Currency Forecasting: Theory & Practice

August 1996

Cartoon courtesy of the Financial Times

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This report, which draws heavily from Michael R. Rosenberg's *Currency Forecasting: A Guide to Fundamental and Technical Models of Exchange Rate Determination* (Irwin, 1996), will appear as a chapter in *The Handbook of Modern Finance, 3rd Edition* (Warren, Gorham and Lamont, 1997), Dennis Logue and Jim Seward, editors.

Currency Forecasting: Theory & Practice

Introduction

It is no exaggeration when economists refer to the exchange rate as the single most important price in an open economy. That is because no other price can affect so many decisions and so many players as the exchange rate does. For example, when exchange rates move by a meaningful amount, corporate profits are likely to be significantly affected as revenue and cost streams in local currency terms are altered. If exchange-rate movements take currency values to extreme overvalued or undervalued levels, the ability of domestic and foreign firms to hold onto and expand market share may be significantly altered. Exchange-rate movements can also have a profound impact on the investment decisions of international fixed income and equity portfolio managers. According to Lee (1993), roughly 30% of the variability of foreign equity returns in U.S.-dollar terms can be attributed to exchange-rate fluctuations, while a whopping 60% of the variability of foreign bond-market returns can be attributed to exchange-rate fluctuations.

The decisions made by policymakers regarding the conduct of domestic monetary and fiscal policies may also be strongly influenced by foreign-exchange market developments. As U.S. Federal Reserve Chairman Alan Greenspan noted in his February 1995 Humphrey-Hawkins testimony:

> "The new world of financial trading can punish policy misalignments with amazing alacrity. This is a lesson repeated time and again, taught most recently by the breakdown of the European Exchange Rate Mechanism in 1992 and the plunge in the value of the Mexican peso (in 1994)... In the process of pursuing their domestic objectives, central banks cannot be indifferent to the signals coming from international financial markets. Although markets can be harsh teachers at times, the constraints that they impose discipline our policy choices and remind us every day of our longer-run responsibilities."

Because exchange-rate movements affect so many business, investment, and policy decisions, "getting the currency right" has become a critical objective of all market participants. Unfortunately, getting the currency right on a consistent basis is a difficult task. Anyone involved in the business of currency forecasting knows only too well that it can be a humbling experience. Forecasts can easily go astray if one's interpretation of the direction that fundamental forces are heading is flawed. Even if one's interpretation of the fundamental forces driving exchange rates is correct, forecasts may still go astray if short-run speculative forces carry exchange rates far away from their fundamental equilibrium path.

Economists have come up with a wide range of theories to explain how exchange rates are determined, but the overwhelming body of evidence from scores of empirical studies indicates that fundamental-based models, while useful in explaining longer-term trends in currency movements, have not met much success in explaining the short- and medium-term trends that exchange rates take. Indeed, most empirical studies suggest that at short- and medium-term horizons, a random walk characterizes exchange-rate movements better than most conventional fundamental-based exchange-rate models.

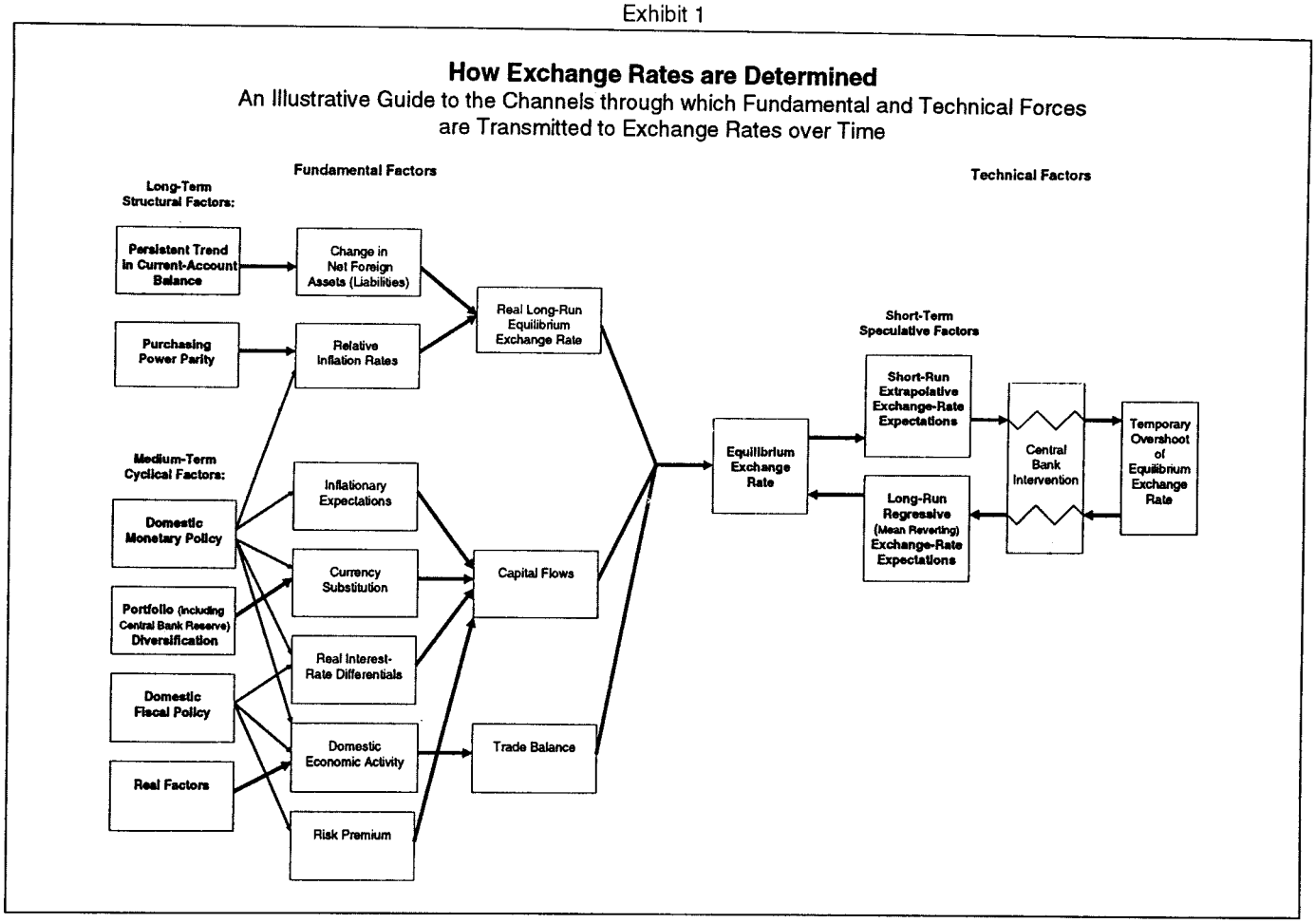
The key reason that fundamental-based models perform so poorly is that changes in macroeconomic variables such as relative money supplies, incomes, interest rates, inflation rates, and current-account balances simply do not exhibit any where near the variability that exchange rates do on a monthly or quarterly basis. As a result, researchers have not been able to unearth any significant relationship between changes in macroeconomic variables and changes in exchange rates over short- and medium-term horizons. Exchange rates may move in the long run in the direction suggested by economic fundamentals, but the often chaotic behavior of exchange rates over short-and medium-term periods is capable of generating so much noise that it tends to obscure any discernible relationship between macroeconomic time series and the short- and medium-term movement of exchange rates.

While it is true that our understanding of the fundamental forces driving exchange rates is very weak over short- and medium-term horizons, it is at least comforting to know that recent empirical work suggests that our understanding of the forces driving exchange rates is stronger at longer-term horizons. Changes in economic fundamentals and changes in exchange rates tend to be more highly correlated over longer-run periods than they do over short- and medium-term periods. In fact, several studies have found that standard exchange-rate models tend to outperform a random walk over longer-run periods.

Unfortunately, although fundamental-based models may perform well over longer-run time periods, many investors may be unwilling to risk significant amounts of capital on the basis of long-term forecasts since fund-manager performance tends to be evaluated over relatively short time spans. Given that exchange rates may deviate considerably from their long-run equilibrium path over short- and medium-term periods, many fund managers may view it as simply too risky to take large long or short positions on the basis of forecasts that may take too long to pan out.

That is a major reason why so many fund managers now turn to technical analysis to help them formulate foreign-exchange investment decisions, particularly over short-term horizons. Indeed a strong case can be made for using technical analysis over short-term horizons since the over-

Exhibit 1



whelming body of empirical evidence indicates that a variety of technical trading rules would have offered significant risk-adjusted profits had they been actively followed in the past.

Unfortunately, total reliance on a technical-based approach to currency forecasting can leave an investor vulnerable to frequent whipsaw losses caused by false technical signals when exchange rates are not moving in discernible trends. Investors may also feel uncomfortable about making an extensive currency bet on the basis of a technical recommendation if there is no fundamental view supporting the position taken. Furthermore, a major drawback of technical-based models is that, while they may be useful for short-term forecasting purposes, they are of little value in predicting the medium- and long-term trend that exchange rates take.

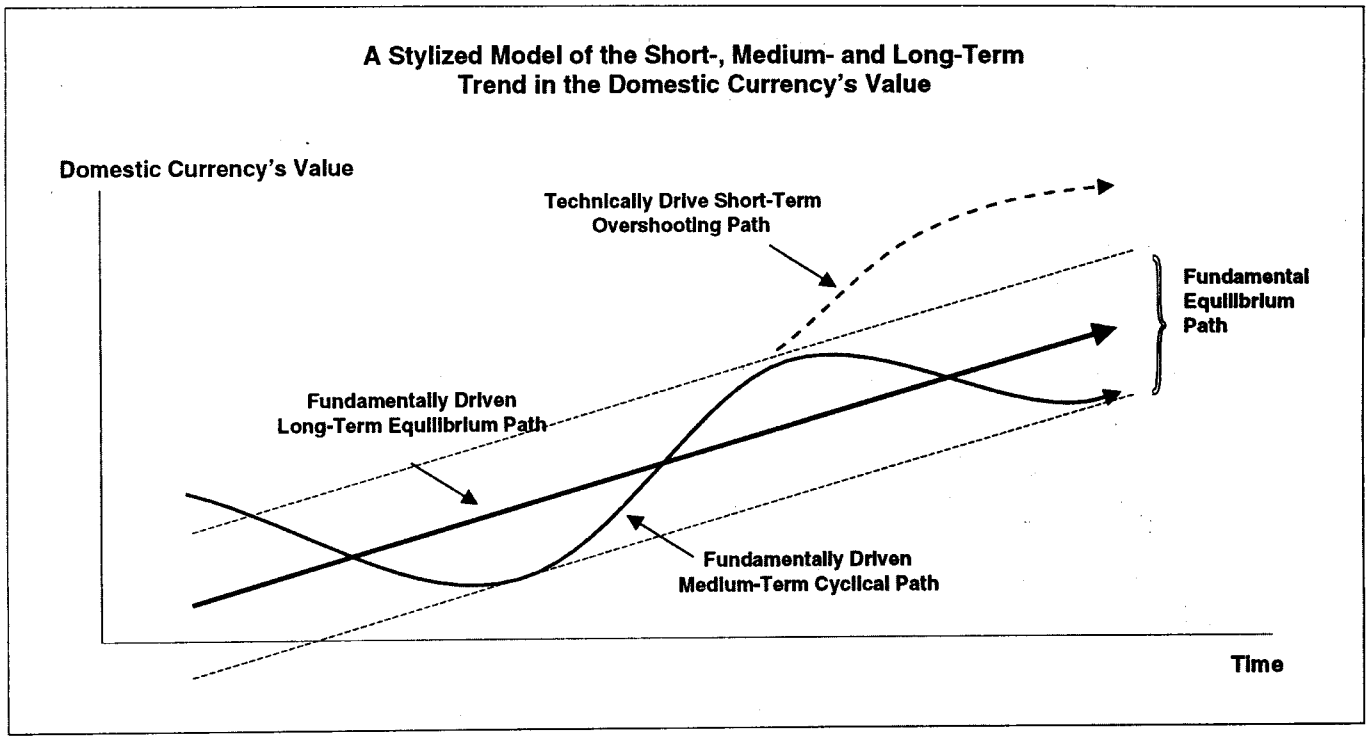
It would seem, therefore, that an ideal approach to currency forecasting would be one that can combine the longer-run advantages of fundamental-based models with the shorter-run advantages of technical-based models. Indeed, the purpose of this paper is to demonstrate how an integrated approach to currency forecasting, one that combines fundamental and technical analysis, can be organized and structured. The paper describes in detail how fundamental forces drive exchange-rate movements over medium- and long-term periods and how speculative forces may cause exchange rates to overshoot their fundamentally driven medium/long-term path over short-term periods. Since exchange rates display a tendency to overshoot their intrinsic equilibrium level from time to time, we recommend that technical-based models be used in conjunction with fundamental-based models to help investors determine their optimal net currency exposures.

Exchange Rate Determination and Strategy: A Brief Overview

Exhibit 1 summarizes the various channels through which fundamental and technical forces affect exchange rates over time. This relatively large flow diagram illustrates that fundamental and technical forces affect exchange rates through a wide range of channels and, because of this, it may not be immediately clear what the response of an exchange rate will be to the myriad of forces pushing and pulling it in different directions.

