PRINCETON STUDIES IN INTERNATIONAL FINANCE NO. 42

Exchange-Rate Determination: A Survey of Popular Views and Recent Models

Peter Isard

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY · 1978

PRINCETON STUDIES

IN INTERNATIONAL FINANCE

This is the forty-second number in the series PRINCETON STUDIES IN INTERNATIONAL FINANCE, published from time to time by the International Finance Section of the Department of Economics at Princeton University.

The author, Peter Isard, is on the staff of the Division of International Finance of the Board of Governors of the Federal Reserve System. He has formerly been a member of the Research Department of the International Monetary Fund and taught at Washington University in St. Louis.

This series is intended to be restricted to meritorious research studies in the general field of international financial problems that are too technical, too specialized, or too long to qualify as ESSAYS. The Section welcomes the submission of manuscripts for the series. While the Section sponsors the studies, the writers are free to develop their topics as they will.

PETER B. KENEN
Director

Princeton University

PRINCETON STUDIES IN INTERNATIONAL FINANCE NO. 42

Exchange-Rate Determination: A Survey of Popular Views and Recent Models

Peter Isard

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY
PRINCETON, NEW JERSEY
MAY 1978

Library of Congress Cataloging in Publication Data

Isard, Peter.
Exchange-rate determination.

(Princeton studies in international finance; no. 42 ISSN 0081-8070)
Bibliography: p.
1. Foreign exchange—Mathematical models. I. Title. II. Series.
HG3821.I75 332.4′5 78-4946

Printed in the United States of America by Princeton University Press
at Princeton, New Jersey

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENT

The views expressed in this study are not necessarily those of the Board of Governors of the Federal Reserve System or anyone else on its staff. I am particularly grateful to my colleagues Dale W. Henderson and Jeffrey R. Shafer for sharpening my focus on numerous issues. I am also indebted to Polly R. Allen, Betty C. Daniel, Rudiger Dornbusch, Allen B. Frankel, Lance W. Girton, George B. Henry, Peter Hooper, Steven W. Kohlhagen, Val Koromzay, Ralph W. Smith, Edwin M. Truman, and John Williamson for valuable comments on earlier drafts. In addition, my thanks extend to Henry C. Wallich for originally encouraging me to undertake this study. None of the above should be blamed for its shortcomings or assumed to agree entirely with its contents.

1 INTRODUCTION

It is uniformly agreed that exchange rates should be viewed as market-clearing prices that fluctuate (under a flexible-exchange-rate regime) to equilibrate demands and supplies in foreign-exchange markets. It is also agreed that foreign-exchange markets are only one part of a complex world economy of interrelated markets, that exchange rates are determined in a process which simultaneously determines many other variables in the world economy, and that accordingly it is not feasible to model the process of exchange-rate determination without making major simplifications. Different views of the process of exchange-rate determination reflect different simplifying assumptions and should be judged by considering the appropriateness of the underlying simplifications, in terms of both theoretical implications and predictive accuracy. The appropriateness of the simplifications depends on the time horizon over which one is interested in predicting exchange-rate fluctuations and can change with the evolution of the international economy.

This study evaluates the appropriateness of alternative theories for explaining short-run movements of exchange rates in today's world.[1] Much of the survey focuses on the recent development of financial-equilibrium models. Before these recent models are discussed, however, Chapter 2 analyzes four popular and older views of exchange-rate determination: (2.1) purchasing-power-parity theory, (2.2) a popular balance-of-payments view, (2.3) forward exchange theory, and (2.4) the speculative-run view. Each of the first three views is shown to be inadequate *by itself*, on both theoretical and empirical grounds, as an explanation of exchange-rate behavior in the short run. This does not deny the usefulness of these views in other contexts. Purchasing-power parity is rejected as a short-run hypothesis, but it may have considerable validity over periods of time sufficiently long for ratios of national price indexes to change radically. The popular balance-of-payments view and forward exchange theory are inadequate in the different sense of being incomplete theories. When embedded in appropriate larger models, each of these views contributes to understanding the short-run behavior of exchange rates. The speculative-run view derives some support from both empirical tests and anecdotal evidence, but proponents of this view have not yet provided an adequate model for predicting exchange rates from historical data.

