

Alternative Views Of Exchange-Rate Determination

By Douglas K. Pearce

The foreign-exchange value of the U.S. dollar has fluctuated widely since fixed exchange rates were abandoned in the early 1970s. The variation in exchange rates under the regime of flexible (floating) rates has been a matter of concern to policymakers because of the fear that uncertainties could have deleterious effects on world trade. Large changes in exchange rates are also thought to have significant impacts on the level and composition of U.S. production by changing the relative prices of exports and **import-competing** goods. Some analysts attribute a substantial part of the current U.S. recession to the impact of the recent rise in the exchange value of the dollar on the manufacturing sector, which exports 20 percent of its output. A stronger U.S. dollar, on the other hand, has a beneficial effect on U.S. inflation in the short run by reducing the domestic prices of imports.¹

¹ Empirical support for the view that exchange-rate volatility has a significantly negative effect on trade flows was

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While much research has been devoted to providing an explanation for the fluctuations in exchange rates, no single theoretical model has emerged predominate. In the beginning of the flexible-rate era, exchange-rate movements were usually analyzed in terms of the demands for and supplies of currencies in the **foreign-exchange** market, with emphasis on the transactions originating from international trade flows. The large short-run movements in exchange rates, however, cast considerable doubt on the adequacy of this approach and led to "asset models" that view the determination of the exchange rate as the outcome of the portfolio behavior of **wealthholders**.² One asset model, labeled the "monetary" model, explains exchange-rate fluctuations largely in

found by Richard K. Abrams, "International Trade Flows Under Flexible Exchange Rates," *Economic Review*, Federal Reserve Bank of Kansas City, March 1980, pp. 3-10. For analyses of the economic impacts of the rise of the dollar, see C. Fred Bergsten, "The Villain is an Overvalued Dollar," *Challenge*, March-April 1982, pp. 25-32, and Robert A. Feldman, "Dollar Appreciation, Foreign Trade, and the U.S. Economy," *Quarterly Review*, Federal Reserve Bank of New York, Summer 1982, pp. 1-9.

² For a critique of the flow model, see Michael Mussa, "Empirical Regularities in the Behavior of Exchange Rates and Theories of the Foreign Exchange Market," in *Policies for Employment, Prices, and Exchange Rates*, Carnegie-Rochester Conference Series on Public Policy, Volume 11, ed. by Karl Brunner and Allan H. Meltzer, pp. 9-57.

terms of changes in the supplies of or demands for respective money stocks. According to this model, a fall in a country's exchange rate reflects excessive growth in its money stock. Another asset model, the "portfolio-balance" model, extends the analysis to consider a wider range of financial assets. In this framework, interest rates and exchange rates are determined simultaneously as wealthholders adjust their financial portfolios. Consequently, imbalances in government budgets and current accounts affect exchange rates by changing the size and distribution of financial-asset **stocks**.³ The lack of consensus on which analytical framework is appropriate is an important problem for policymakers since the predicted effects of domestic economic policy on the exchange rate, and hence on the trade sector, differ across these models.

This article reviews the factors considered important in determining exchange rates and examines the integration of these factors into the exchange-rate models. The first section provides background on the distinctions between fixed and flexible exchange-rate policies along with a brief history of the U.S. dollar exchange

rate since the adoption of floating rates. The second section discusses the influences of such variables as inflation, real income, and the interest rate on the exchange rate. The third section describes specific models of exchange-rate determination. The fourth section reports how well these models explain movements in the **U.S.-Canadian** exchange rate. The final section summarizes the findings of the article.

EXCHANGE-RATE POLICIES AND RECENT DOLLAR MOVEMENTS

The choice of exchange-rate policy is an important decision for any country. This section reviews the differences in policies, discusses how policies affect a country's international balance of payments and its domestic money supply, and describes the recent behavior of the U.S. dollar under a flexible exchange-rate policy.

Alternative exchange rate policies

A country has a choice of three major exchange-rate policies—flexible, fixed, or managed—which are distinguished by the extent to which the government, usually through its central bank, intervenes in the foreign-exchange market to affect the exchange rate of its currency.⁴ If a country adopts a flexible (floating) exchange-rate policy, its central bank does not participate in the foreign-exchange market. Instead, the price of the country's currency relative to foreign currencies is determined by supply and demand in the foreign-exchange market. The supply comes from

³ One version of the flow model is given in Robert A. Mundell, "The Monetary Dynamics of International Adjustment Under **Fixed** and Flexible Exchange Rates," *Quarterly Journal of Economics*, May 1960, pp. 227-57. For a discussion of the origins of the monetary model, see Jacob A. Frenkel, "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence," *Scandinavian Journal of Economics*, May 1976, pp. 200-24. Several studies employing this framework are collected in *The Economics of Exchange Rates: Selected Studies*, ed. by Jacob A. Frenkel and Harry G. Johnson, Addison-Wesley, 1978. For analyses using the portfolio-balance model, see William H. Branson, Hanna Halttunen, and Paul Masson, "Exchange Rates in the Short Run," *European Economic Review*, December 1977, pp. 303-24, and Joseph Bisignano and Kevin Hoover, "Some Suggested Improvements to a Simple Portfolio Balance Model of Exchange Rate Determination with Special Reference to the U.S. Dollar/Canadian Dollar Rate," *Weltwirtschaftliches Archiv*, Heft 1, 1982, pp. 19-37.