We will discuss the importance of these fundamental and technical channels in the sections below, but initially it may

Exhibit 2



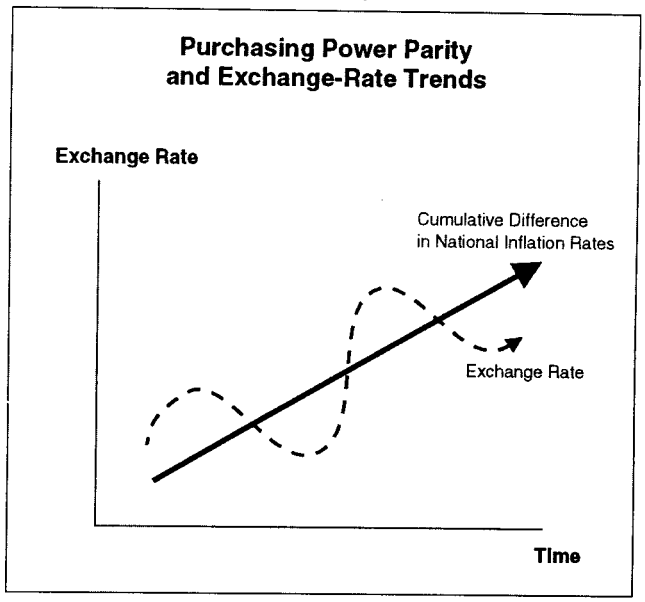
be useful to lay out the bare bones of the exchange-rate determination process with a simple stylized diagram that describes how exchange rates are simultaneously determined by long-term structural, medium-term cyclical, and short-term speculative forces. The stylized diagram in Exhibit 2 highlights the fact that there exists some equilibrium level or path that a currency will gravitate to in the long run. A currency's long-term equilibrium path is likely to be driven by either purchasing power parity (PPP) or external-balance considerations. If PPP considerations were the dominant factor driving long-term movements in currency values, nominal exchange rates would adjust over time to offset differences in national inflation rates. If external-balance considerations were the dominant factor driving long-term movements in currency values, exchange rates would adjust over time to insure that a balanced current account was attained in the long run.

Medium-term cyclical forces such as changes in real interest-rate differentials or relative business-cycle developments will cause a currency to deviate from this long-term equilibrium path. But over time, longer-run fundamental forces should work to push a currency's value in the direction of its long-term equilibrium path. However, it needs to be recognized that medium-term cyclical deviations from a currency's long-term equilibrium path can be quite sizable at times if real or financial shocks give rise to significant shifts in either trade flows or capital movements.

Together, medium-term cyclical and longer-term structural forces interact to determine a currency's fundamental equilibrium path. However, exchange rates may, at times, wander away from this fundamental equilibrium path if short-run speculative forces push currency values far beyond the levels justified by fundamental factors alone. Evidence suggests that foreign-exchange market participants tend to have extrapolative expectations over short-run horizons. Such expectations, if pervasive, may accentuate and perpetuate exchange-rate movements far beyond the levels justified by fundamentals alone over short-term periods. Such overshooting behavior can persist for appreciable periods of time, but at some point fundamental forces should reassert themselves to bring a currency back into line with its fundamental equilibrium path.

The question that market participants need to address is how far and for how long exchange-rate overshoots can persist? One of the major points that this paper seeks to get across is that if market participants wish to minimize the risk of underperformance, then extreme contrarian bets need to be avoided. We recommend that overweight or underweight positions be undertaken only if an investor's fundamental assessment of a currency's value is confirmed by the investor's technical assessment of that currency's value. If the investor's technical assessment fails to confirm the investor's fundamental assessment, then extreme over- or underweight bets should be avoided.

Exhibit 3



Assessing a Currency's Real Long-Run Equilibrium Value

Identifying what path a currency will take in the long run is important for forecasting purposes for several reasons. First, currency movements tend to exhibit a great deal of noise over short-run time periods. From a forecasting perspective, we would be able to filter out such noise more easily if we had a framework that would enable us to focus our attention on the fundamental forces driving exchange rates over longer-run time periods. Second, knowing what value constituted a currency's real long-run equilibrium level would enable us to quantify the degree of exchange-rate misalignment that might exist at any point in time. Finally, knowing what value constituted a currency's real long-run equilibrium level would prove useful to fund managers who invest in markets where the exchange rate is pegged. An attempt by policymakers to peg an exchange rate at a level that is not consistent with a currency's true long-run equilibrium level will not be sustainable in the long run.

Various methods exist to calculate a currency's real long-run equilibrium level, but at times these approaches may yield quite different estimates of a currency's fair value. In fact, at times, on the basis of one criteria a currency might appear to be overvalued, but on the basis of another criteria, that same currency might appear to be undervalued. If different approaches yield different estimates of a currency's real long-run equilibrium value, it might not be immediately clear which approach yields the correct estimate of the true equilibrium real exchange rate.

Purchasing Power Parity

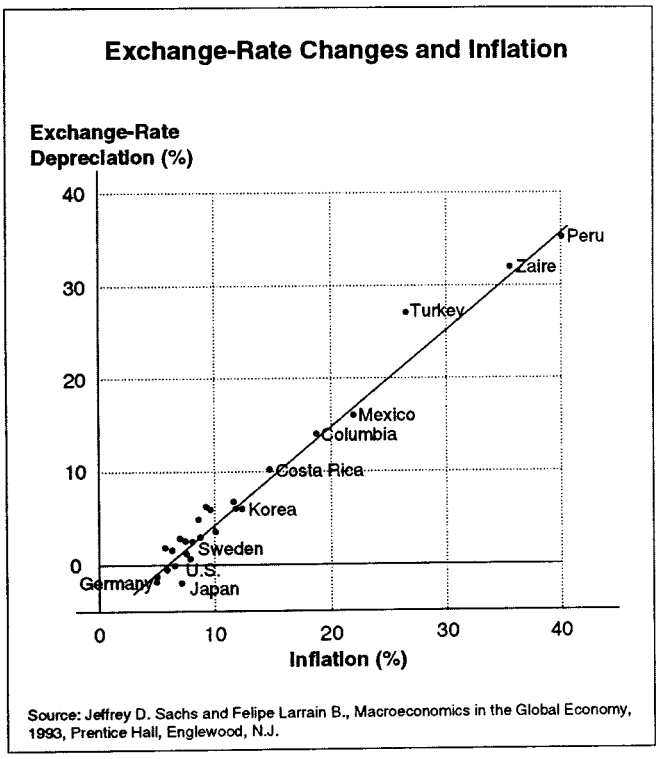
Perhaps the most popular approach used by economists to calculate equilibrium exchange rates is the purchasing power parity (PPP) approach. The PPP approach posits that nominal exchange rates move over time to offset differences in domestic and foreign price-level movements.

The PPP framework is illustrated graphically in Exhibit 3. This stylized diagram shows that if PPP was valid, an exchange rate's long-term equilibrium path would be completely determined by the long-term trend in domestic relative to foreign inflation. That is, high inflation countries would see their currencies depreciate over time in direct proportion to the trend in relative inflation rates, while low inflation countries would tend to see their currencies appreciate over time. Transitory deviations from the long-run PPP path might occur, but fundamental forces should work to push exchange rates toward their long-run PPP path

The empirical evidence is largely supportive of PPP, but only as a long-run proposition. Exhibit 4 shows that long-run changes in exchange rates have been highly positively correlated with long-term changes in relative inflation rates. Unfortunately over short- and medium-term periods, the deviations from PPP can and have been quite large and persistent. Froot and Rogoff (1994) summarize the broad body of empirical evidence on PPP by noting that the estimated half-life of PPP deviations is around four years for most industrial nations. In other words, for any given deviation of an exchange rate from its estimated PPP value, roughly one-half of that deviation will tend to be removed in four years time.

Since the deviations from PPP can be large and persistent over short- and medium-term horizons, it can be dangerous to pursue strategies that are based on an expected rapid return to PPP. If investors could count on a rapid return to PPP, they would purchase undervalued currencies in the hope that the undervaluation would soon be

Exhibit 4

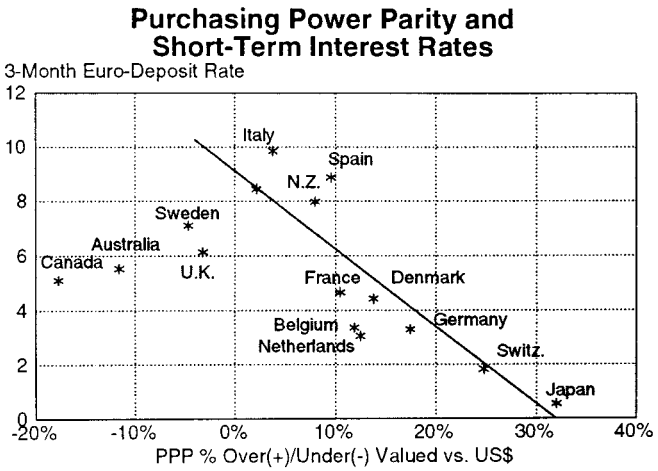


Source: Jeffrey D. Sachs and Felipe Larrain B., Macroeconomics in the Global Economy, 1993, Prentice Hall, Englewood, N.J.

corrected via an appreciation of the currency. Similarly, they would wish to sell overvalued currencies. The major risk to such strategies is that the deviations from PPP may initially widen instead of narrow. Investors would have to have substantial risk capital on hand to absorb losses that could be incurred if the departures from PPP proved to be sizable and persistent.

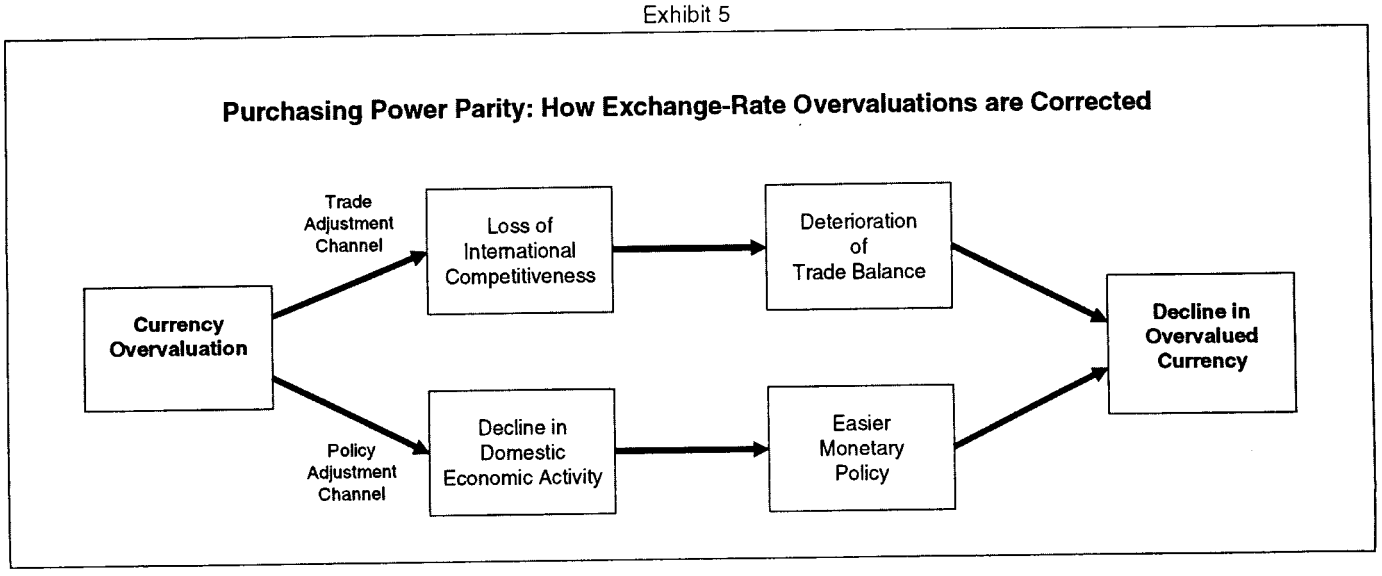
Eventually, market forces do come into play to correct sizable deviations from PPP. Unfortunately, it is difficult to predict when such corrections will take place. Exchange-rate overvaluations and undervaluations will normally be corrected through two channels: a trade-adjustment channel and a policy-adjustment channel. For example, consider the case of an overvalued currency (see Exhibit 5). Currency overvaluation typically gives rise to a loss in international competitiveness, which then leads to a deterioration of the trade and current-account balance. The deterioration of the trade and current account, in turn, will give rise to an excess supply of the overvalued currency on the foreign-exchange market, which will then lead to a decline in the overvalued currency's value and thereby correct the initial overvaluation.

Exhibit 6



Because currency overvaluation results in a loss in international competitiveness, this often will lead to a decline in domestic economic activity. To counteract the weakening trend in domestic economic activity, monetary policy will, in most cases, be eased. This easing in policy will tend to depress the value of the overvalued currency. If the policy-adjustment channel was important, we would expect to find that countries with the most overvalued exchange rates would have the lowest short-term interest rates and vice versa. Indeed, as Exhibit 6 shows, this was indeed the case in early 1996.

Exhibit 5



Internal/External Balance and the Equilibrium Real Exchange Rate

The failure of PPP to hold over medium-term and sometimes even over long-term horizons has led may economists to consider alternative approaches to assess long-term value in the currency markets. Perhaps the most widely followed alternative approach to assess long-term value is the internal/external-balance approach. According to this approach, the long-run equilibrium real exchange rate can be defined as that rate that results in the simultaneous attainment of internal and external balance. Internal balance is normally defined as the attainment of the full employment level of output, while external balance is typically defined as the attainment of a zero current-account balance.

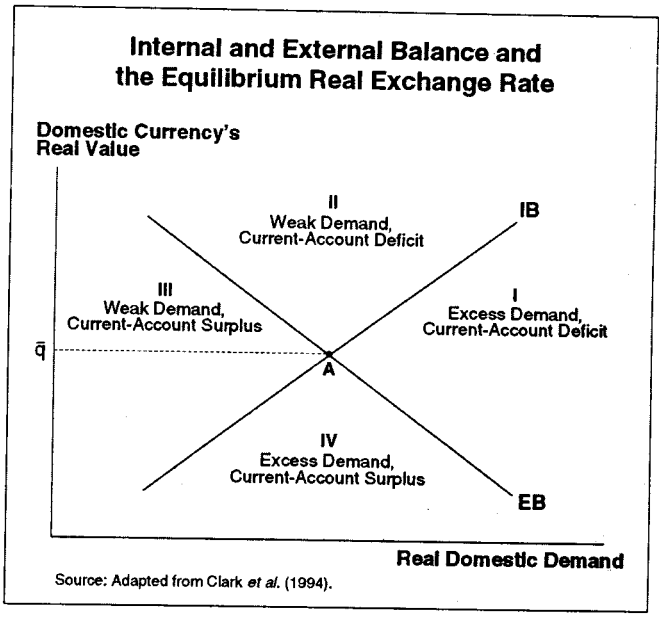
Exhibit 7 illustrates how a currency's real long-run equilibrium value is determined according to the internal/external-balance approach. While there exists a wide array of real exchange rates that can satisfy the conditions of internal or external balance, only one real exchange rate, the "equilibrium" real exchange rate, can simultaneously satisfy both. In Exhibit 7, we show that a currency's real long-run equilibrium value is determined at the point where the Internal Balance (*IB*) and External Balance (*EB*) schedules intersect at point *A*. The *EB* schedule shows various combinations of the real exchange rate and real domestic demand that will satisfy the requirement that the current account attains its targeted level. Note that points off the *EB* schedule indicate the existence of a current-account imbalance. Points to the right of the *EB* schedule indicate the existence of a current-account deficit while points to the left indicate the existence of a current-account surplus.