[1] Although much of the study focuses jointly on spot and forward exchange rates, the term "exchange rate," when unmodified, should be interpreted to refer to spot rates and not necessarily to forward rates.

Chapter 3 turns to the analytic insights provided by open-economy models with financial markets. Sections 3.1 and 3.2 discuss the historical background and basic structures of these models. Section 3.3 then summarizes the insights that a streamlined model provides about the short-run impacts of unanticipated open-market monetary policies and exchange-market interventions. As is shown in the appendix to Chapter 3, the impact of such policies on exchange rates depends on the degree of substitutability between assets denominated in domestic and foreign currencies, the extent to which changes in observed exchange rates lead to revisions in expectations about future exchange rates, and the extent to which financial portfolios are diversified between assets denominated in domestic and foreign currencies. Section 3.4 argues that extensions of the streamlined model do not substantially alter the basic insights about how exchange rates respond to central-bank policies. Section 3.5 discusses the limited literature analyzing the sensitivity of exchange-rate movements to anticipations of the policy changes or other exogenous events that generate them. Section 3.6 briefly considers the relevance of long-run neutrality results.

Section 3.7 shifts to the analysis of fiscal policies. Many models of financial equilibrium are unsuitable for analyzing the effects of policy-induced shifts in wealth, and analysis of fiscal policy has suffered from this deficiency. A balanced-budget fiscal expansion is conventionally viewed to induce a once-and-for-all exchange-rate appreciation, but induced shifts in the current account also have wealth effects that put opposite and continuing pressure on the exchange rate. Thus, there is a presumption that a balanced-budget fiscal expansion will cause the exchange rate to depreciate in the long run. And this presumption is even stronger for a fiscal expansion financed by increasing the supply of debt denominated in home-currency units.

The desire to distinguish formally between the short-run and long-run effects of policy changes has generated several models of exchange-rate dynamics. Section 3.8 discusses a few of these models. Section 3.9 then turns to the analysis of exchange-rate volatility and overshooting. It is argued that much of the volatility of observed (and expected) exchange rates is not explained by the type of overshooting that arises in the dynamic models discussed in section 3.8 but may rather reflect the influence of discrete (even if small) revisions in expectations about the future time paths of money supplies and other policy variables.

Chapter 4 describes selected empirical applications of open-economy models with financial markets. Section 4.1 discusses examples of the monetary approach, and section 4.2 considers multiple-equation models. Chapter 5 concludes the study with a discussion of important challenges for research.

2 POPULAR VIEWS OF EXCHANGE-RATE DETERMINATION

2.1 *Purchasing-Power-Parity Theory*

The term "purchasing-power parity" (PPP) originated with Cassel (1918), who is generally credited with first formulating PPP as an empirically testable hypothesis. Myhrmann (1976) notes, however, that PPP played a key role in the monetary view of exchange-rate determination both during the Bullionist Controversy in early nineteenth-century England and during earlier debates in mid-eighteenth-century Sweden. And Einzig (1970, pp. 145-146) traces PPP theory as far back as Spanish writers in the sixteenth and seventeenth centuries (see Officer, 1976a, for a recent review article on PPP theory).

PPP theory has many variants, but this study considers only those popular variants that view exchange rates as being held strictly in line with relative price indexes.[1] The *absolute* PPP hypothesis states that the exchange rate between the currencies of any pair of countries should equal the ratio of the general price levels in the two countries. This is not a useful operational hypothesis, however, because price information is usually compiled in the form of price indexes rather than absolute price levels. Consequently, this study focuses on the "strict" *relative* PPP hypothesis, which states that the exchange rate between the currencies of any pair of countries should be a constant multiple of the ratio of general price indexes of the two countries, or, equivalently, that percentage changes in the exchange rate should equal percentage changes in the ratio of price indexes. This proposition does not necessarily imply that relative-price movements cause exchange-rate fluctuations. Nor does it pretend to be a complete model of exchange-rate determination, since it does not explain the behavior of relative prices.