⁴ The foreign-exchange market is not in any one location, as is, say, the New York Stock Exchange. Rather, it is a worldwide market connected by electronic communications. This market is essentially never closed and has the largest trading volume of any financial market. See Robert Z. Aliber, *The International Money Game*, 3rd ed., New York: Basic Books, 1979, pp. 54-55.

holders of domestic currency that need foreign currency to buy foreign goods and services (imports) or assets denominated in foreign currencies. The demand comes from foreigners that want to buy domestic goods and services (exports) or assets denominated in the domestic currency. Under this policy, the exchange rate moves to keep the amount of currency demanded just equal to the amount supplied.⁵ An increase in the demand for (supply of) domestic currency, arising, say, from an increase in demand for domestic (foreign) goods by foreigners (domestic residents), causes an immediate appreciation (depreciation) in the exchange rate. The exchange rate, then, reflects the activities of private economic agents or foreign central banks but not the direct actions of the domestic central bank.⁶

If a country adopts a fixed exchange-rate policy, its government or central bank is active in the foreign-exchange market, buying or selling the country's currency when its exchange rate starts to deviate from the fixed or pegged value.⁷ If there is an excess demand for the country's currency at the fixed rate, the central bank must satisfy the excess demand by buying foreign exchange—that is, by supplying its own currency—to keep the exchange rate from rising. If there is an excess supply of the country's currency, the central bank must purchase its own currency to prevent the exchange rate from falling. This is done by supplying foreign exchange. Hence, shifts in the private supply of

domestic currency, or shifts in the private demand for the currency, cause fluctuations in the central bank's holdings of foreign exchange rather than fluctuations in the exchange rate.

If a country adopts a managed exchange-rate policy, its central bank participates in the foreign-exchange market when it decides a movement in its exchange rate is undesirable. There is no formal commitment to defend a specific exchange rate. Under a managed exchange-rate policy, the effect of a shift in the supply of domestic currency, or the demand for it, is uncertain. If the central bank wants the exchange rate change that would result from the shift, it takes no action and the exchange rate is allowed to move to its new equilibrium value. If the central bank does not want the change, it enters the market to keep the rate constant. If the central bank merely wants to smooth the movement in the exchange rate, as is often the case, it buys or sells just enough currency for the exchange rate to adjust slowly to its new equilibrium value.

Exchange rate policy, the balance of payments, and the money supply

A country's transactions with the rest of the world are reported for specific periods as its balance of payments statistics. Private transactions are classified either as current or capital transactions. Included in the current account are purchases or sales of goods and services and transactions involving interest payments. Transactions involving the exchange of financial claims appear in the capital account.⁸ The

⁵ The exchange rate discussed in this paper is the spot rate, the price of foreign exchange for immediate delivery. The forward exchange rate is the price of foreign currency that will be delivered at a specific date in the future.

⁶ Domestic monetary policies that affect interest rates, inflation, or real incomes may, of course, lead to exchange-rate changes.

⁷ In practice, there is usually a narrow band in which the exchange rate can fluctuate without the central bank intervening.

⁸ The current account is essentially the sum of the trade balance (the value of exports minus imports) and net interest income (interest earned from foreign assets less interest paid to foreigners). For a description of alternative methods of reporting the international balance of payments, see Leland B. Yeager, *International Monetary Relations: Theory, History, and Policy*, 2nd ed., New York: Harper & Row, 1976, chap. 3.

net private capital flow is the value of domestic financial assets purchased by foreigners minus foreign assets purchased by domestic private residents. If the current account plus the net private capital flow balance out, the country has a zero balance of payments. If the sum is positive, the country has a balance of payments surplus. If the sum is negative, the country has a balance of payments deficit.

Under a cleanly floating exchange-rate policy, the balance of payments is always zero. This is because any surplus (deficit) implies an excess demand for (supply of) the domestic currency in the foreign-exchange market that an appreciation (depreciation) of the exchange rate would eliminate. There is no direct relation between the foreign-exchange market and the domestic money supply. Under a fixed exchange-rate policy, a balance of payments surplus (deficit) raises (lowers) the domestic money supply unless the central bank takes offsetting **actions**.⁹ Hence, the choice of **exchange-rate** policy has important implications for the control of the domestic money supply.

U.S. dollar under flexible exchange rates

The foreign-exchange value of the dollar has varied considerably since the effective end of the Bretton Woods regime in **mid-1971**.¹⁰ Chart

1 traces the bilateral exchange rates between the dollar and the West German mark, the **Japa**-nese yen, the French franc, the Canadian dollar, and the English pound. The chart illustrates an important point: the dollar may simultaneously appreciate relative to one currency and depreciate relative to another. Generally, however, it fell against most currencies immediately after the mid-1971 collapse of the fixed exchange-rate system and has appreciated across the board since **mid-1980**.¹¹ Between these two periods the dollar fell substantially relative to the "hard" currencies of West Germany and Japan, despite considerable intervention by the central banks of these countries." Over the same period, the dollar rose relative to the Canadian dollar, stayed roughly constant relative to the French franc, rose and then fell back relative to the British pound. To give an overview of the exchange rate of the dollar, Chart 2 shows a weighted average of the dollar's value relative to 10 ma-

⁹ Assume, for example, the country runs a \$10 billion balance of payments surplus. To keep the exchange rate from appreciating, the central bank has to supply the \$10 billion excess demand for the home currency so that the domestic monetary base (currency plus bank reserves) will rise \$10 billion. All else constant, this would lead to an increase in the domestic money supply. To offset or "sterilize" the balance of payments surplus, the central bank would have to sell \$10 billion of domestic government securities from its portfolio.

¹⁰ The 1944 Bretton Woods conference of the Allies set up a system of fixed-exchange rates among most currencies. Under this system, the U.S. dollar was **fixed** in terms of gold and other currencies were pegged to the dollar. The

United States generally did not intervene in the foreign-exchange market, leaving defense of the pegged rates to the countries involved, even though the United States typically ran balance of payments deficits. As a result of foreign central banks exchanging much of their dollar reserves for gold—the U.S. gold stock fell about 50 percent from 1950 to 1970—President **Nixon** eliminated the right of central banks to convert U.S. dollars to gold in August 1971. This led to the Smithsonian Agreement of December 1971 in which exchange rates were realigned. This arrangement did not last long, however, and the United States formally adopted a flexible-rate policy in March 1973. For a detailed account of the Bretton Woods agreement, see Kenneth W. Dam, *The Rules of the Game*, Chicago: University of Chicago Press, 1982, chap. 4. For a review of the **fixed-rate** period, see Richard K. Abrams, "Federal Reserve Intervention Policy," *Economic Review*, Federal Reserve Bank of Kansas City, March 1979, pp. 15-23.