The *IB* schedule shows various combinations of the real exchange rate and real domestic demand that satisfy the requirement of internal balance. Note that points off the *IB* schedule indicate the existence of excessive or depressed levels of aggregate demand relative to total output. Points to the right of the *IB* schedule represent episodes of excessive demand while points to the left represent periods of depressed levels of aggregate demand.

Only at point *A*, where the *EB* and *IB* schedules intersect, are the conditions for internal and external balance simultaneously satisfied. Note that the equilibrium real exchange rate, $\bar{q}$, is determined at this point where the two schedules intersect. If the actual real exchange rate exhibited a tendency to significantly and persistently deviate from its long-run equilibrium level, it would give rise to serious macroeconomic imbalances either in the form of large and persistent current-account surpluses or deficits and/or excessive or depressed levels of aggregate demand relative to total output.

For example, consider the case of a country facing a huge current-account deficit and whose level of real domestic demand exceeds its full employment level of output. Such a country would find itself in quadrant I of Exhibit 7. The U.S. found itself in this quadrant in the early 1980s when a major U.S. fiscal expansion contributed to excessive domestic demand and to a significant deterioration in the U.S. trade and current-account balance. A depreciation of the dollar's real value was required to restore equilibrium to the current account, and the pursuit of restrictive demand-management policies was required to curb the level of U.S. domestic demand. The dollar eventually did fall, but not until long after the imbalances had become a serious problem.

Exhibit 7



Source: Adapted from Clark *et al.* (1994).

Many of the ERM countries — notably the U.K., Italy, and Spain — faced a slightly different dilemma in the early 1990s. Those countries suffered from depressed levels of output and a deterioration of their current-account balances. Their problems stemmed largely from the pursuit of overly tight monetary policies as they attempted to peg their currencies at levels vis-à-vis the Deutschemark that were clearly overvalued on the basis of internal as well as external-balance considerations. In terms of Exhibit 7, those countries found themselves in quadrant II. With the objective of internal balance being progressively compromised for the sake of maintaining a fixed exchange-rate link to the Deutschemark, the U.K., Italy, and Spain eventually were forced to devalue or delink their currencies from the Deutschemark in September 1992.

Quadrant III best characterizes the position of Japan in 1993-94. Japan amassed a record current-account surplus at the same time that domestic demand was weak relative to potential output. The huge surplus necessitated a rise in the yen's real value to remedy the imbalance while the depressed level of domestic demand required an expan-

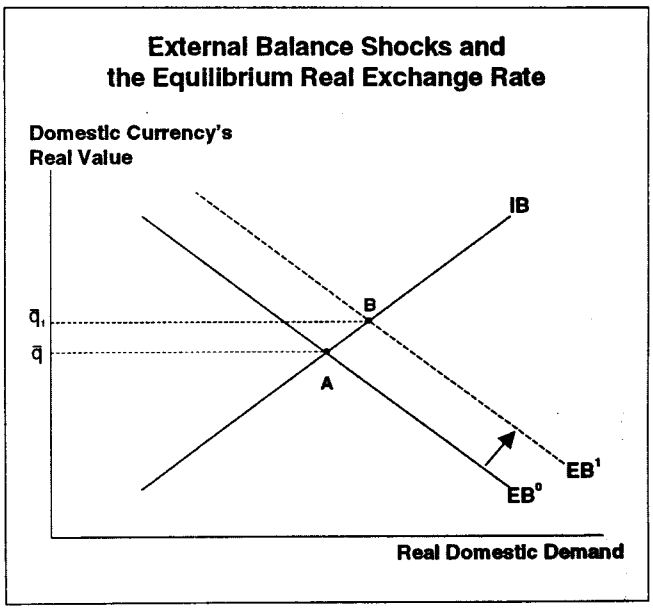
sionary fiscal policy to close the gap between actual and potential GDP, both of which occurred (unfortunately, with limited success) in 1993-94.

As the above examples amply demonstrate, although internal and external imbalances often require significant real exchange-rate adjustments to remedy the underlying problem, the imbalances may persist for appreciable periods of time before corrective adjustments in real exchange rates actually take place. This should serve as a reminder that exchange rates do not move to balance the current account in each and every period.

Under certain restrictive conditions, the equilibrium real exchange rate calculated using the internal/external-balance approach may yield the same equilibrium real exchange rate that is derived using the PPP approach. The two approaches would yield the same equilibrium real exchange rate estimate if, and only if, PPP was consistent with the attainment of a zero current-account balance. However, the restoration of PPP is no guarantee that external balance will be achieved. A variety of real factors such as productivity shocks, terms-of-trade changes, resource discoveries, and structural differences in income elasticities and growth rates can and often do influence the long-term trend in current-account balances independent of differences in national price levels; and it is the trend in current-account balances that necessitates changes in real exchange rates to insure that external balance is satisfied in the long run.

Real shocks affect the trend in the equilibrium real exchange rate by altering the internal- and external-balance schedules of Exhibit 7. A positive real shock that results in a fundamental improvement in a country's current-account

Exhibit 8



balance will shift the *EB* schedule to the right to EB^1, as shown in Exhibit 8. This will have the effect of driving the domestic currency's real long-run equilibrium value upward. What Exhibit 8 suggests is that in a world where real shocks tend to cause persistent swings in current-account balances, the equilibrium real exchange rate will not be a fixed constant, but a trending variable that responds directly to real shocks.

If a country enjoyed a string of favorable real shocks, this could result in a steadily rising current-account surplus and in a steady appreciation of the currency's real value, and

Exhibit 9

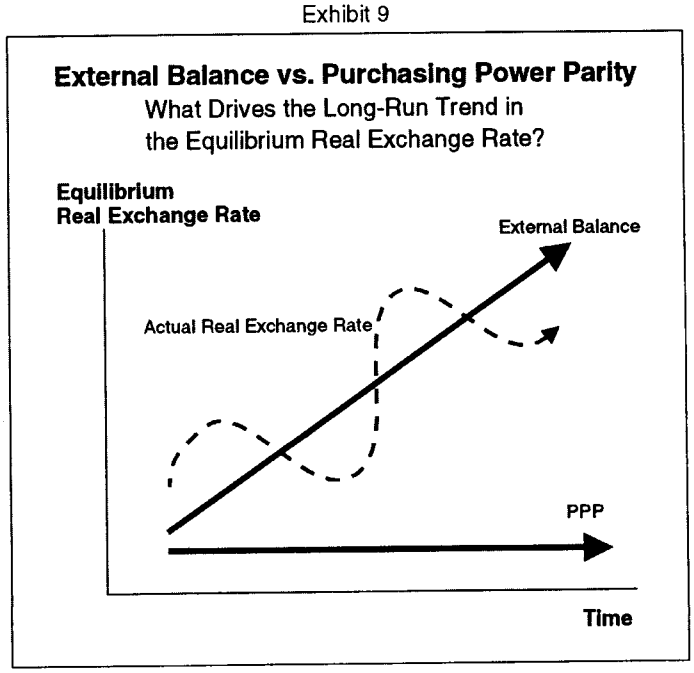


Exhibit 10

The Yen/US$ Exchange Rate and the U.S./Japan Cumulative Current-Account/GDP Differential

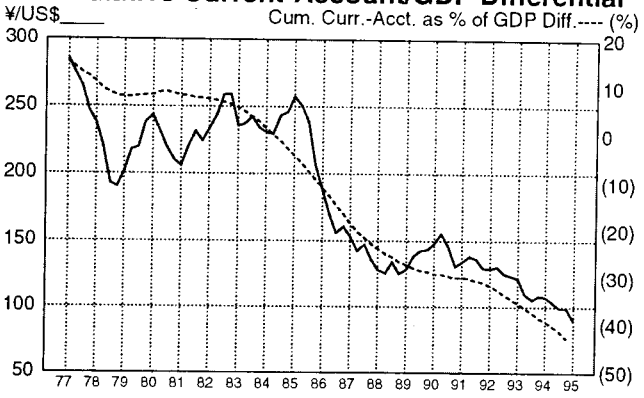
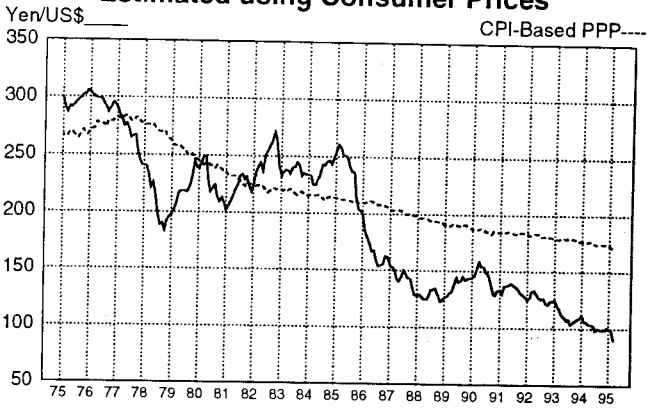


Exhibit 11

Japanese Yen Purchasing Power Parity Estimated using Consumer Prices

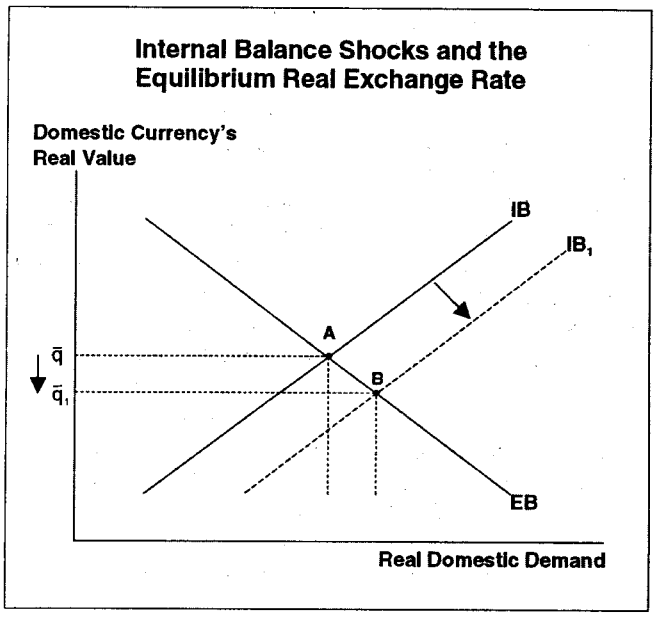


vice versa. That means that a country that runs a persistent current-account surplus, such as Japan, could see the equilibrium real value of its currency trend higher over time, even if that trend was inconsistent with the long-term trend in purchasing power parity. This is illustrated in Exhibit 9 where we show that a currency's long-term equilibrium path might be driven more by external-balance considerations than by purchasing-power parity considerations. Indeed, this has been true in the case of the yen. The yen/US$ exchange rate has been highly positively correlated with the U.S./Japan cumulative current-account balance/GDP differential (see Exhibit 10), but weakly correlated with the trend in U.S./Japan relative inflation rates (see Exhibit 11).

Although economists tend to concentrate on external balance considerations in assessing a currency's long-term equilibrium value, internal-balance considerations can be just as important. Internal-balance considerations played a key role in the breakup of the ERM in 1992-93 and also played an important role in depressing the yen's and Deutschemark's value in 1995-96. In theory, internal-balance considerations can lead to a decline in a currency's real long-run equilibrium value if structural forces give rise to a secular increase in the domestic unemployment rate. For example, structural rigidities in the labor market may make it difficult for domestic firms to compete effectively in international markets. The result of such rigidities would be a loss of output and a rise in the unemployment rate. If those rigidities cannot be eliminated, then a depreciation of the domestic currency's value may be needed to restore competitiveness. This is illustrated in Exhibit 12 where it is shown that structural rigidities in the labor market may give rise to a downward shift in the Internal Balance schedule from *IB* to IB_1 and, in turn, to a decline in the domestic currency's real long-run equilibrium value.

Exhibit 12

Internal Balance Shocks and the Equilibrium Real Exchange Rate



Exchange Rate Determination: A Medium-Term Perspective

Medium-term cyclical forces may cause a currency to significantly deviate from its long-run equilibrium path for months and sometimes years at a time. For example, changes in monetary and fiscal policy may give rise to changes in interest rates and output that will materially affect the trend that exchange rates take over medium-term horizons. Medium-term cyclical forces may also alter a country's current-account position for a period of time, and the resultant shift in the supply of or demand for foreign exchange might, in turn, lead to significant change in exchange rates over that period.

Economists have devised a number of models to describe how real and financial forces give rise to medium-term changes in exchange rates. These models can be conveniently compartmentalized into two distinct frameworks: flow models and asset models of exchange-rate determination. In flow models of exchange-rate determination, a currency's value is assumed to be determined by medium-term changes in the flow supply of and demand for foreign exchange on the foreign-exchange market. Changes in the flow supply of and demand for foreign exchange arise as shifts in current-account and capital-account transactions occur over time. In asset models of exchange-rate determination, a currency's value is determined by the supply of and demand for the outstanding stock of financial assets. In such models, increases in the supply of and demand for money and bonds affect the relative attractiveness of holding assets denominated in competing currencies.