Several points must be clarified to put PPP into proper perspective. First, PPP is a theory about the equilibrium relationship between an exchange rate and some designated ratio of price indexes. Underlying this theory is the notion that any divergence of the exchange rate from the designated ratio of price indexes will set in motion corrective forces acting to restore equilibrium. Because these corrective forces may take time to restore equlibrium, however, the validity of PPP depends on the time horizon under consideration. Evidence of purchasing-power disparities that persist in the short run does not prove that PPP is invalid in the long run, and support for PPP based on data spanning a long time horizon does

[1] In contrast, Officer (1976a) applies the term PPP more broadly to all theories that include a relative-price index among the variables on which the exchange rate is assumed to depend.

not deny the possibility of substantial purchasing-power disparities in the short run.

Proponents of PPP hold vague and differing views about which particular ratio of price indexes should parallel the exchange rate. These views correspond to vague and differing notions about the forces that act to correct purchasing-power disparities. A monetarist school of thought, to which Cassel adhered, views the exchange rate to be held in line by general price indexes that summarize the prices of both tradable and nontradable goods and services: "People value currencies primarily for what they will buy and, in uncontrolled markets, tend to exchange them at rates that roughly express their relative purchasing powers" (Yeager, 1958, p. 516). A second version of PPP views exchange rates to be held in line by cost-of-production indexes, arguing that competition and the international mobility of industry will prevent persistent purchasing-power disparities (see Hansen, 1944). A third version, not inconsistent with the first two, focuses on commodity arbitrage through international trade as the mechanism that corrects purchasing-power disparities: "The proposition that general price levels in different countries are connected through the prices of internationally traded goods is the foundation of the purchasing-power parity doctrine" (Haberler, 1975, p. 24, who is critical of PPP theory). Implicit in this third version is the additional proposition that relative prices of tradables and nontradables remain fairly constant within countries.

A fourth version of PPP combines the propositions that (a) the expected rate of change in the exchange rate between any two currencies is approximately equal (assuming approximate risk neutrality) to the difference between the nominal rates of interest on assets denominated in the two currencies, (b) nominal rates of interest equal real rates of interest plus expected rates of domestic price inflation, and (c) real rates of interest tend to equality across countries. Jointly, these three propositions argue that the expected rate of change in the exchange rate is approximately equal to the difference between expected rates of domestic price inflation. This version is further argued to suggest that observed rates of exchange-rate change approximate differences between observed rates of domestic price inflation. Equivalently, observed rates of exchange-rate change are viewed to approximate observed rates of change in ratios of domestic price indexes.

Each of these four views can be challenged. The fourth version is disputed by evidence that differences between nominal rates of interest have been highly inaccurate predictors of actual exchange-rate movements in recent years—evidence that will be presented in section 2.3 below. Yeager's statement of the monetarist view must bow to the fact that transportation and other transactions costs in reality leave room for substantial purchasing-power disparities to occur before residents in any one country would find it economical to exchange an "overvalued" local currency for currencies to use in purchasing goods and services abroad. Similarly, advocates of the cost-parity view must recognize that high information and relocation costs weaken the equilibrating forces sufficiently to permit substantial purchasing-power disparities.