¹¹ Canada adopted a floating exchange rate in June 1970 and the Canadian dollar immediately appreciated against the U.S. dollar.

¹² For a discussion of this intervention, see Victor Argy, *Exchange Rate Management in Theory and Practice*, Princeton Studies in International Finance, No. 50, October 1982.

Chart 1
EXCHANGE RATES- U.S. DOLLAR AND MAJOR CURRENCIES

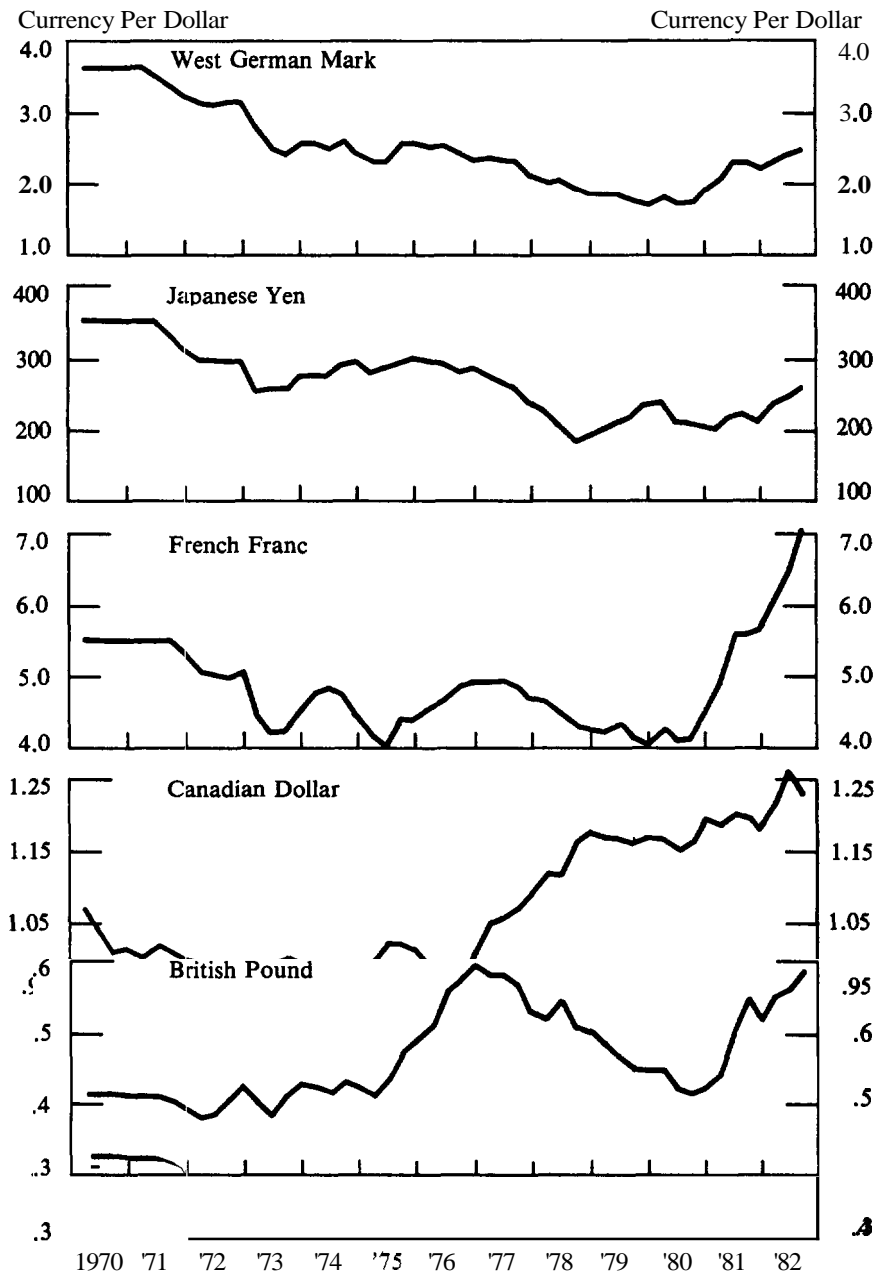
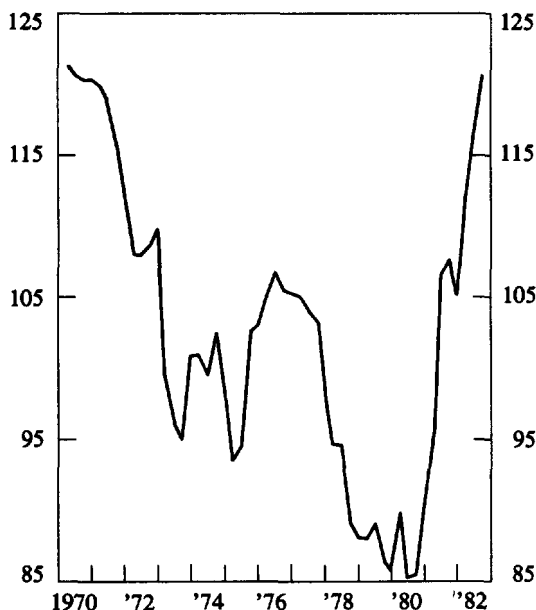


Chart 2
TRADE-WEIGHTED EXCHANGE RATE
OF U.S. DOLLAR
 (March 1973 = 100)



for currencies, with the weights based on the dollar-volume of trade with each country. This composite measure indicates the dollar depreciated generally over the 1970s but has rebounded in the last two years.

FACTORS AFFECTING EXCHANGE RATES

Before discussing specific theories of exchange-rate determination, it is useful to review factors generally thought to influence exchange rates. The factors include a country's inflation rate, real economic growth rate, interest rates relative to the rest of the world, and private speculation. Theories of the exchange rate differ because of the assumptions they make about the importance of these factors.