Balance of Payments Flow Model of Exchange Rate Determination

The Balance of Payments (BOP) flow model of exchange-rate determination is an approach that is widely followed by market practitioners who closely monitor the medium-term behavior of exchange rates. Since the flow supply of and demand for foreign exchange are generated by current and capital account transactions, BOP flow models operate on the assumption that changes in exchange rates can be completely explained by underlying changes in balance of payments flows. For example, if balance of payments flows determine the supply of and demand for dollars, then it should be the case that when the balance of payments between the U.S. and the rest of the world is in equilibrium that the supply of and demand for dollars should be in equilibrium as well.

This is illustrated in Exhibit 13 where the dollar's equilibrium value (E_2) is determined by the intersection of the supply ($S\$$) and demand ($D\$$) schedules for dollars. If the dollar's value was temporarily set a rate below E_2, such as E_1, then the flow demand for dollars would exceed the flow supply of dollars, with the market's excess demand for dollars equal to AB. Such a condition would not exist for long because the market's excess demand for dollars at E_1 would, over time, work to push the dollar's value upward toward E_2 where a position of flow equilibrium could be attained.

How much the dollar's value must rise to restore flow equilibrium will depend on the elasticity of the supply and demand for dollars. The more inelastic the supply and demand schedules for dollars are, the more the dollar will need to rise to correct the initial excess demand condition. This is illustrated in Exhibit 14 where we show that if the $S_\$$

Exhibit 13

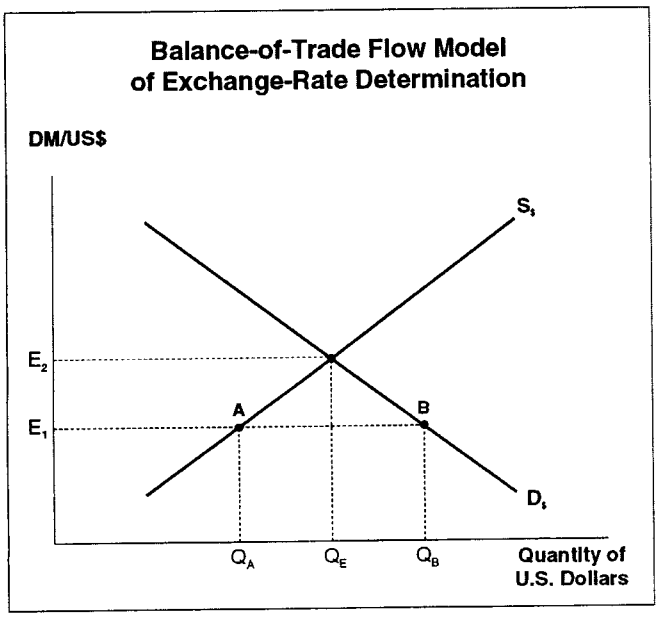


Exhibit 14

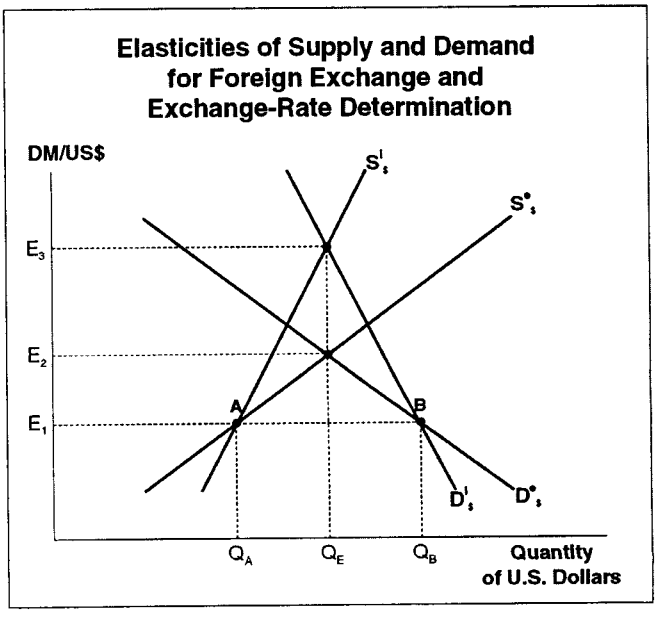
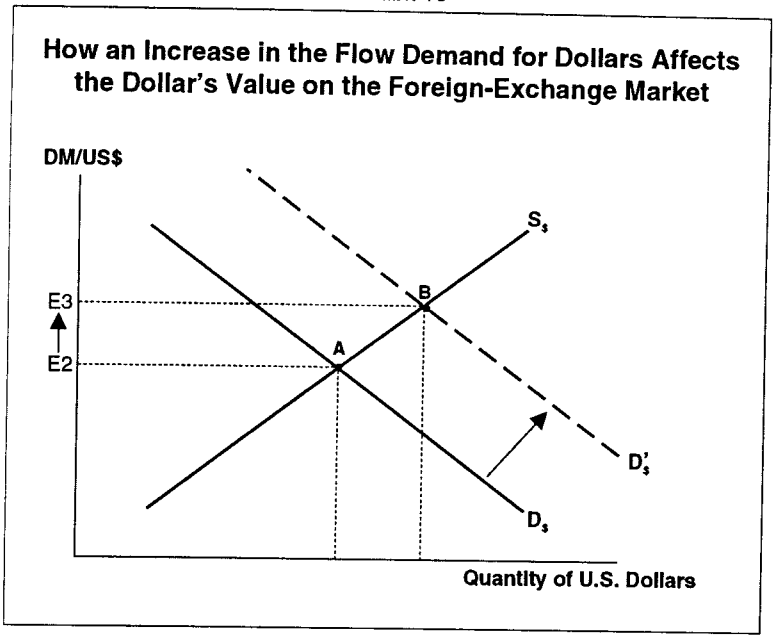


Exhibit 15



and $D_{\$}$ schedules are drawn as highly inelastic schedules, a large appreciation of the dollar from E_1 to E_3 will be required to eliminate the initial excess demand for dollars. On the other hand, if the S_e and D_e schedules are highly elastic, only a small appreciation of the dollar from E_1 to E_2 would be required to restore flow equilibrium.

Shifts in the supply of and demand for dollars are assumed to have a profound impact on exchange-rate trends in the BOP flow model. For example, a relative increase in overseas economic activity will increase foreign demand for U.S. goods and services and, in turn, that will generate an increased demand for dollars to make payment for the increase in U.S. goods and services demanded. As shown in Exhibit 15, an increased demand for dollars would lead to a rightward shift in the $D_{\$}$ schedule, resulting in a rise in the dollar's value from E_2 to E_3.

Exhibit 15 could also be used to describe the impact that a rise in U.S. interest rates will have on the dollar's value. A rise in U.S. interest rates relative to interest rates overseas will make dollar assets more attractive. The interest-rate induced increase in the demand for dollars will shift the $D_{\$}$ schedule to the right, giving rise to an increase in the dollar's value from E_2 to E_3.

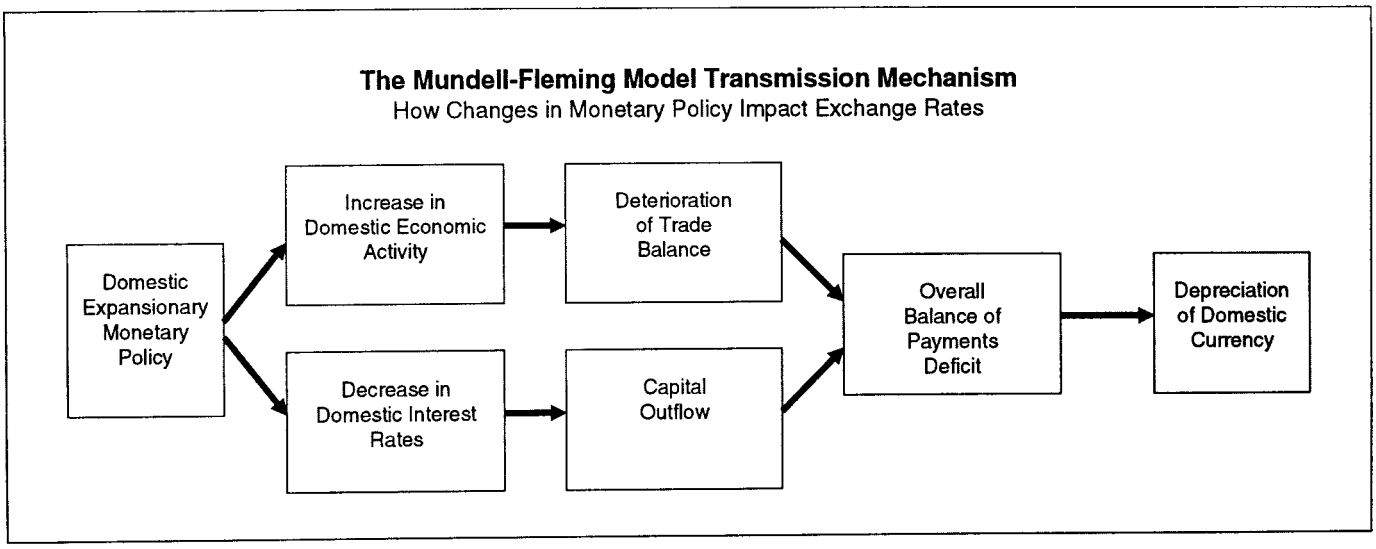
Based on the foregoing, advocates of the BOP flow model would argue that a relative rise in foreign economic activity should boost the dollar's value, while a relative rise in U.S. economic activity should undermine the dollar's value. At the same time advocates of the BOP flow model would contend that a relative rise in U.S. interest rates should boost the dollar's value, while a relative decline in U.S. interest rates would do the opposite.

The Mundell-Fleming Model and the Determination of Exchange Rates

Our understanding of the impact that monetary and fiscal policy changes have on exchange rates owes much to the pioneering work of Robert A. Mundell (1963) and J. Marcus Fleming (1962). Their work clearly showed that the pursuit of certain policy mixes could have a profound impact on the trend in both interest rates and exchange rates. Indeed, more often than not, the economics profession's interpretation of economic and financial events have been strongly influenced by their writings. For example, there is now widespread acceptance among economists that the dollar's dramatic rise during the early 1980s was attributable to the pursuit of an extremely tight monetary policy which, when combined with the pursuit of a highly expansionary U.S. fiscal policy, drove both U.S. real interest rates and the dollar sharply higher. The sharp appreciation of the Deutschemark and the effective collapse of the ERM in the early 1990s following German unification could also be attributed to a similar policy mix in Germany. Both the dollar's rise and the Deutschemark's rise could have been predicted using a Mundell-Fleming framework to analyze the future trend in exchange rates.

The Mundell-Fleming (M-F) model is essentially an extended BOP flow model where the model describes how changes in monetary and fiscal policy affect interest rates and economic activity and how the induced changes in interest rates and economic activity affect the direction of capital flows, the trade balance, and ultimately the exchange rate. The M-F model has become the textbook standard by which most students today study the role of monetary and fiscal policy in an open economy.

Exhibit 16



Consider first the role that monetary policy plays in the determination of exchange rates according to the M-F model. An expansionary monetary policy will typically lead to a depreciation of the domestic currency in part because the resultant increase in domestic economic activity will cause the trade balance to deteriorate and, in part, because the induced decline in domestic interest rates will give rise to an outflow of capital. The combined deterioration in the trade and capital account will give rise to an overall balance of payments deficit, and thus to a decline in the domestic currency's value (see Exhibit 16). The more mobile capital is — that is, the more sensitive capital movements are to changes in interest rates — the greater the outflow will be following a monetary expansion, and thus the greater will the currency depreciate following a monetary expansion.

With respect to fiscal policy, a deficit-financed rise in government spending will typically result in a rise in domestic interest rates and an increase in economic activity. As shown in Exhibit 17 the rise in interest rates will induce a capital inflow that should contribute to a rise in the domestic currency's value, but the consequent rise in economic activity will contribute to a deterioration of the trade account, which should put downward pressure on the currency's value. On the surface, this would imply that the exchange rate's response to an expansionary fiscal policy is ambiguous. However, if we know how sensitive capital movements are to a rise in domestic interest rates, we can determine whether the induced capital inflow will dominate the deterioration in trade or vice versa. If the degree of capital mobility is high, the domestic currency should appreciate in response to a fiscal stimulus, and vice versa.

Econometric studies generally support the M-F model's thesis that in a world of high capital mobility, expansionary monetary policies are bearish for a currency, while expansionary fiscal policies are bullish for a currency. Exhibit 18 reports the results on the estimated impact that a 4% increase in the U.S. money supply would have on the dollar's value one year after the monetary increase, using eleven different econometric models to gauge the impact.

