Vol. 3 No. 2 (1985).

13. This, however, is a controversial matter. Some authors argue for the difference between the current spot and the forward rate. Others believe cost should be viewed as the difference between the forward contract and the spot

In order for FASB 52 to provide an accurate representation of true economic value, all items on the balance sheet must be marked to market.

Match Assets and Liabilities in the Medium Term and Use Actual or Synthetic Instruments.

In the medium term—say, one to five years—foreign exchange risk encompasses both transaction and translation risks. Translation risk relates to the effects of nominal exchange rate changes on balance sheet exposures. Firms try to manage such exposures by matching assets and liabilities in a particular currency as well as by using the above-mentioned techniques and instruments. Nevertheless, such efforts have limited effectiveness because of transaction costs and various constraints.

An understanding of translation exposure requires knowledge of accounting rules and regulations such as FASB 8 and FASB 52. For instance, the more recent, and more relevant, FASB 52 rule states that all translation must be carried out at the prevailing spot rates when the accounting statements are prepared. By contrast, FASB 8 translates monetary items at the exchange rate on the reporting date and nonmonetary items at the exchange rates prevailing at the time of acquisition. Another difference between the two rules concerns the separation of foreign exchange income from operating income. FASB 8 reports translation gains and losses in current income, blurring the distinction between operating income and foreign exchange income. FASB 52, on the other hand, incorporates foreign exchange gains and losses in an equity account (except for certain aspects of the operations of foreign subsidiaries that use a certain "functional" currency as reported in FASB 8).

For the purpose of judging a firm's economic value, FASB 52 is incomplete unless it is accompanied by thorough inflation accounting at home and abroad. In order, then, for FASB 52 to provide an accurate representation of true economic value, all items on the balance sheet must be marked to market. To illustrate, consider a foreign subsidiary located in an inflationary environment where price increases are fully matched by local currency depreciation (such that PPP is maintained). To the extent that the fixed assets of the subsidiary are valued at historical book value and translated at current exchange rates, translation according to FASB 52 will understate the value of these fixed assets. Because share prices are likely to reflect real economic performance rather than that indicated by translated accounting earnings, it might be argued that accounting exposure should not be a matter of concern. Nonetheless, translation exposure can have some important effects. Accounting conventions affect tax payments, royalty payments, executive compensation, and various other contractual obligations.

Try to Forecast Real Exchange Rates in the Long Term.

Long-term exchange risk (more than five years), also known as "real" or "economic" exchange risk, arises from permanent secular changes in real exchange rates and from permanent differences in real returns across countries. Such changes influence the profitability of various production locations around the globe and are critical to decisions about foreign production and investment.

It is very difficult to hedge real exchange risk in the marketplace with any precision. Explicit instruments for such operations are either nonexistent or thinly traded. Nevertheless, there are some, admittedly crude, approaches to hedging economic exchange risk. For example, a U.S. multinational sourcing some of its components in Brazil will face reduced profitability if the real exchange value of the cruzado appreciates—that is, if Brazilian prices (wages and other costs) rise faster than the rate of cruzado depreciation. To protect itself, the company can construct a hedge by buying Brazilian cruzados forward, together with forward contracts of Brazilian commodities. Or it can buy forward cruzados and Brazilian real assets.

The problem with these strategies, however, is that long-dated forward markets for the cruzado and for Brazilian commodities are probably extremely thin. One alternative is to borrow in the U.S. and lend in Brazil. But these sets of transactions are too cumbersome to be economical. Yet another alternative is to attempt to forecast real exchange rates, particularly since long-term real exchange rates are probably easier to forecast than short-term rates.

Under certain assumptions, an improvement in overall home productivity points to a real appreciation of the home currency. This suggests that when

rate at maturity. Still others vote for the difference between the forward rate and the expected future spot rate. Ultimately, though, the cost of the forward cover is the income of units that provide this cover. This income is the bid-ask spread, and it is this cover that has to be compared to the alternative of transacting in the spot market.

Despite persuasive arbitrage arguments, real rates of interest may be consistently different across countries, even after adjusting for exchange rate changes. Perhaps the reason is that there is risk associated with being long in a certain country.

TABLE 3
Spot and Forward Rates for the BP and SF on 3/22/85

Sample	Spot	30 Days	90 Days	180 Days
$/BP	1.1740	1.1692	1.1623	1.1594
$/SF	.3663	.3674	.3696	.3743

multinationals produce abroad, they should invest in industries with higher than average expected productivity growth. Such a strategy helps to ensure that the cost of the components sourced in these countries remains competitive.