Relative inflation

Because international trade in goods and services underlies many of the transactions in the foreign-exchange market, changes in domestic prices relative to foreign prices are thought to affect the exchange rate. If domestic inflation exceeds that of a country's trading partners, the demand for domestic goods falls, the demand for foreign goods rises, and the exchange rate of the home currency falls.¹³ However, the extent and speed of the adjustment of exchange rates to different inflation rates are unresolved issues. According to the theory of purchasing power parity, the exchange rate moves quickly to keep the effective prices of goods equal across countries. In its strict form, this theory asserts that the exchange rate always equals the ratio of the foreign price level to the domestic price level. For example, if a particular good costs \$3.00 in the United States and 15 francs in France, the exchange rate must be 5 francs to the dollar. The theory predicts that domestic inflation higher than world inflation results in an immediate depreciation of the domestic exchange rate. Empirical evidence suggests, however, that the relationship between inflation rates and exchanges rates is much looser than this theory maintains.¹⁴

Relative real growth

Another factor affecting trade flows—and thus supplies of and demands for the home cur-

¹³ This assumes the sum of the absolute values of the price elasticities for domestic exports and domestic imports exceeds one.

¹⁴ The literature on purchasing power parity is substantial. For a historical review, see Jacob A. Frenkel, "Purchasing Power Parity: Doctrinal Perspective and Evidence From the 1920s," *Journal of International Economics*, May 1976, pp. 169-91. A thorough review of the issues involved in this theory is given by Lawrence H. Officer, "The Purchasing-Power-Parity Theory of Exchange Rates: A Review Article," *Staff Papers*, International Monetary Fund, March 1976, pp. 1-61.

rency in the foreign-exchange market—is the growth rate of domestic **real** income relative to the rest of the world. With all else held constant, high domestic real growth is thought to weaken a currency's exchange rate because increases in domestic real **income** raise the demand for imports and **hence** the demand for foreign currency relative to the available supply.¹⁵ This line of **reasoning** assumes, however, that higher domestic growth affects only the current account. If investors at home and abroad view the higher income growth as an indication of higher **returns** on capital, there could be a net capital inflow that would more than offset the current-account deficit. In that case, the home currency would appreciate rather than depreciate.

Relative interest rates

A rise in interest rates that makes domestic assets more attractive to investors (at home and abroad) can cause a capital inflow leading to an appreciation in the exchange rate. This result—that an increase in interest rates creates a comparative advantage in the return on domestic over foreign **assets** and tends to increase the exchange rate—depends crucially on the reason for the widening interest differential.

Consider a case where **investors** see foreign and domestic assets as perfect substitutes. Their portfolios will be in **equilibrium** only when the expected returns on alternative assets are equal. The expected return on a foreign asset, as viewed by a domestic resident, is the foreign interest rate plus the **expected** change in the exchange rate. Perfect substitutability, then, implies that in equilibrium the interest differential between two countries just equals the expected

change in the exchange rate. If, say, new one-year U.S. and West German Treasury notes are perfect substitutes and pay 10 percent and 5 percent, respectively, the expected appreciation of the mark over the year must be 5 percent.

This suggests, however, that the interest-rate differential will widen if investors come to believe for some reason that the mark will appreciate more than 5 percent. In that case, a larger interest differential could occur without encouraging a capital flow from West Germany to the United States. The interest differential could be just enough to compensate for a higher expected appreciation of the mark. Thus, the source of the interest-rate differential determines whether a widening of the differential causes an exchange-rate appreciation.

Private speculation

Speculation—the purchase (sale) of foreign exchange for **the** sole purpose of profiting from an expected fall (rise) in the domestic exchange rate—is often said to account for much of the volatility of exchange rates. Volatility, then, is seen as stemming from the actions of speculators rather than from changes in the factors determining the equilibrium exchange rate. One such view assumes that a fall (rise) in the exchange rate leads speculators to think a further decline (increase) is imminent and prompts sales (purchases) of the domestic currency in the foreign-exchange market that drive its price down (up) further. According to this view, speculation is a destabilizing force that magnifies fluctuations in flexible exchange rates and makes fixed rates preferable.

Some analysts, however, see speculation as a stabilizing force. Since, to make profits, speculators must buy when the exchange rate is below its equilibrium level and sell when it is above its equilibrium level, the action of profitable speculators (the only ones that can survive over time) push the exchange rate toward its

¹⁵ This result presumes that the rise in domestic income did not originate from an increase in net exports caused, for example, by an exogenous shift in the demand for domestic goods.

equilibrium rather than away from it.¹⁶ In any case, to argue for government intervention to counteract speculation is to argue that government officials are better judges of the equilibrium exchange rate than private speculators.¹⁷

ALTERNATIVE EXCHANGE RATE MODELS

This section describes three models that have been proposed to explain movements in exchange rates. The first focuses on the demand and supply flows in the foreign exchange market and is referred to here as the "traditional flow" model. The other two models are asset models. In their analytical framework, the exchange rate is determined by the equilibrium conditions in asset markets. One of these is the "monetary" model, which looks solely at the supply of and demand for money in each country. The other is the "portfolio-balance" model, which extends the analysis explicitly to include other assets.

Traditional flow model

The traditional flow model used in many textbooks analyzes the flow demands and sup-

plies in the foreign-exchange market. The exchange rate is in equilibrium when supply just equals demand—when any current-account imbalance is just matched by a net capital flow in the opposite direction. The current account is assumed to be determined by relative prices and relative real incomes. Increases in domestic prices relative to foreign prices are predicted to have a negative effect on the current account and hence, all else constant, to cause a depreciation. Goods prices, however, are presumed to move sluggishly so that purchasing power parity is not imposed. This allows exchange-rate changes originating from other sources to change the relative prices of domestic and foreign goods. An increase in domestic real income is thought, all else being equal, to cause the exchange rate to fall. This is because an increase in income tends to increase imports, reducing the current account, with no offsetting effect on capital flows.

The model posits that foreign and domestic assets are imperfect substitutes in a portfolio. An increase in the domestic interest rate, with no change in the foreign interest rate, is predicted to cause a net capital inflow that results in an appreciation of the exchange rate. Thus, according to this model, a country that wants to strengthen the exchange value of its currency must adopt policies to lower prices, raise interest rates, and reduce real growth.