The third version of PPP, which postulates commodity arbitrage combined with constant relative prices of tradables and nontradables, has been attacked on both counts. Cassel himself recognized that real changes in an economy are likely to alter the relative prices of tradables and nontradables, while Isard (1977) has attacked the practical relevance of commodity arbitrage with empirical evidence that disputes the "law of one price" at the most disaggregated level of product classification for which available price data can be readily matched across countries. Isard's evidence shows that, at this level of commodity detail, tradable goods manufactured by different countries behave like differentiated products that systematically exhibit large changes in their relative common-currency prices. Moreover, large relative-price disparities at this level of commodity detail can persist for at least several years. Thus, aggregate price indexes constructed from available data on tradable-goods prices are also likely to be such that the ratio of price indexes for any pair of countries diverges substantially from the corresponding exchange rate for periods of at least several years (see Dornbusch and Krugman, 1976, for additional support of this proposition).

These criticisms substantially weaken the theoretical basis of PPP. Nevertheless, it is appropriate to examine how well PPP stands up as an empirical proposition. The most carefully constructed price indexes available for PPP comparisons are those of Kravis *et al.* (1975) and Gilbert and Kravis (1954). Table 1 compares exchange rates with relative-price indexes (ratios of gross product deflators) available from those sources. Although this sample of data is small, it suggests that ratios of exchange rates to relative-price indexes do change noticeably over time.[2]

[2] Such changes over time seem consistent with cross-section evidence that ratios of gross-product deflators deviate from exchange rates in a manner correlated with the relative per capita gross products of the countries under comparison (see Balassa, 1964, or Kravis *et al.*, 1975; but also see the challenge by Officer, 1976b). The cross-section evidence is generally conjectured to reflect (a) rough equality between exchange rates and ratios of the tradable-goods components of gross-product deflators, combined with (b) a tendency for prices of nontradables (e.g., services) to be lower, relative to prices of tradables, the less advanced is a country's stage of development, as indexed by per capita gross product. Consistently, the ratios in Table 1 generally increase toward unity over time, though not always monotonically, as the per capita gross products of foreign countries rise relative to that of the United States.

TABLE 1

PURCHASING-POWER-PARITY COMPARISONS

Country[a]	Ratio of Exchange Rate to Relative-Price Index[b]	Percentage Change from Previous Period[c]
France:		
1950	0.75	
1970	0.81	8
Germany:		
1950	0.72	
1970	0.87	19
Italy:		
1950	0.70	
1970	0.74	6
Japan:		
1967	0.66	
1970	0.68	3
United Kingdom:		
1950	0.70	
1967	0.83	17
1970	0.72	−14

SOURCES: Kravis *et al.* (1975), Tables 1.5, 1.6, 13.17 and 13.19; and Gilbert and Kravis (1954), Table 4.

[a] Paired with the United States.

[b] Relative-price indexes are ratios of gross-domestic-product deflators for 1967 and 1970, and ratios of gross-national-product deflators for 1950. Both exchange rates and relative-price indexes are expressed in U.S. dollars per currency unit of the partner country.

[c] Based on midpoints of the intervals of change.

Table 1 can also be used to illustrate the potential pitfalls of using PPP comparisons to make normative judgments about appropriate levels of exchange rates. Between 1950 and 1970 the dollar equivalent of Germany's price level increased by 19 per cent more than the U.S. price level. Yet who would have argued in 1970 that the mark was overvalued by 19 per cent, or that the mark should have been devalued by 5 per cent rather than revalued by 14 per cent during the 1950-70 period?

It may be objected that the data in Table 1 reflect observations at only a few widely spaced points in time. Table 2 is based on a larger number of observations taken one year apart during the 1969-76 period, for each of six industrial countries paired with the United States. For each of the six countries, using both consumer and either industrial or wholesale price indexes, the table focuses on the foreign-country price index (P_f) converted at the prevailing exchange rate (X, in dollars per unit of foreign currency) into a dollar-equivalent price index (P_fX), expressed as a proportion of the U.S. price index (P_{us}).