Exhibit 17

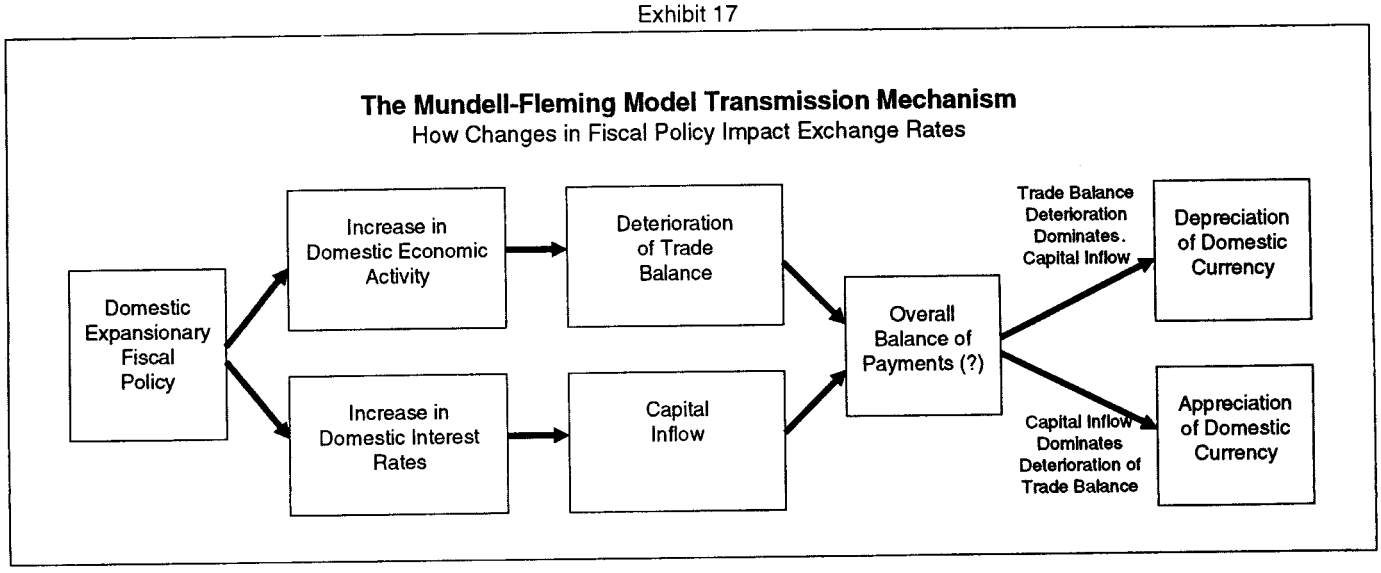


Exhibit 18

Econometric-Model Simulation of a 4% Increase in U.S. Money Supply and its Impact on the Dollar's Value One Year After Monetary Injection

Large-Scale Econometric Model	Percent Change in Dollar's Value
MCM	-6.0%
EEC	-4.0%
EPA	-6.4%
LINK	-2.3%
Liverpool	-3.9%
MSG	-2.0%
MINIMOD	-5.7%
OECD	-2.6%
Taylor	-4.9%
Wharton	-1.0%
DRI	-14.6%

Source: Caves, Frankel, and Jones (1990) p. 632.

Exhibit 19

Econometric-Model Simulation of a 1% Increase in U.S. Government Spending as a Percent of GNP and its Impact on the Dollar's Value One Year After Fiscal Stimulus

Large-Scale Econometric Model	Percent Change in Dollar's Value
MCM	+2.8%
EEC	+0.6%
EPA	+1.9%
LINK	-0.1%
Liverpool	+1.0%
MSG	+3.2%
MINIMOD	+1.0%
OECD	+0.4%
Taylor	+4.0%
Wharton	-2.1%
DRI	+3.2%

Source: Caves, Frankel, and Jones (1990) p. 631.

In all eleven cases, the dollar is projected to fall following the expansionary U.S. monetary policy, although the magnitudes of the decline do differ among the various models.

Exhibit 19 reports the results on the estimated impact that a 1% increase in U.S. government spending as a percent of GNP would have on the dollar's value one year after the spending increase. In nine of the 11 econometric models, the dollar is projected to appreciate, which is consistent with the M-F model assertion that under conditions of high capital mobility a currency will appreciate in response to an expansionary fiscal policy.

Asset Models of Exchange Rate Determination

Both the balance of payments flow approach and the Mundell-Fleming model stress the role that flow supplies of and demands for foreign exchange play in the determination of exchange rates. Asset models, in contrast, stress the role that stock supplies of and demands for national moneys and other financial assets play in the determination of exchange rates. The monetary model of exchange-rate determination is the most basic of the asset models. In the monetary model, the supply of and demand for money determines the medium-term trend that exchange rates take. In the monetary model, the supply of and demand for financial assets other than money play no role in the determination of exchange rates. The portfolio balance model of exchange rate determination rectifies this omission by broadening the menu of financial assets that could theoretically influence the medium-term trend that exchange rates take. In the portfolio balance model, the exchange rate is assumed to depend not only on the supply of and demand for domestic and foreign moneys, but on the supply of and demand for domestic and foreign bonds as well.

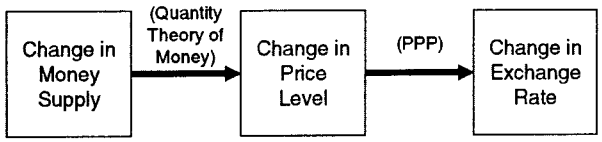
The Monetary Model of Exchange Rate Determination

The monetary model of exchange rate determination is essentially an extension of the Quantity Theory of Money to an open economy. According to the Quantity Theory, monetary forces are the primary determinant of price level changes. In its most extreme version, an x% rise in the domestic money supply will give rise to an x% rise in the domestic price level. Assuming that purchasing power parity holds, a monetary-induced rise in domestic prices relative to foreign prices should lead to an equiproportionate depreciation of the domestic currency (see Exhibit 20).

In the monetary model, changes in the demand for money as well as changes in the supply of money determine the medium-term trend that exchange rates take. In conventional models of the demand for money, money demand is assumed to be positively related to changes in income and inversely related to changes in domestic interest rates. Thus, an increase in domestic economic growth that increases the demand for money, should lead to currency appreciation. Likewise, a rise in domestic interest rates that reduces the public's desire to hold money should lead to currency depreciation.

Exhibit 20

The Direct Effect of Money Supply Changes on Exchange Rates in the Flexible-Price Monetary Model of Exchange Rate Determination



Note that the roles that changes in interest rates and economic activity play in the determination of exchange rates in the monetary model is completely different from the roles that they play in the balance of payments flow model. In the balance of payments flow model, an increase in domestic economic activity gives rise to a deterioration of the trade balance and thus to a depreciation of the domestic currency. In contrast, in the monetary model an increase in domestic economic activity gives rise to an increase in the demand for money, which then leads to an appreciation of the domestic currency (see Exhibit 21). Similarly, the monetary and balance of payments flow models come up with different directional impacts of changing interest rates on exchange rates. In the balance of payments flow model, rising domestic interest rates are positive for a currency since they attract an inflow of capital, whereas in the monetary model, rising domestic interest rates are negative for a currency since this will result in a decline in the demand for money (See Exhibit 21). It is essentially an empirical issue to determine which of these channels will dominate.

The monetary approach has been tested in scores of econometric studies. Unfortunately, the weight of empirical evidence suggests that the model's ability to explain, let alone predict, exchange-rate movements has been quite poor. Having said that, the monetary model does provide several valuable lessons for both policymakers and investors. Countries that pursue relatively lax monetary policies will tend to see their currencies weaken over time while countries that pursue relatively tight monetary policies will tend to see their currencies strengthen over time.

There clearly have been episodes when the monetary approach has been useful in explaining exchange-rate movements. Consider the case of the Deutschemark in 1994-96. As shown in Exhibit 22, the large trade-weighted appreciation of the Deutschemark in 1994-95 could be explained by the contraction in German M3 growth over that period and the Deutschemark's subsequent depreciation in 1995-1996 could be explained by the re-acceleration of German M3 growth beginning in the second half of 1995.

Exhibit 21

How Changes in Economic Activity and Interest Rates Influence Exchange Rates in the Balance of Payments and Monetary Models of Exchange Rate Determination

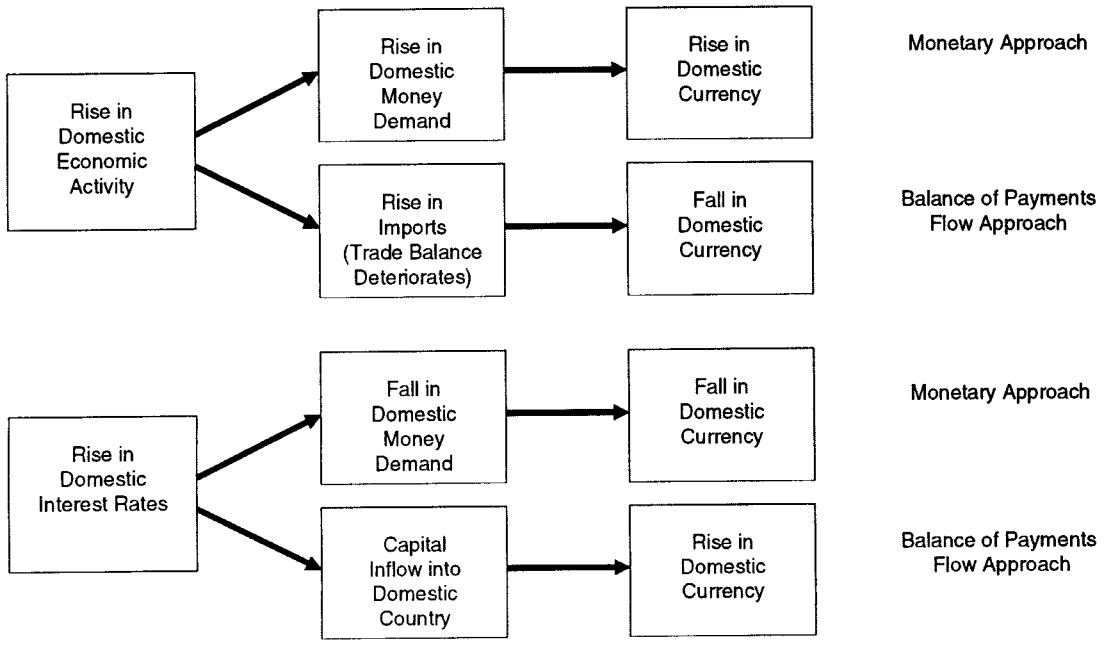


Exhibit 22

German Money Supply Growth & the DM

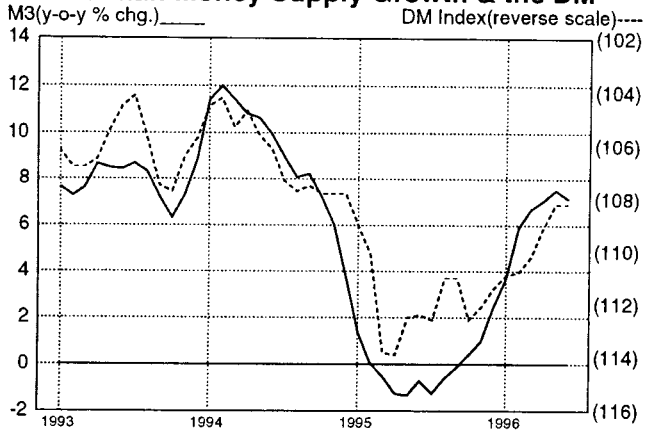
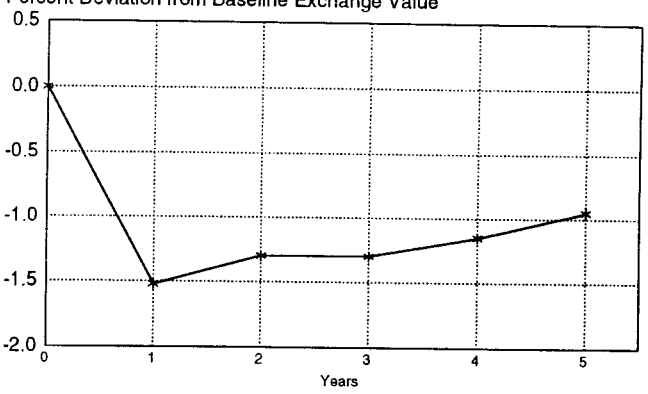


Exhibit 23

Average Effect of a 1% Rise in U.S. Money Stock on the Exchange Value of the U.S. Dollar



Source: Bryant, Helliwell, and Hooper (1989).
Models Simulated: DRI, EEC, NIESR, IMF, LINK, Liverpool, MCM (Federal Reserve Board), OECD, Taylor.

Dornbusch Overshooting Model of Exchange Rates

One of the major shortcomings of the monetary model is the assumption that purchasing power parity holds at all times. In the monetary model, a rise in the domestic money supply will give rise to an equiproportionate change in the exchange rate by first pushing domestic prices higher relative to foreign prices and, via the purchasing power parity criterion, the change in relative prices will then give rise to a change in the exchange rate. Since purchasing power parity rarely holds in either the short or medium run, the monetary model will not provide a realistic explanation of the impact of monetary forces on the exchange rate.

To rectify that problem Professor Rudiger Dornbusch of MIT University constructed a modified monetary model of the exchange rate that assumed that prices were sticky in the short run, but flexible in the long run. The long-run flexibility of the price level insures that any increase in the domestic money supply will give rise to an equiproportionate depreciation of the domestic currency in the long run, and thus is consistent with the monetary model. However, if the domestic price level is assumed to be sticky in the short run, the Dornbusch model demonstrates that the domestic currency may actually overshoot to the downside in the short run before it recovers to its PPP path in the long run. Dornbusch demonstrates this by noting that if domestic prices are sticky in the short run, then any changes in the domestic nominal money supply will result in identical changes in the domestic real money supply over the relevant short-term period. That, in turn, will give rise to short-run liquidity effects, i.e., domestic interest rates will decline in the short-run in response to the increase in the domestic real money supply. Assuming capital is freely mobile, the liquidity-induced decline in domestic interest rates will generate an outflow of capital that will cause the domestic currency to depreciate in the short run.

This short-run depreciation will exceed the long-run depreciation described in the monetary model. The direct impact of a domestic money-supply increase in the monetary model was an equiproportionate depreciation of the domestic currency. In the Dornbusch model, given the extra kick from the liquidity-induced decline in domestic interest rates that generated an outflow of capital, the monetary model's long-run impact is reinforced by a short-run capital outflow that leads to exchange-rate overshooting in the short run.

Evidence on the success of the Dornbusch model is mixed. Bryant, Helliwell, and Hooper (1989) undertook an exercise to simulate what impact a permanent one percent rise in the U.S. money supply would have on the U.S. dollar's trade-weighted value. Examining the simulation results from a wide range of large-scale econometric models, Bryant, Helliwell, and Hooper found that, on average, the dollar initially overshot to the downside in the first year — declining about 1.5 percent in the first year in response to the 1.0 percent rise in the U.S. money supply. However, in the long run, the dollar's depreciation after five years averaged about 1.0 percent, roughly in line with the 1.0 percent rise in the U.S. money supply (see Exhibit 23). These results are generally consistent with the Dornbusch model.

However, Eichenbaum and Evans (1993) find that there are often substantial delays between Federal Reserve policy actions and their maximal effect on the dollar's value. They find that it takes two to three years before a change in U.S. monetary policy has had its maximal impact on the dollar. Such findings suggest the possibility of exchange-rate undershooting, which is inconsistent with the Dornbusch overshooting model.