The main theoretical criticism of the traditional flow model is directed at its implications for the asset market. The model predicts that an exchange rate could be in equilibrium when a country is running a current-account deficit if the domestic interest rate is high enough to maintain an offsetting net capital inflow. This implies that at a constant interest differential, there is a steady, potentially infinite, accumulation of domestic assets by foreigners. No account is given of how the portfolios of foreigners are brought into equilibrium.

¹⁶ For arguments that speculation is likely to be destabilizing, see Paul Einzig, *The Case Against Floating Exchanges*, London: MacMillan, 1970, chap. 9. For arguments that speculation is likely to be stabilizing, see Milton Friedman, "The Case for Flexible Exchange Rates," in *Essays in Positive Economics*, Chicago: University of Chicago Press, 1953.

¹⁷ Political, as well as economic, instability also affects a country's exchange rate although its impact is difficult to quantify. Political decisions that result in trade restrictions and capital controls create artificial barriers that interfere with the economic forces bearing on exchange rates. More dramatic actions, such as the nationalization of banks in Mexico or the election of the Socialist party in France, make investments appear riskier and often lead to domestic capital outflows. The political stability of the United States makes it the natural recipient of such capital flows. Consequently, the dollar usually appreciates when international disruptions occur.

Monetary model

There are several variations of the monetary model, but they all share the premise that movements in the exchange rate between two currencies can be explained by changes in the demand for or supply of money in the two countries. In contrast to the traditional model, in which the exchange **rate** is determined by trade and capital flows, this model asserts that the equilibrium exchange rate depends on the stock-equilibrium **conditions** in each country's money market. The model is derived from several assumptions. First, purchasing power parity holds continuously **so** that the exchange rate always equals the ratio of price levels in the two countries. Second, domestic and foreign bonds are perfect substitutes so that any difference in interest rates equals the expected rate of change in the exchange rate. These two assumptions imply that interest differentials just equal differences in expected inflation rates. Third, the demand for money in each country is a stable **function** of the domestic interest rate and real income. Fourth, if out of equilibrium, the money market adjusts rapidly, with domestic prices **moving** quickly to eliminate any excess supply of **or** demand for money.

These assumptions yield an equation for the equilibrium exchange **rate** in terms of differences between the two countries' money supplies, interest rates, and real **incomes**.¹⁸ The partial effects of these variables are predicted to be as follows. An increase in the domestic money supply reduces the **exchangerate** as the initial excess money supply drives domestic prices up and hence, through purchasing power parity, the exchange rate down. An increase in domestic real income causes excess money **de-**

mand that, with a fixed nominal money supply, results in a reduction in domestic prices and, through purchasing power parity, pulls the exchange rate up. An increase in the domestic interest rate, which is assumed to reflect higher expected inflation, lowers money demand, raises prices, and lowers the exchange rate. Changes in foreign variables have symmetric effects. The domestic exchange rate is increased by a rise in the foreign money supply, by a reduction in foreign real income, and by an increase in the foreign interest rate.

Like the traditional flow model, the monetary model predicts that changes in domestic real income and interest rates affect the exchange rate. The effects are in the opposite direction, however, since the monetary model asserts that rapid economic growth and low interest rates should cause the exchange rate to appreciate rather than depreciate.

Criticism of the monetary model centers on its assumptions. First, several investigators have reported evidence that purchasing power parity does not hold in the short **run**.¹⁹ In particular, it is argued that prices are "sticky" in the short run and do not have the required flexibility to keep the money market in equilibrium. Second, if domestic and foreign bonds are not perfect substitutes, as the monetary model assumes, the model must take into account changes in the composition of portfolios with respect to these two assets. This consideration leads to the portfolio-balance model.

Portfolio-balance model

The portfolio-balance model views the exchange rate and interest rates as determined

¹⁸ This assumes that the demand for money functions in each country have identical parameters.

¹⁹ The strength of commodity arbitrage in keeping individual prices in line was found to be weak by Irving B. Kavis and Robert E. Lipsey, "Price Behavior in the Light of Balance of Payments Theories," *Journal of International Economics*, May 1978, pp. 193-246.

simultaneously by the portfolio equilibrium conditions for wealthholders in each country. Residents of each country are assumed to allocate their net financial wealth among three assets: the domestic monetary base, domestic government bonds, and net foreign bonds denominated in foreign **currency**.²⁰ The desired proportions of these assets are assumed to depend on their respective yields, with domestic and foreign bonds considered imperfect substitutes. An increase in the domestic (foreign) interest rate causes investors to increase the desired proportion of their wealth in domestic (foreign) bonds and to lower the desired proportions in the monetary base and foreign (domestic) bonds. The outstanding stocks of these assets are fixed at any point in time so that the exchange rate and the two interest rates equal the values at which **wealth**holders are just willing to hold existing assets, assuming asset markets clear continuously.

Stocks of financial assets change over time, causing interest rates and the exchange rate to change. Bond-financed government deficits (surpluses) increase (decrease) the private holdings of government bonds. **Money**-financed deficits (surpluses) increase (decrease) the monetary base. Current-account surpluses (deficits) increase (decrease) net domestic holdings of foreign debt.

An increase in the domestic monetary base would increase domestic wealth and raise the proportion of wealth held in this asset. At the

original interest rates and exchange rate, **port**-folios would no longer be in their desired proportions, since domestic wealthholders would want to redistribute their wealth increase toward domestic bonds and foreign bonds. With the foreign interest rate fixed, actions of domestic investors to realign their portfolios would result in a drop in the domestic interest rate and a depreciation of the exchange rate." An increase in net holdings of foreign bonds resulting from a current-account surplus would also increase domestic wealth and disturb portfolio equilibrium. In that case, domestic wealthholders would want to hold some of the wealth increment in the form of domestic assets. This would lead to a fall in the domestic interest rate and an appreciation of the exchange rate.