Use Active Strategies If You Have A View.

At the opposite end of passive strategies in the risk-management spectrum are those that maximize expected value regardless of risk. Examples of some active management strategies, which are geared toward achieving a profit target at the expense of incurring some risk, are discussed below.

Borrow Low, Lend High.

As shown above, the current spot rate may be a better predictor of future spot rates than the corresponding forward or futures rates (as predicted by the random walk model). Although even this relationship is not precise, it can be exploited if investors are willing to bear some risk. The strategy is to make buy or sell decisions in the forward markets based on the assumption that, on average, the current spot rates will prevail in the future.

To illustrate, consider the spot and forward rates for the British pound (BP) and the Swiss Franc (SF) in Table 3. Note that the pound is at a discount and the SF is at a premium throughout the forward horizon of 30 to 180 days. For the 180-day horizon, the forward rates imply that the pound is at a 2.48 percent per year discount, and the SF is at a 4.36 percent per year premium. Under the above strategy, which essentially bets on the current spot rate against the forward rate, the company should take a long forward position in pounds and a short forward position in SFs. In essence, this means taking a long forward position in BPs because forward BPs are incorrectly cheaper than spot BPs. That is, in the relevant future, the spot BP will not be as cheap as the forward rates indicate but, instead, will be just as expensive as the current spot rate. The converse is true for the SF. The strategy expects to make profits of .0048c/BP, .0117c/BP and .0146c/BP on the 30-, 90- and 180-days contracts, respectively.

Such a strategy, incidentally, is virtually identical to borrowing in countries with low interest rates and lending in countries with high interest rates. Borrowing in Switzerland is the same as being short Swiss bonds. At maturity, SFs must be bought to pay one's liabilities; and this is thus identical to shorting forward SFs. Similarly, lending in the U.K. means that one is long British bonds, which is equivalent to being long in forward pounds.

Under these circumstances, it is no wonder that international arbitrage and the figures given in the table indicate that annualized British and Swiss interest rates are approximately 248 basis points higher, and 436 basis points lower, than U.S. rates, respectively. Another example: when 15-year interest rates were 8 percent for the SF and 17 percent for the US$, the World Bank was funding some of its operations in the Swiss franc. The Bank calculated that the breakeven point would occur at a 9 percent annual rate of appreciation for the SF vis-a-vis the dollar. Over 15 years, this would compound to a 364 percent appreciation, or a change to $1.75/SF from the 48c/SF prevailing at the time. Since the World Bank reasoned that this was an unlikely outcome, they accepted the risk and funded in SFs.

But let me offer one caveat in betting against the forward rate. In doing so, one maintains naked positions in the forward markets. Put differently, the expected return of this strategy may be viewed as a reward to the risk associated with the strategy. Despite persuasive arbitrage arguments, real rates of interest may be consistently different across countries, even after adjusting for exchange rate changes. Perhaps the reason is that there is risk associated with being long in a certain country. This risk can be mitigated in two ways: first, by using foreign exchange options, which put a limit on losses; and, second, by using a portfolio approach to currency management.

Use the Portfolio Approach to Exploit Correlations, or Lack Thereof, among Currency Movements.

The portfolio approach takes advantage of the correlations, or lack thereof, among various ex-

International portfolio diversification pays off if national financial markets are sufficiently segregated.

change rate changes. For example, we know that movements in the Dutch guilder (DG) and the German mark (DM) are highly correlated vis-a-vis the dollar. If Dutch interest rates suddenly go up, the portfolio approach suggests that one should borrow marks and lend guilders. This is a less risky strategy than borrowing dollars and lending guilders because it involves uncertainty in only one exchange rate—that is, the DM/DG. By contrast, borrowing US$ and lending DG entails uncertainty in two exchange rates: the $/DM and DM/DG. (Here, it is useful to think of the DM as a price leader and the DG as a price follower.)

While it is useful to exploit high degrees of co-movements, managers can reduce overall variability when there are low degrees of co-movement between returns on different assets or markets. This can be done by diversifying away from a single market or asset toward several markets or assets. For example, if returns on French securities, after accounting for exchange rate changes, have almost no correlation with returns on Australian securities, a U.S. investor could reduce the overall variability of his portfolio by holding both French and Australian securities. This is similar to selling life insurance to a diverse group of people.

International portfolio diversification pays off if national financial markets are sufficiently segregated. If they are, arbitrage relationships such as PPP may not hold while returns, measured in the home currency of the investor, may be uncorrelated. The risk of this approach is that correlations among the returns of various assets may be unstable over time. Even so, the evidence suggests that international portfolio diversification does pay off by reducing risk when an expected return is the main goal, or by increasing expected return when a specific level of risk is kept under control.