Currency Substitution and the Determination of Exchange Rates

Individuals and businesses domiciled in less developed countries often have had a desire to hold both domestic and foreign currency balances as part of their total money holdings. The main reason that individuals and business have wished to hold foreign-currency balances is that developing countries' currencies have been subject to periodic speculative attacks, with the result being that many of these currencies have lost considerable value at times. Because many developing-country currencies remain vulnerable to periodic speculative attack, this has rendered them as unattractive not only as stores of value, but as mediums of exchange as well.

During periods of expected currency turbulence, individuals will feel compelled to aggressively switch from domestic to foreign currency balances. The process of switching from domestic to foreign currency balances is known as currency substitution. If pervasive, currency substitution can have a profound impact on exchange-rate movements. Consider the impact that an expansionary monetary policy may have on exchange-rate movements in the presence of a high degree of currency substitution. If an expansionary monetary gives rise to expectations of higher inflation and to a decline in the purchasing power of domestic currency balances, individuals and businesses may aggressively switch more of their money holdings from domestic to foreign currency balances. This substitution of domestic for foreign currency balances could lead to a pronounced decline in the domestic currency's value that far exceeds the rate of depreciation that would have been predicted by the conventional monetary model of exchange-rate determination.

The presence of currency substitution may be one of the principal reasons why emerging market currencies have been prone to large and volatile swings. If currency substitution is pervasive, emerging-market central banks may face an extremely unattractive policy tradeoff. To maintain credibility, emerging-market central banks may be forced to pursue highly restrictive monetary policies to limit switches from perceived riskier domestic to foreign currency balances. An attempt to pursue a more expansionary monetary policy to promote stronger real growth could seriously backfire if expectations of higher inflation prompt individuals and businesses to switch their money holdings in favor of foreign currency balances.

Portfolio Balance Model of Exchange Rate Determination

As we discussed above, the monetary model of exchange-rate determination is narrowly focused in that the supply of and demand for money are presumed to be the sole determinants of exchange-rate movements. In the monetary model, the supply of and demand for financial assets other than money play no role in the determination of exchange rates. The portfolio balance model is a more encompassing model of exchange-rate determination in that it broadens the menu of financial assets that can theoretically influence exchange-rate movements. In the portfolio balance model, the exchange rate is presumed to depend not only on the supply of and demand for money, but on the supply of and demand for bonds as well.

In the portfolio balance framework, it is assumed that investors are risk averse and therefore will wish to hold a diversified portfolio that includes domestic as well as foreign bonds. If the outstanding supply of foreign bonds suddenly increased, investors would be willing to buy and hold this increased supply of foreign bonds only if they were compensated in the form of a higher expected return or risk premium on foreign bonds. A higher expected return on foreign bonds could come from one of several sources: (1) a higher yield on foreign bonds, (2) an expected appreciation of the foreign currency or (3) some combination of (1) and (2). In order to generate the expectation that the foreign currency will rise in value in the future, the foreign currency will need to decline relative to its equilibrium level now, from which it then can be expected to rise to its higher long-run equilibrium level in the future. Hence, an increased supply of foreign bonds that gives rise to an increase in the risk premium associated with holding foreign bonds should lead to either an immediate rise in foreign interest rates, an immediate decline in the foreign currency's value, or some combination of the two.

Assuming the adjustment comes solely through the change in the exchange rate, the portfolio balance model suggests that countries that pursue persistent highly expansionary fiscal policies will see their currencies weaken over time. The portfolio balance model serves as a useful reminder that unsustainable fiscal stances will not go unpunished in the foreign-exchange markets. Steady increases in the stock of outstanding government debt can have the same directional impact on exchange rates as would steady increases in the supply of money.

Real Interest-Rate Differentials and the Determination of Exchange Rates

In a variety of models of exchange-rate determination, changes in real interest-rate differentials play an important role linking changes in policy to changes in exchange rates. For example, in the Mundell-Fleming model, monetary policy's impact on exchange rates operates primarily through an interest-rate channel. Assuming a central bank pursues an expansionary monetary policy, the rise in the domestic money supply will act to push domestic real interest rates lower. Lower real interest rates will then induce capital to flow overseas and thereby cause the domestic currency to depreciate. Fiscal policy's impact on exchange rates also operates, in part, through an interest-rate channel. An expansionary fiscal policy that boosts

Exhibit 24

The DM/US$ Exchange Rate and the U.S./German Real Interest-Rate Differential

(10-Year Bond Yields Less CPI, 1976-1989)

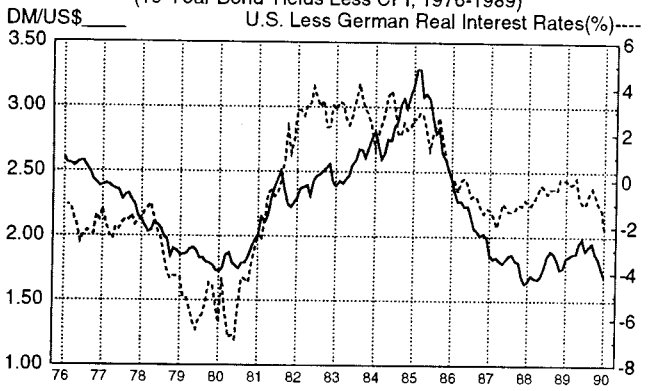
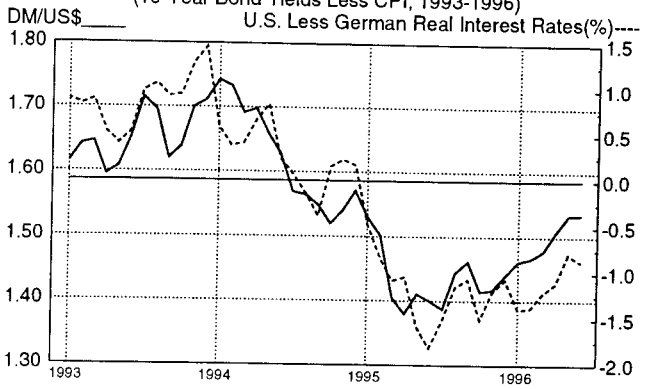


Exhibit 25

The DM/US$ Exchange Rate and the U.S./German Real Interest-Rate Differential

(10-Year Bond Yields Less CPI, 1993-1996)



domestic demand will tend to put upward pressure on domestic real interest rates and, assuming high capital mobility, the rise in domestic real interest rates should induce a capital inflow that causes the domestic currency to appreciate.

Real interest-rate differentials have played an important role in influencing the path in the DM/US$ exchange rate. For example, many observers believe that the dollar's rise versus the Deutschemark in the early 1980s was attributable to a substantial widening of the U.S./German real long-term interest-rate differential. Similarly, many believe that the dollar's subsequent fall in the second half of the 1980s was attributable to a narrowing of that differential (see Exhibit 24). As shown in Exhibit 25, the cyclical fluctuations in the DM/US$ exchange rate over the 1993-96 period can also be explained by the trend in U.S./German real long-term interest-rate differential.

While real interest-rate differentials may be important in explaining the medium-term trend in the DM/US$ exchange rate, it is not necessarily the case that changes in real yield spreads are capable of explaining changes in the dollar's value versus other currencies. Academic studies examining the overall influence that real interest-rate differentials have had on exchange rates yield mostly mixed results. It needs to be noted that even in econometric studies where real interest-rate differentials are found to exert a significant impact on exchange rates, by itself the real interest-rate differential does not explain a large part of the variation in most exchange rates over time.

Fiscal Policy and the Determination of Exchange Rates

Changes in fiscal policy are transmitted to exchange rates through a variety of channels. Some of those channels may transmit positive influences on a currency's value, while other channels may transmit negative influences on a currency's value. Whether a given fiscal policy change will result in a rise or a decline in a currency's value will depend on whether the positive channels dominate the negative ones or vice versa.

For example in the Mundell-Fleming model of exchange-rate determination (discussed above), an expansionary fiscal policy will typically result in a rise in domestic interest rates and an increase in economic activity. The rise in domestic interest rates will induce a capital inflow that should contribute to a rise in the domestic currency's value, but the consequent rise in domestic economic activity will contribute to a deterioration of the trade account, which should put downward pressure on the domestic currency's value. How sensitive capital movements are to the rise in domestic interest rates will determine whether the induced capital inflow will dominate the deterioration in trade or vice versa. Under conditions of high capital mobility, the domestic currency should appreciate in value and vice versa.

If taken to its logical conclusion, the Mundell-Fleming Model would seemingly imply that if a country ran persistent stimulative fiscal policies, it would see its domestic currency steadily appreciate in value over time assuming that capital mobility was high. This, of course, is not realistic since the market is unlikely to reward policymakers who pursue fiscal stances that are not sustainable. In fact, the exact opposite will be the more likely course. If the market is being obliged to buy and hold an ever increasing supply of government debt, they will demand a steadily rising risk premium on such debt to absorb it into their portfolios. As we demonstrated above in our discussion of the portfolio balance model of exchange-rate determination, a steadily rising risk premium will lead to a depreciation of the profligate government's currency.

Indeed, if one considers the longer-run dynamics of expansionary fiscal policies, it becomes obvious that the short-run impact of a fiscal-stimulus package may differ greatly from its long-run impact. Consider the following. If a steady string of rising budget deficits was required to finance a

Exhibit 26

The U.S. Dollar and the U.S. Federal Budget Deficit

(1976-1989)

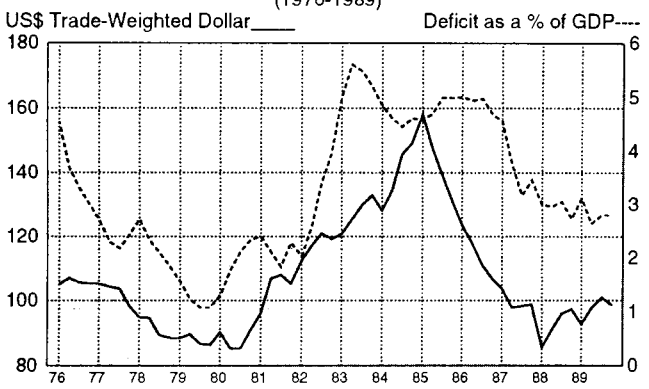
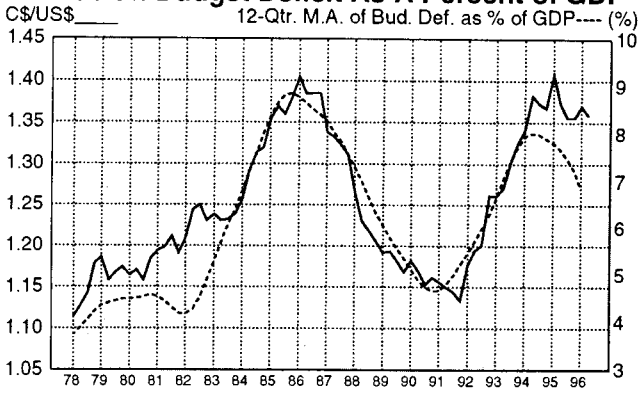


Exhibit 27

The C$/US$ Exchange Rate and the Canadian Budget Deficit As A Percent of GDP



sustained increase in government spending, the outstanding stock of government debt could potentially rise without limit. Initially, the domestic currency may rise in value in response to the fiscal stimulus. However, at some point, risk-averse investors may balk at buying and holding an ever-rising stock of government debt. When that point is reached, the original stimulus may have to be unwound. As the fiscal stance turns toward restraint, the domestic currency should depreciate, reversing the initial appreciation. In fact, the contractionary fiscal stance in the latter phase may have to exceed the original stimulus in the initial phase since taxes would have to be raised not only to finance the original increase in government spending but also to finance the increased interest payments on the now larger stock of outstanding government debt. Thus, although domestic fiscal stimulus may give rise to an appreciation of a domestic currency's value in the short run, the unwinding of that stimulus package may eventually lead to a long-run depreciation of the domestic currency that exceeds the initial appreciation.

Since fiscal-policy changes affect exchange rates through a variety of channels, it should not be surprising that the empirical evidence on fiscal policy's role in the determination of exchange rates is mixed. Most studies have concluded that the relative thrust of U.S. and foreign fiscal policies played a decisive role in the dollar's rise in the early 1980s. During that period the U.S. pursued a highly expansive fiscal policy while Germany's and Japan's fiscal stances were highly contractionary. The relative thrust of U.S. and foreign fiscal policies helped push U.S. real interest rates upward relative to real interest rates in Germany and Japan, thereby encouraging large capital inflows into the U.S. and a stronger U.S. dollar.

Indeed, Exhibit 26 shows that the U.S. dollar's trade-weighted value was highly positively correlated with the trend in the U.S. federal budget deficit as a percent of GDP in the 1980s. That is, larger deficits were associated with a stronger dollar in the first half of the 1980s, while smaller U.S. budget deficits were associated with a weaker dollar in the second half of the 1980s.

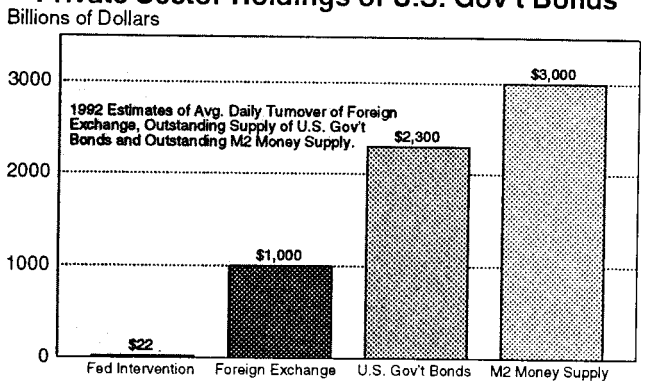
This strong positive relationship between budget deficits and exchange rates does not hold in all cases. Indeed, in the case of Canada, the exact opposite relationship appears to hold. That is, over time the Canadian dollar has tended to strengthen when the Canadian (federal plus provincial) budget deficit/GDP ratio has fallen and has tended to weaken when the deficit/GDP ratio has risen (see Exhibit 27). The negative relationship between the C$ and the Canadian budget deficit/GDP ratio may be due to the fact that changes in the Canadian fiscal stance exerts a marked impact on the risk premium on Canadian debt. Canada has one of the largest outstanding stocks of government debt relative to GDP among the G-7 nations and international investors own roughly 40% of the outstanding debt. Because of the large outstanding stock of Canadian government debt, the marketplace is extremely sensitive to fiscal-policy changes that may add to or subtract from the outstanding debt. Hence the C$ rises in value when the deficit/GDP ratio falls and vice versa.