Unlike the first two cases, an increase in domestic government bonds has an uncertain effect on the exchange rate. On the one hand, the increase in wealth would increase domestic demand for foreign assets resulting in an exchange-rate depreciation. On the other hand, the increase in domestic government debt would raise the domestic interest rate, making foreign bonds less attractive. If this substitution effect were larger than the wealth effect, the net result would be an appreciation of the exchange rate.

²⁰ The model is concerned with the allocation of the net wealth of all private domestic wealthholders. Since demand deposits are liabilities of domestic banks, the monetary base rather than the money supply appears in the model. The inclusion of domestic government debt in the hands of domestic residents assumes that this too is an "outside" asset—that residents do not take account of the present value of the implied tax liability associated with the government debt. Note that an appreciation of the exchange rate lowers the domestic currency value of foreign assets and hence lowers domestic wealth.

²¹ An increase in the monetary base causes an excess supply of this asset at the original exchange rate and interest rates under the usual assumption that the partial derivative of the demand function for each asset with respect to wealth is less than one. The excess supply is matched by excess demands for domestic and foreign bonds. The excess demand for domestic bonds raises their price—lowers the domestic interest rate—which increases the proportion of wealth held in domestic bonds. The excess demand for foreign bonds (denominated in foreign currency) increases the demand for foreign currency resulting in a depreciation that increases the proportion of wealth held in foreign bonds. Equilibrium is restored when these proportions reach their higher desired levels.

The portfolio-balance model incorporates elements of both the traditional flow model and the monetary model. By including foreign currency-denominated assets, it allows **current-account** imbalances to affect exchange rates as the flow model predicts. By including the monetary base of each country, it allows differences in monetary growth to affect exchange rates, as the monetary **model** predicts. The channels of influence differ, however. Because the portfolio model focuses only on disturbances to asset portfolios, it ignores the underlying determinants of trade as well as the role of purchasing power parity."²²

There have been reservations about the portfolio-balance model. Because comparative returns on domestic and foreign assets are important in the model, expected exchange-rate movements must be considered. Different assumptions about how **agents** form their expectations can lead to very different predictions from the model. This **issue** is particularly important if one country is a net debtor rather than creditor in foreign currency-denominated bonds. Under some assumptions about the formation of exchange-rate expectations, the model may be **unstable**.²³ The model may also be difficult to use in empirical work because of the scarcity of data on domestic holdings of foreign financial assets.

²² Changes in the composition of wealth that leave its level initially unchanged also have exchange rate effects according to this theory. An open market purchase (sale) of domestic government bonds by **the** central bank reduces the domestic interest rate and cause!; a depreciation (appreciation) of the exchange rate. **Intervention** in the exchange market by the central bank in the form of purchases or sales of foreign bonds has the same qualitative effects on the domestic interest rate and the exchange rate as open market operations.

²³ If one country is a large net **debtor** in foreign currency denominated financial claims **and** agents have static expectations—if they assume that exchange rates will not change—the portfolio-balance model is generally unstable. This instability disappears, however, if expectations are **ra-**

EMPIRICAL EVIDENCE ON ALTERNATIVE THEORIES: THE U.S.-CANADIAN EXCHANGE RATE

This section examines how well the different theories explain movements in the **U.S.-Canadian** exchange rate. This particular case was chosen for several reasons. First, Canada and the United States are each other's largest trading partner, so fluctuations in this exchange rate can have substantial effects on trade flows. Second, Canada adopted a flexible-rate policy in June 1970, before most other countries, so a longer time period is available for empirical tests. Third, data on bilateral asset holdings, required for estimation of the portfolio-balance model, are more extensive for these countries than for most other countries.

Graphical overview

Before examining statistical estimates of the models, a graphic overview may help show broad relationships between the exchange rate and its possible determinants. Chart 3 compares movements in the ratio of Canadian to U.S. price levels, measured by the wholesale price indexes, with the exchange rate measured as Canadian dollars per U.S. dollar. According to the theory of purchasing power parity, these two series should move together quite closely. As the chart shows, the price ratio does roughly correspond with the exchange rate. While the relationship is not very close in terms of quarterly movements, the fall in the exchange value of the Canadian dollar since 1976 has coincided with higher Canadian inflation, as the theory of purchasing power parity predicts.

tional and speculation is stabilizing. See Dale W. Henderson and Kenneth Rogoff, "Negative Net Foreign Asset Positions and Stability in a World Portfolio Balance Model," *Journal of International Economics*, August 1982, pp. 85-104.

Chart 3
CANADIAN-U.S. EXCHANGE RATE
AND RATIO OF PRICE LEVELS

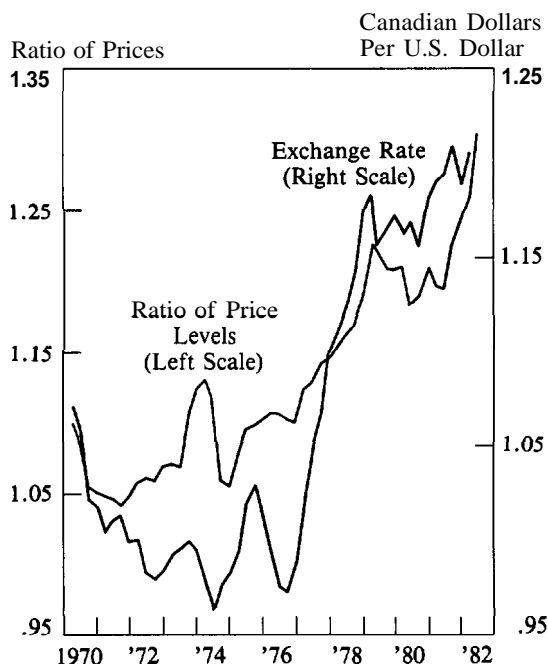
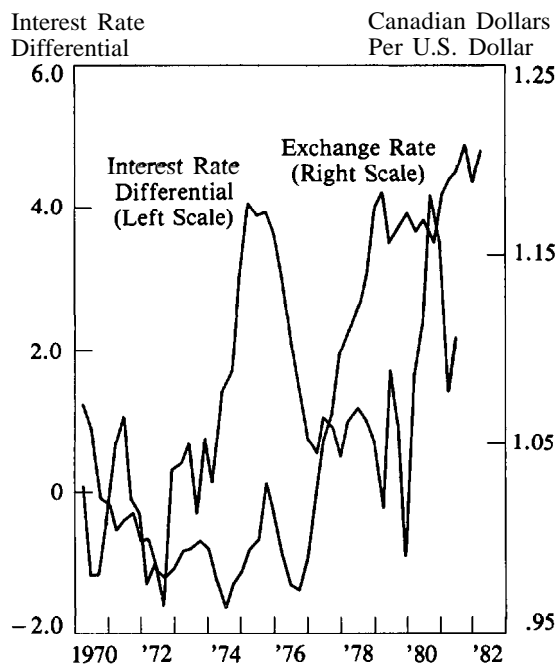