Concluding Comments

The facts about exchange rate behavior summarized in this article suggest that it is difficult to forecast exchange rates with any degree of confidence. The reason is that exchange rate movements are largely unanticipated and are more volatile than market fundamentals. In addition, correlations with market fundamentals and among rates are unstable. Though there is a gradual move towards purchasing power parity—at an average of about 4 percent a month—this is nonetheless not a very useful forecasting paradigm, given the volatility of foreign exchange rates. Even forward rates may not be accurate forecasters because of built-in biases and because of the rapidity with which new information hits the markets.

Because of this difficulty in forecasting exchange rates, corporate treasurers are well advised to hedge net exposures by using readily available (or synthetically constructing) hedging instruments such as forwards, swaps, and options. The markets for these instruments are usually very deep for tenors of one to two years, and are deepening for maturities of up to 15 years—especially in the major currencies. It is noteworthy that these instruments can also allow corporate treasurers to exploit borrowing or investment "windows" across the globe while reducing foreign exchange risk.

In managing longer-term, economic exposures, however, there is more room for economic analysis and perhaps even forecasting—despite the risks. For instance, if exchange rates are misaligned according to most PPP calculations, then treasurers might want to position themselves so as to benefit from a shift of rates back toward PPP. Similarly, interest rate differences might indicate certain borrowing or lending strategies even after accounting for possible exchange rate adjustments. It also might be wise to reduce production costs by sourcing overseas in industries where the expected productivity growth of the sourced component is higher than the overall rate of productivity growth in the source country. More adventurous corporate treasurers can attempt to exploit correlations among currency movements and to benefit from the insights provided by some of the more esoteric econometric techniques—although these should also be used with caution.

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APPENDIX
Pros and Cons of Various Foreign Exchange Hedgers

Instruments	Description	Pros	Cons
Forwards	An almost custom-made contract to buy or sell foreign-exchange in the future, at a presently specified price.	Maturity and size of contract can be determined individually to almost exactly hedge the desired position.	Use up bank credit lines even when two forward contracts exactly offset each other.
Futures	A ready-made contract to buy or sell foreign exchange in the future, at a presently specified price. Unlike forwards, futures have a few maturity dates per year. The most common contracts have maturity dates in March, June, September, or December. But, these contracts are almost continuously traded on organized exchanges. Contract sizes are fixed.	No credit lines required. Easy access for small accounts. Fairly low margin requirements. Contract's liquidity guaranteed by the exchange on which it is traded.	Margin requirements cause cash-flow uncertainty and use managerial resources.
Options	A contract that offers the right but not the obligation to buy or sell foreign exchange in the future, at a presently specified price. Unlike forwards and futures, options do not have to be exercised. Available on an almost custom-made basis from banks or in ready-made form on exchanges.	Allow hedging of contingent exposures and taking positions while limiting downside risk and retaining upside potential for profit. Also permit tradeoffs other than risk versus expected return.	Since an option is like insurance coupled with an investment oportunity, its benefits are not readily observable, leading some to conclude that it is "too expensive."
Swaps	An agreement to exchange one currency for another at specified dates and prices. Essentially, a swap is a series of forward contracts.	Versatile, allowing easy hedging of complex exposures.	Documentation requirement might be extensive.

Techniques	Description	Pros	Cons
Borrowing and lending	Creates a synthetic forward by borrowing and lending at home and abroad. For example, a long forward foreign-exchange position is equivalent to borrowing at home, converting the proceeds to foreign exchange and investing them abroad. The converse holds for a short forward foreign-exchange position.	Useful when forwards, futures or swaps markets are thin—particularly for long-dated maturities.	Utilizes costly managerial resources. May be prohibited by legal restrictions.
Commodity hedging	Going short (long) a commodity contract denominated in a foreign currency to hedge a foreign-exchange asset (liability).	Commodity markets are usually deep, particularly for maturities up to a year.	Price changes of commodities, in terms of home currency, may not exactly offset price changes in the asset (liability) to be hedged. Commodity hedging may not be possible for maturities of over one year.
Leading and lagging	Equating foreign-exchange assets and liabilities by speeding up or slowing down receivables or payables.	Avoids unnecessary hedging costs.	Appropriate matches may not be available. Utilizes costly managerial resources.
Matching	Equating assets and liabilities denominated in each currency.	Avoids unnecessary hedging costs.	Appropriate matches may not be available.