Central Bank Intervention and the Determination of Exchange Rates

Policymakers have a variety of tools at their disposal to influence the path exchange rates take. The first is domestic monetary policy. Unfortunately, assigning monetary policy the job of meeting some exchange-rate objective means that other goals such as inflation or unemployment may have to be sacrificed. Another tool that can be used by policymakers to influence exchange-rate movements is outright controls on capital movements or barriers to international trade. Such restrictions may be necessary to promote exchange-rate stability in markets where the credibility of policymakers is low. Finally, central banks may influence exchange rates by directly intervening in the foreign-exchange markets.

Exhibit 28

Federal Reserve Intervention is Usually Small Relative to Foreign Exchange Activity, M2, & Private Sector Holdings of U.S. Gov't Bonds



Intervention affects exchange rates through a variety of channels, which may be classified in two categories: direct channels, which stress the importance of the volume and intensity of the intervention operations themselves; and indirect channels, which stress the importance of market responses to the intervention operations and how private investor expectations and positions may be altered.

Economists have identified three direct channels through which central bank intervention might have an immediate impact on exchange rates. First, intervention that alters the flow supply of foreign exchange relative to the demand for foreign exchange can directly affect the short-term trend in exchange rates. Intervention operating through that channel can be effective only if the volume of intervention is sizable relative to the daily turnover in the foreign-exchange market. Second, nonsterilized intervention that alters the supply of money relative to the private sector's demand for money can directly affect the medium-term trend in exchange rates. Intervention operating through the monetary channel can be effective only if the volume of intervention is sizable relative to the outstanding stock of domestic money holdings. Third, sterilized intervention that alters the supply of domestic bonds relative to the supply of foreign bonds in private portfolios can also have a direct impact on the medium-term trend in exchange rates. Intervention operating through that channel can be effective only if the volume of intervention is sizable relative to the stock of publicly traded domestic and foreign bonds held in private portfolios.

Unfortunately, the weight of evidence suggests that the volume of intervention is often quite small relative to the daily turnover of foreign-exchange activity, the stock of money held by the private sector, and the stock of publicly traded domestic and foreign bonds in private portfolios (see Exhibit 28). Thus, most studies conclude that the direct effect of intervention on exchange rates is either statistically insignificant or quantitatively unimportant. If so, why then do central banks continually intervene in the foreign-exchange markets? Perhaps central bank intervention can exert an indirect influence on exchange rates beyond that suggested by the size of the intervention operations themselves.

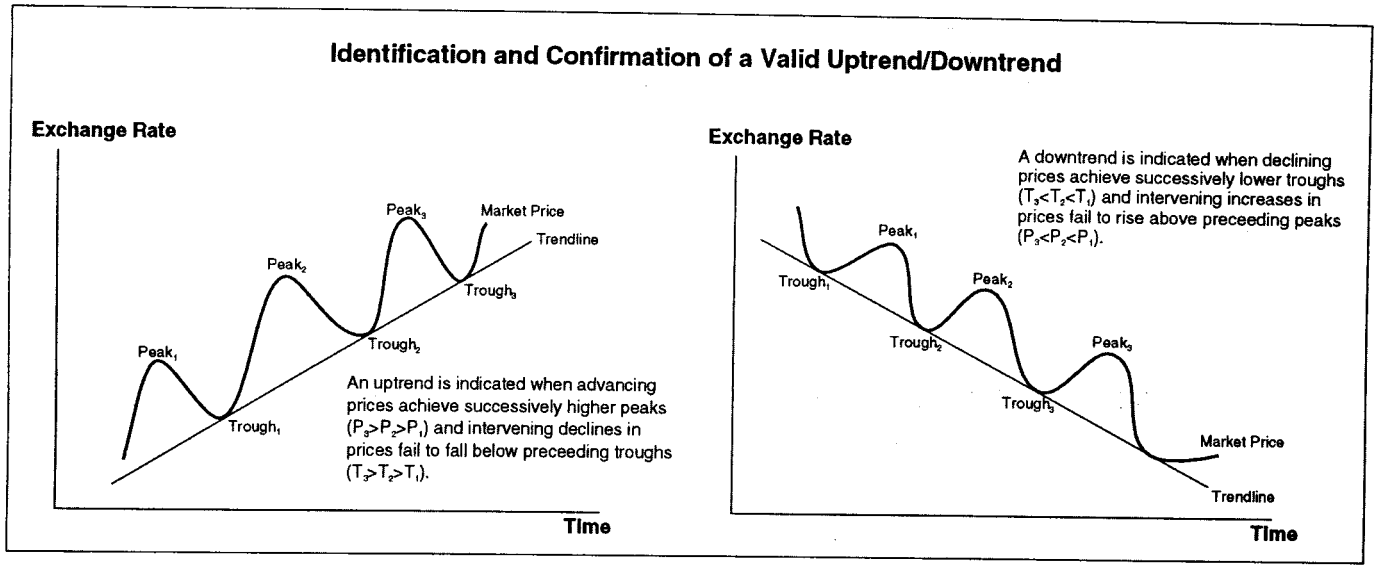
Economists have identified three indirect channels through which intervention can alter investors' expectations and positioning and, in so doing, help push currency values in the desired direction. First, a central bank may use intervention as a signal of its monetary-policy intentions. To the extent that expectations of monetary growth are altered, intervention could have an immediate impact on spot exchange rates. Second, a central bank may use intervention as a signal to the market that the exchange rate is deviating too far from its long-run equilibrium value. To the extent that intervention helps anchor market expectations to the true long-run equilibrium exchange rate, it can have a stabilizing influence. Third, a central bank may want to take advantage of the element of surprise and intervene when exchange rates have overshot their equilibrium levels and the market is heavily overbought or oversold. If trend followers dominate foreign-exchange activity and drive exchange rates far from their true long-run equilibrium values, a surprise round of intervention, appropriately timed, could force traders with vulnerable long or short positions to unwind their positions. Such actions could serve to break the prevailing trend and possibly lead to a trend reversal if trend followers could be persuaded to jump in and help reinforce the new trend in exchange rates. As was the case above, the evidence in support of intervention operations operating through one of these indirect channels is mixed. There have clearly been selected episodes of successful intervention operations, but most studies conclude that central banks cannot unduly influence exchange rates on a sustained basis.

Currency Forecasting Using Technical Analysis

Technical analysis has become extremely popular among market participants. Many, if not most, traders and fund mangers today utilize at least some technical input in their investment decisions, particularly for investments over short-term horizons. The growing popularity of technical analysis in the foreign-exchange market stems in large part from market participants' dissatisfaction with fundamental models of exchange-rate determination. The swings in exchange rates since the beginning of floating exchange rates have generally been greater than expected, frequently overshooting the intrinsic equilibrium levels of traditional, fundamental-based models such as purchasing power parity, monetary, and balance of payments models of exchange-rate determination.

While technical analysis may be enthusiastically embraced by most market participants, until recently it has been the subject of considerable scorn in academic circles. Academics have long argued that if one could devise consistently profitable trading rules based on the past behavior

Exhibit 29



of market prices, then such information would be available to all market participants, who would then be expected to exploit such models until the trading rules ceased being profitable. While logic would seem to favor the academic critique, the empirical evidence on the profitability of technical trading rules suggests the contrary. Almost unanimously, the evidence on the foreign-exchange market clearly indicates that a variety of technical-trading rules would have offered significant risk-adjusted profits had they been actively followed in the past. Such findings have led academic researchers to seriously question whether asset markets are truly efficient as once thought. Alternative hypotheses have recently been proposed to explain why financial-asset prices may not fluctuate randomly as the random-walk hypothesis suggests, but instead may move in discernible trends that can be captured with various trend-following trading rules.

In contrast to fundamental-based forecasts, which require independent projections of the underlying economic variables determining exchange rates, technical models generate exchange-rate forecasts by extrapolating the past sequence of currency movements into the future. For example, if a currency begins to edge higher and rises above some critical value, a technical model will typically issue a recommendation to go long that currency, the presumption being that the newly formed exchange-rate trend will continue to carry the currency higher until a reversal is signaled. Similarly, a recommendation to go short would be issued if, after having edged lower, the currency fell below some critical level. Such trading rules would be profitable only if the ensuing currency movements persisted long enough and carried far enough beyond the levels where the buy and sell signals were initially triggered. That would be the case if exchange rates moved in broad, well-defined trends. That is not to say that exchange rates must always move in large swings for trend-following trading rules to be profitable. What matters is that such swings should occur on a frequent enough basis to overcome those periods when currency movements are not highly trended.

An investor who rigidly adhered to a trend-following trading rule would, more often than not, find himself trading with and not against the trend. That is because, by definition, a trend-following trading rule assumes that a trend is in existence until a reversal is signaled. And if exchange rates move in broad, well-defined trends, such trading rules would, if rigidly followed, essentially require investors to be long when the currency is trending upward, and vice versa.

A wide variety of trend-following trading rules abound, but by and large they all share the basic property of extrapolation. Because these models generate forecasts by extrapolating the recent past trend of exchange rates into the future, buy or sell signals can only be issued after a currency has already started rising or falling. Thus, trend-following models do not attempt to catch the very top and bottom of market moves. Instead, they attempt to capture enough of a market move in the hope of earning a sizable profit. That would only be possible if the ensuing exchange-rate swings persisted long enough and carried far enough to yield a profit.

Trend-following trading rules come in many forms. They may require the subjective interpretation of price formations on a bar chart, or they may be purely mechanical, with buy or sell signals generated by a mathematical formula that can be easily cranked out by a computer. What all trend-following trading rules have in common is that they seek to identify which direction the broad trend in market prices is heading.

Exhibit 30

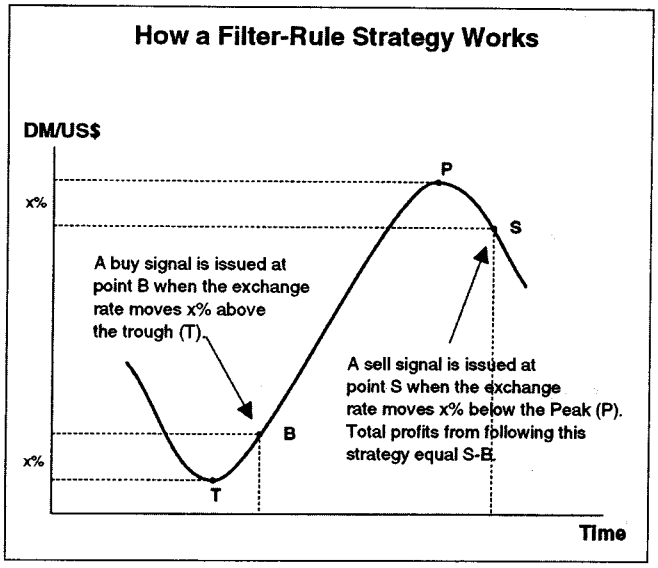
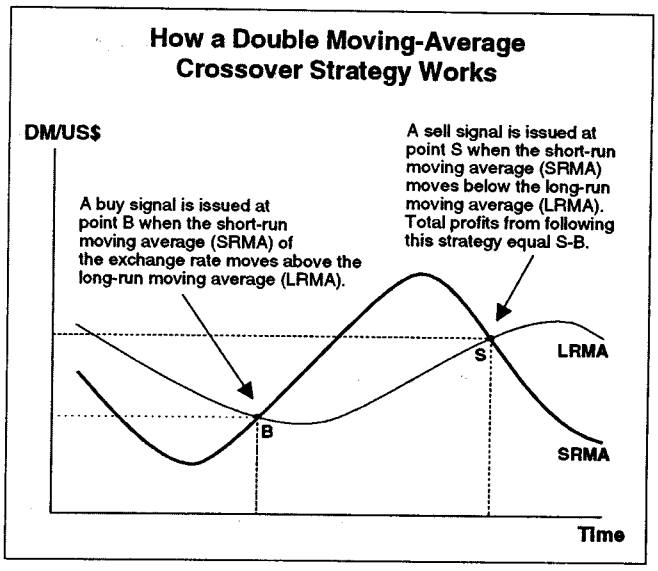


Exhibit 31



One can visualize the trend in market prices as a series of primary and secondary waves. The primary waves refer to the large, broad moves in market prices that carry the underlying trend in market prices either upward or downward. The secondary waves refer to the temporary corrections or partial retracements of the primary trend that takes place over the course of a full cycle. What trend-following trading models attempt to do is to identify which direction the primary waves are heading. A chartist, who monitors the behavior of market prices on a bar chart, will determine whether an asset's price action conforms to the typical behavior of an advancing or declining market. An uptrend will be indicated if advancing prices achieve successively higher peaks and intervening declines fail to fall below preceding troughs. Similarly, a downtrend will be indicated when declining prices establish successively lower troughs and intervening advances fail to rise above preceding peaks (see Exhibit 29).