Chart 4 compares the interest-rate differential, measured by the Canadian commercial-paper rate less the U.S. commercial-paper rate, with the exchange rate. The traditional flow model predicts that the two series should be inversely related, because it asserts that a wider differential will cause a net capital flow into Canada, raising the value of the Canadian dollar. The monetary model, on the other hand, predicts a positive relationship, because it assumes a wider differential reflects higher expected inflation in Canada and, thus, a depreciation in the Canadian dollar. Graphic evidence suggests that larger interest differentials are associated with a rising Canadian dollar, although the relationship appears weak. The bulge in the interest differential in 1975-76 coincided with a stronger Canadian dollar and

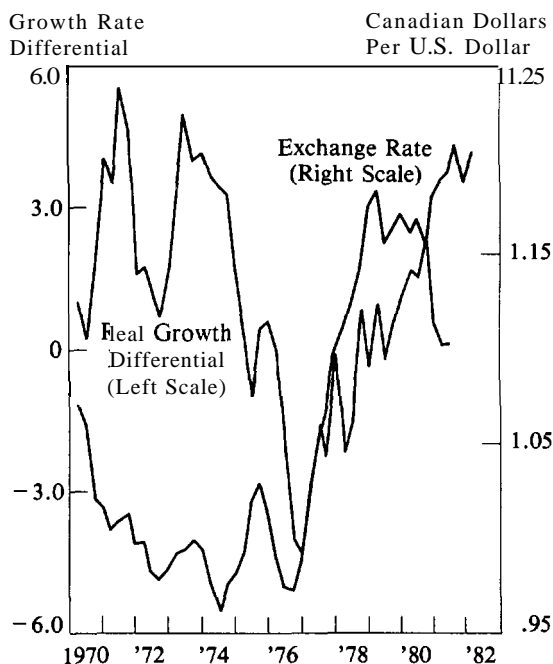
Chart 4
CANADIAN-U.S. EXCHANGE RATE AND
INTEREST RATE DIFFERENTIAL



the decline in the differential from mid-1976 to mid-1978 occurred as the value of the Canadian dollar declined steeply.

Chart 5 compares the differences in real growth rates, measured as the annualized rate of change in real GNP in Canada less the U.S. counterpart, with the exchange rate. The traditional flow model asserts that higher economic growth in Canada should cause the Canadian dollar to fall, due to its adverse effects on the current account. In contrast, the monetary model asserts that faster real income growth should strengthen the Canadian dollar, since it raises the demand for Canadian money. Although the graphic evidence indicate no discernible short-run relationship between relative growth rates and the exchange rate, the Canadian economy grew faster than the U.S.

Chart 5 CANADIAN-U.S. EXCHANGE RATE AND REAL GROWTH DIFFERENTIAL



economy in the first half of the 1970s and the Canadian dollar was strong. In the second half of the 1970s, U.S. growth was generally higher and the Canadian dollar fell. Thus, the evidence does not support the traditional flow model but is weakly consistent with the monetary model. These graphic implications could be misleading, however, since the theories predict the effect of one variable holding all others constant and the graphs allow other variables to change. The next section, therefore, presents statistical evaluations of each exchange-rate model.

Estimates of exchange rate models

Table 1 presents the single-equation representations of the traditional flow, monetary, and portfolio-balance models, which have been

used in past work to capture the essence of the alternative theories.²⁴ The purchasing power parity equation is also included because strict purchasing power parity is an assumption of the monetary model and is assumed by the traditional flow model to hold partially. Above each coefficient is the sign expected from each theory. Table 2 presents estimates of the different models, based on quarterly data over the flexible-rate period from 1971:Q1 to 1982:Q1.

The estimation results point to the conclusion that none of the theories is fully supported by the Canadian-U.S. experience.²⁵ The estimate of the purchasing power parity model implies that a Canadian inflation rate one percentage point above the U.S. inflation rate is associated with a depreciation of the Canadian dollar of only 0.5 percentage points, half the impact predicted by the theory.²⁶

²⁴ Other representations of the models have been proposed. For a version of the monetary model that relaxes the assumption of strict purchasing power parity, see Jeffrey A. Frankel, "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials," *American Economic Review*, September 1979, pp. 610-22. Another monetary model that allows for central bank intervention is given in Lance Girton and Don Roper, "A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience," *American Economic Review*, September 1977, pp. 537-48. An alternative version of the portfolio model does not assume that the foreign interest rate is exogenous and therefore includes the corresponding foreign asset holdings.

²⁵ Similar negative results, based on forecasting performance, were found for other exchange rates by Richard A. Meese and Kenneth S. Rogoff, "Empirical Exchange Rate Models of the Seventies: Are Any Fit to Survive?" *International Finance Discussion Papers*, No. 184, Board of Governors of the Federal Reserve System, 1981.

²⁶ The effect of the inflation differential on the exchange rate was also not estimated precisely. Only at the 6 percent significance level can one reject both the hypothesis that the change in the exchange rate is unrelated to the inflation differential and the hypothesis that the exchange rate moves on a one-to-one basis with the inflation differential (purchasing power parity holds).

Table 1
ALTERNATIVE MODELS OF EXCHANGE RATE DETERMINATION

A. Purchasing Power Parity

$$\ln e_t = a_0 + a_1^{(+)} \ln(P^c/P^u)_t + \epsilon_t$$

B. Traditional Flow Model

$$\ln e_t = b_0 + b_1^{(+)} \ln(y^c/y^u)_t + b_2^{(+)} \ln(P^c/P^u)_t + b_3^{(-)} (r^c - r^u)_t + \epsilon_t$$

C. Monetary Model

$$\ln e_t = c_0 + c_1^{(+)} \ln(M^c/M^u)_t + c_2^{(-)} \ln(y^c/y^u)_t + c_3^{(+)} (r^c - r^u)_t + \epsilon_t$$

D. Portfolio Balance Model

$$e_t = d_0 + d_1^{(+)} MB_t^c + d_2^{(\pm)} B_t^c + d_3^{(-)} F_t^c + d_4^{(+)} r_t^u + \epsilon_t$$

Definitions:

- e = spot exchange rate defined as number of Canadian dollars per U.S. dollar
- P^i = price level in country i
- y^i = real income in country i
- r^i = nominal interest rate in country i
- MB^c = monetary base in Canada
- B^c = Canadian government debt held by Canadian residents
- F^c = net U.S. dollar **claims** held by Canadian residents
- c = Canada
- u = United States
- ϵ = error term

The estimate of the traditional flow model indicates that only the prediction that higher Canadian interest rates were associated with an appreciation of the Canadian dollar is consistent with the evidence. Even this effect is not strongly supported. The estimate of the monetary model shows similarly negative results. The difference in money-supply growth had no

statistically significant effect on the exchange rate, while the interest-rate differential did not have the positive impact specified by the **theory**.²⁷ The portfolio-balance model fares little better. Canadian asset stocks had no discernible effect on the exchange rate, although the **U.S.** interest rate did have the predicted result. A higher U.S. interest rate was associated with a lower exchange rate for the Canadian dollar.²⁸

There could be several reasons for the lack of success with the models. The models assume stable asset-demand functions, a premise that may not have held in the **1970s**.²⁹ The models do not incorporate the behavior of speculators, and the frequent economic and political shocks over the period may have made speculation an important factor. The models, in assuming freely floating exchange rates, do not allow for intervention by central **banks**.³⁰

²⁷ While the lack of support for purchasing power parity may be viewed as a **priori** evidence that the monetary model must be invalid, it has been argued that because published price indexes are inadequate for evaluating purchasing power parity, monetary models should be tested directly. This argument is made, for **example**, by John F. O. Bilson, "**Rational** Expectations and the Exchange Rate," in *The Economics of Exchange Rates: Selected Studies*. Estimates of the monetary model developed by Frankel ("On the Mark..."), which relaxes strict purchasing power parity, also yield results that do not support the monetary model.

²⁸ Estimates of the portfolio-balance model that include U.S. asset stocks instead of the U.S. interest rate produce essentially similar results.

²⁹ The demand for money appears to have been unstable over the 1970s and, assuming at least part of money demand is for wealth portfolio needs, this implies instability in other asset demand functions. For a survey of the money demand evidence, see John P. Judd and John L. Scadding, "The Search for a Stable Money Demand Function," *Journal of Economic Literature*, September 1982, pp. 993-1023.

³⁰ Allowing for a reaction function by the Bank of Canada along the lines suggested by Branson, Halttunen, and Masson, "Exchange Rates in the Short Run," does not, however, significantly change the estimation results for the portfolio-balance model.

Table 2
ESTIMATED EXCHANGE RATE MODELS

Estimation Period: 1971:I-1982:I

Model	Constant	$\ln(P^C/P^U)$	$\ln(M^C/M^U)$	$\ln(y^C/y^U)$	$(r^C - r^U)$	R^2	SEE	DW	$\hat{\rho}$
A. Purchasing Power Parity*	.511 (1.906)					.015			
B. Traditional Flow	.143 (.321)	.347 (1.243)		-.137 (-1.155)	-.004 (-1.821)	.136	.015	1.41	.99
C. Monetary	.285 (.500)		0.54 (.551)	-.154 (-1.245)	-.004 (-1.704)	.093	.016	1.24	.99

Estimation Period: 1971:I-1981:IV

Model	Constant	MB^C	B^C	F^C	r^U	R^2	SEE	DW	$\hat{\rho}$
D. Portfolio Balance	.917 (15.881)	.001 (.086)	.003 (1.451)	-.001 (-.972)	.004 (3.222)	.321	.019	1.84	.91

*Estimated in first-difference form.

Note: See Table 1 for definitions of variables.
Numbers in parentheses are t-statistics.

R^2 = multiple correlation coefficient

SEE = standard error of estimate

DW = Durbin-Watson statistic

$\hat{\rho}$ = estimated autocorrelation coefficient

SUMMARY AND CONCLUSIONS

The recent rise in the foreign-exchange value of the **U.S.** dollar has important implications for many sectors of the U.S. economy as well as for other countries. This article has reviewed the major factors thought to influence the exchange rate, especially relative inflation, relative growth in real income, and interest-rate differentials. Three models of exchange-rate determination were discussed.

The first model focuses directly on the flow demands and supplies in the foreign-exchange market arising from international trade in goods and assets. The second attributes exchange-rate changes to differences in the growth rates of money supplies. The third asserts that exchange-rate movements reflect asset portfolio readjustments caused by

government-budget or current-account imbalances.

Each of these models was estimated to see if it accounted for changes in the Canadian-U.S. exchange rate over the flexible-rate period. The empirical results suggest that none of the models can be considered an adequate guide for economic policy. There was little evidence of a systematic, short-run relationship between the exchange rate and differences in money growth, differences in economic growth, or changes in asset portfolios. Two regularities did emerge from the empirical work, however: first, although the short-run relationship is imprecise, inflation higher than in other countries is linked to exchange-rate depreciation, and second, domestic interest rates higher than in other countries are associated with an exchange-rate appreciation.

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