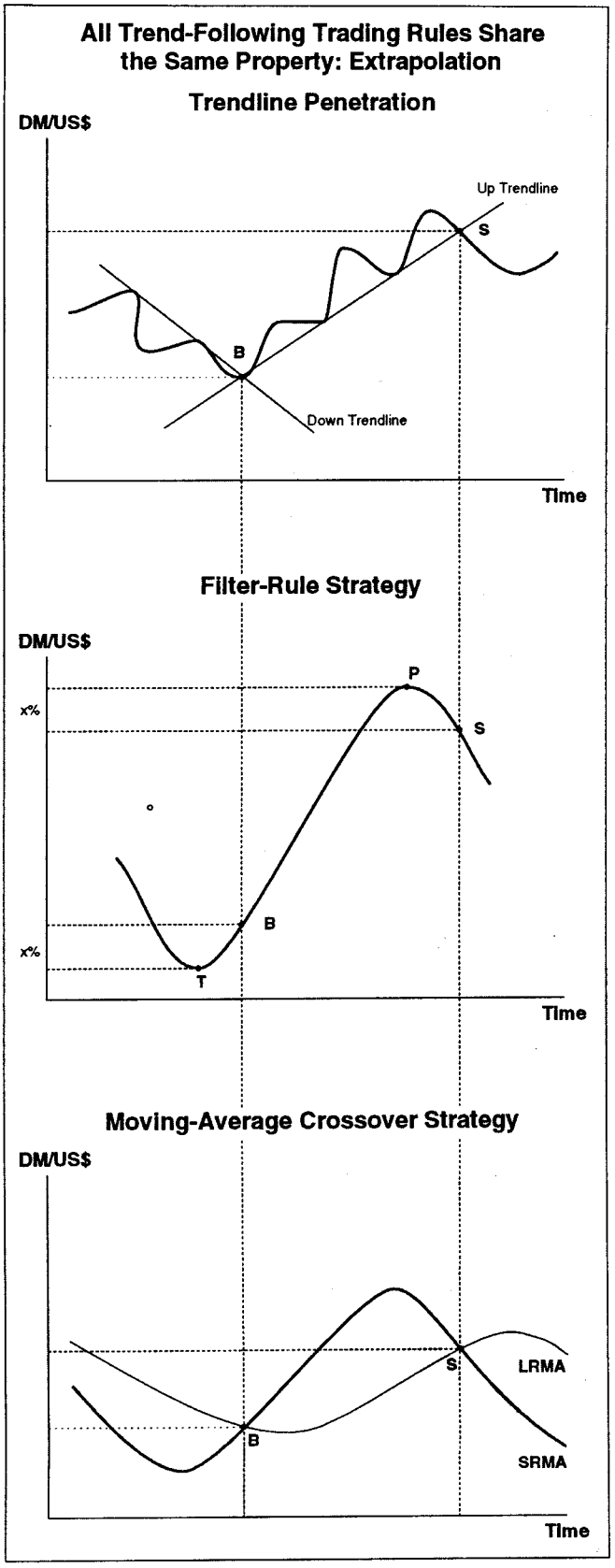
In a rising market, each rally and partial retracement will be higher than its predecessor. As long as advancing prices achieve successively higher peaks, it indicates that buying pressure is overcoming selling pressure. When the wave-like series of rising peaks and troughs is broken, a reversal in market trend is signaled. That is because the failure of market prices to rise above previous highs indicates that selling pressure is finally beginning to overcome buying pressure.

Although chartism remains popular, many investors now use more sophisticated extrapolation techniques with the assistance of a computer. These more mechanical techniques have the advantage over basic chartism in that they do not require the subjective interpretation of chart patterns, which can sometimes differ widely depending on the eye of the beholder. One popular mechanical formula is the filter rule, which issues buy recommendations if exchange rates rise *x*% above their most recent trough and sell recommendations if exchange rates fall *x*% below their most recent peak.

Exhibit 30 illustrates the working of a filter rule. The DM/US$ rate depicted falls gently during the early stages, reaching a trough at point *T*; then steadily climbs to a peak at point *P*, after which it then drifts lower. An investor would be able to ride a large portion of this upswing in the DM/US$ rate by adhering to an *x*% filter rule trading strategy. For example, if a 1% filter is chosen, a buy-US$ recommendation would be issued after the DM/US$ rate rises 1% above its trough at *T* and a sell-US$ recommendation after the DM/US$ rate falls 1% below its peak at *P*. An investor who rigidly adhered to a 1% filter rule trading strategy would buy at *B* and sell at *S*, the spread between *B* and *S* representing the profit margin per dollar invested. By varying the size of the filter, an investor would be able to capture changes in trend earlier or later. Obviously, a smaller filter would capture the big swings earlier, but at the expense of more frequent whipsaws (see Exhibit 33) when movements in the DM/US$ rate are not highly trended.

Another favorite trading rule is one based on the crossover of short- and long-run moving averages. Constructed to smooth the erratic movement of daily exchange rates so that the primary trend in exchange rates can be isolated, an advance of the short-run average above the long-run average is seen as an indication of buying strength and vice versa. Exhibit 31 shows how the crossover of moving averages of the DM/US$ rate can be used to project the future course of the DM/US$ exchange rate. The long-run moving average (LRMA) will always lag behind the movement in the short-run average (SRMA) because the latter series will weigh the impact of recent moves of the DM/US$ rate more heavily than the former. Thus, the SRMA will lie

Exhibit 32



below the LRMA when the DM/US$ rate is trending lower and above it when it is rising. Therefore, the crossover of the SRMA above or below the LRMA can be used as an indication of a shift in market direction. If the SRMA moves above the LRMA, it indicates that the dollar is rising and vice versa. In terms of Exhibit 31, a crossover of the SRMA above the LRMA would trigger a buy US$ signal at *B* while a crossover of the SRMA below the LRMA would trigger a sell US$ signal at *S*. Varying the time span of the moving averages in question will affect the sensitivity of the SRMA and LRMA to changes in the dollar's underlying trend.

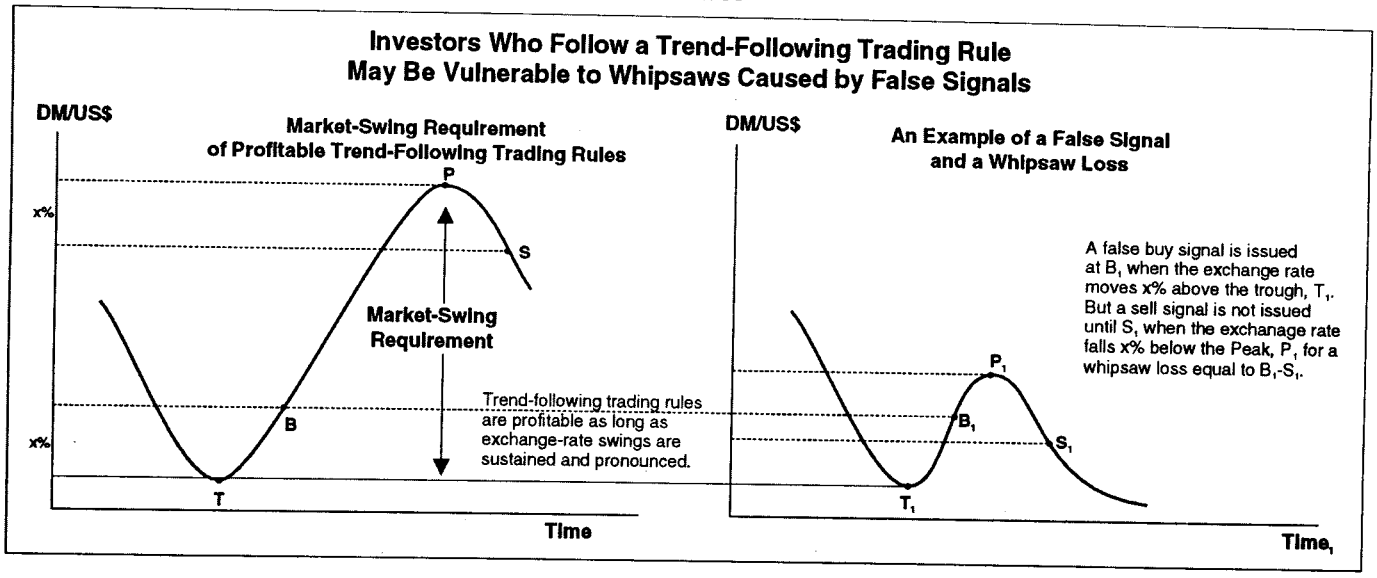
Exhibit 32 seeks to highlight the fact that all trend-following trading rules share the same property — extrapolation. In all cases, exchange-rate forecasts are generated by extrapolating the past sequence of exchange-rate movements into the future. Essentially, it really does not matter which trend-following rule you use. Since a trend is a trend, all trend-following models should roughly yield the same forecast and, in fact, we show this to be the case as all recommended trades are plotted in Exhibit 32 to occur at the same point in time.

Unfortunately, technical analysis does have its pitfalls. In markets that exhibit little overall price variation or are not highly trended, an investor who follows a technical trading rule will be vulnerable to whipsaws caused by false signals. Consider the two exchange-rate series depicted in Exhibit 33. The series on the left is the same DM/US$ rate depicted in Exhibit 30. The series on the right behaves in a similar fashion as the series on the left, except for the fact that the dollar's upward swing is less pronounced; the swing in the DM/US$ rate from T_1 to P_1 falls short of the swing from *T* to *P*. Although the DM/US$ rate swings upward following the buy US$ signal at B_1, the swing fails to carry the dollar far enough to yield a profit. The dollar's upward momentum loses steam early, turning down at P_1, and a sell US$ signal is not triggered until the exchange-rate move carries to S_1. The spread between B_1 and S_1 represents the margin of loss per dollar invested. Hence, the buy US$ recommendation at B_1 proved to be a false signal, with the investor whipsawed in the process.

It is not necessary that exchange rates always move in large swings for technical analysis to be profitable, but that such swings should occur on a frequent enough basis to overcome those periods when currency movements are not highly trended. Since there will be many periods when exchange rates will exhibit little overall variation, the technical analyst needs to construct a trading rule that will, on the one hand, minimize the whipsaws caused by false signals yet, on the other hand, be sufficiently sensitive to capture a large portion of the major exchange-rate swings.

The profits from following a trend-following trading rule come less from the fact that technical models are able to correctly predict the trend in market prices more than 50% of the time — in fact they don't (see Schulmeister (1987))

Exhibit 33



— but more from the fact that profits are allowed to ride when exchange rates are highly trended, while losses are taken quickly when whipsaws are incurred. Even if the number of false signals exceeds the number of true signals, profits could still be earned if a lot of small losses are offset by a few large profits generated by riding a few large correctly predicted moves. The problem for an investor who rigidly follows a trend-following trading system is that it cannot be guaranteed that the system will be bailed out occasionally by a highly trending market. That is why an investor needs sufficient capital to absorb losses if a string of false signals is issued.

Numerous studies have been conducted to investigate whether changes in exchange rates can be predicted solely on the basis of their past price action. Such investigations have generally taken two forms. In the first line of research, researchers have conducted serial correlation tests to establish whether there exists a stable positive linear relationship between today's change in the exchange rate with the exchange-rate change in the preceding period. Evidence of a stable, positive linear relationship would confirm the existence of trends. The existence of trends would mean that technical analysis represents a legitimate approach to forecast foreign-exchange rates. In the second line of research, investigators have analyzed directly whether the use of mechanical trading rules would have yielded significant risk-adjusted returns had they been rigidly followed in the past.

Most empirical studies have found that technical trading rules would have yielded significant risk-adjusted returns had they been followed in the past. Yet, most serial correlation studies conclude that there exists no stable positive linear relationship between successive exchange-rate changes. Instead, serial correlation studies have concluded that exchange-rate changes closely approximate a random walk process. How is it possible then that exchange rates can supposedly fluctuate randomly yet, at the same time, trend-following trading rules have been found to be highly profitable?

The answer is that traditional serial-correlation tests are flawed because they seek to determine only if a stable *linear* relationship exists between successive exchange-rate movements. Although successive exchange-rate changes may be found to be linearly independent, they may nevertheless exhibit significant *non-linear* dependence. Traditional serial-correlation tests will not be able to detect if non-linear dependence exists. Since moving-average and filter-rule trading strategies are essentially non-linear models, they appear to be picking up the non-linear dependence that evidently exists in exchange-rate movements that, of course, cannot be captured in simple, linear random walk tests.

Conclusion

As we have demonstrated above, total reliance on either a fundamental or technical-based approach to currency forecasting can prove costly. That is why we favor a composite approach that integrates fundamental and technical analysis in the formulation of currency investment strategies. A composite approach would help to discipline investment managers in that they would not take on aggressive overweight or underweight positions in any currency unless they had confirmed buy or sell signals from both forecasting frameworks.

A composite approach to formulating currency-investment strategy would work in the following manner. First, based on an analysis of the fundamental forces driving a currency's value over a medium/long-term horizon, an investor would determine the fundamental equilibrium path that

Exhibit 34

Integrating Fundamental and Technical Analysis in Formulating Currency Investment Strategies

Currency	Fundamental Assessment	Technical Assessment	Strategy
A	Bullish	Bullish	Overweight
B	Bullish	Bearish	Neutral
C	Bearish	Bearish	Underweight
D	Bearish	Bullish	Neutral

a currency should take over time. This exercise would establish whether the investor's fundamental assessment of a currency's medium/long-term trend is bullish, bearish, or neutral. At the same time, the investor would rely on a trend-following trading system to assess whether a currency's short-term trend would take it nearer to or further away from its longer-term fundamental equilibrium path. This exercise would establish whether the investor's technical assessment of a currency's value is bullish, bearish or neutral. Once the investor's fundamental and technical assessments are known, an overweight (underweight) position in a given currency would be taken only if the investor's fundamental and technical assessments regarding that currency were both bullish (bearish). If the investor's fundamental assessment was bullish (bearish) and at the same time the investor's technical assessment was bearish (bullish), then a neutral position would be adopted (see Exhibit 34).

Such an approach to currency-investment strategy would work to minimize the risk of underperformance since extreme contrarian bets would be avoided whenever the investor's technical assessment failed to confirm the investor's fundamental assessment. Such a disciplined approach would also work to insure that both eyes of the investor remain fixed to the road. By so doing, careless mistakes can be avoided.

By adopting an integrated approach to currency forecasting and strategy, it forces an investor to be both systematic and flexible. A stubborn reliance on fundamental analysis alone can get an investor into trouble if his assessment of the fundamentals is flawed or if the market carries exchange rates to extreme over- or undervalued levels. By bringing a trend-following trading methodology into the currency decision-making process, it forces an investor to respect market forces by restraining him from leaning too heavily against the wind.

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