Tests of the validity of PPP amount to tests of how narrowly the purchasing-power exchange rate (P_fX/P_{us}) fluctuates about some long-run equilibrium level. Accordingly, Table 2 reports how observed values of

TABLE 2

PERCENTAGE DEVIATIONS OF PURCHASING-POWER EXCHANGE RATES FROM THEIR MEANS, 1969-76[a]

	1969	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*
Canada:								
CPI	− 5.7	− 4.4	− 4.5	0.9	0.9	5.3	0.1	7.4
IPI	− 7.9	− 7.6	− 8.3	− 2.1	6.7	11.5	0.9	6.7
France:								
CPI	− 7.4	−16.1	−15.5	− 4.4	14.2	− 1.5	23.3	7.4
IPI	n.a.	n.a.	−14.6	− 5.9	17.1	6.6	5.2	− 8.5
Germany:								
CPI	−27.4	−21.8	−18.1	− 7.2	16.2	19.7	25.9	12.7
IPI	−26.9	−17.5	−13.8	− 5.2	15.4	19.1	21.1	7.8
Italy:								
CPI	− 5.8	− 6.9	− 6.0	3.2	6.5	1.4	14.8	− 7.1
IPI	−10.1	− 7.2	− 7.1	− 0.7	6.1	11.0	11.2	− 3.2
Japan:								
CPI	−18.9	−18.8	−15.9	1.5	23.3	9.1	9.5	10.3
IPI	−14.0	−14.7	−17.6	− 5.8	15.5	22.3	8.4	6.0
United Kingdom:								
CPI	− 8.8	− 8.8	− 2.7	6.6	10.3	0.5	10.9	− 7.9
IPI	− 4.4	− 2.9	2.6	10.1	10.2	− 4.2	2.7	−14.1

SOURCE: Calculations are based on both consumer price indexes (CPI) and either industrial or wholesale price indexes (IPI), taken from *International Financial Statistics*. Exchange rates are taken from the *Federal Reserve Bulletin*. Data are for June of each year.

[a] Purchasing-power exchange rates are constructed as $P_f X/P_{us}$, where P_f and P_{us} denote price indexes for the foreign (tabulated) country and the United States respectively, and where X denotes the exchange rate in dollars per unit of foreign currency.

purchasing-power exchange rates have fluctuated about their sample means. On the assumption that sample means (for the eight selected time periods) are good estimates of any long-run equilibrium levels of purchasing-power exchange rates, the table entries can be interpreted as percentage deviations of observed exchange rates from estimated PPP levels. Independently of this interpretation, however, Table 2 emphasizes that purchasing-power exchange rates have fluctuated widely in recent years, indicating substantial short-run variation in exchange rates relative to corresponding ratios of price indexes.

Such empirical evidence, piled on top of the theoretical weaknesses noted above, discredits PPP as a theory that can be relied upon to provide accurate predictions of exchange-rate behavior in the short run. Predictions confidently held about relative movements in national price levels over short time horizons (up to several years) cannot be translated into predictions confidently held about movements in corresponding exchange rates. This does not imply, however, that PPP has no predictive usefulness. Over periods of time long enough for ratios of national price indexes to change radically, PPP may have considerable validity.[3]

2.2 *A Popular Balance-of-Payments View*

The notion that exchange rates move to equilibrate supplies of and demands for currencies, and hence to bring balance to international payments, goes back at least as far as the mid-1600s.[4] As a general statement, this view is uniformly accepted by economists today. Few economists, however, subscribe without qualification to the popular notion that increases in a country's trade or current-account deficit are likely to lead to exchange-rate depreciation.

This notion, here labeled the "popular balance-of-payments view," received nourishment during the Bretton Woods regime of adjustable pegs. During that regime, official permission or pressure to adjust exchange rates was predicated on the occurrence of "fundamental disequilibrium," which for practical purposes became associated with the occurrence of persistent current-account imbalances. Thus, the Bretton Woods Agreement sanctioned, and thereby induced, a correlation between current-account imbalances and subsequent changes in exchange rates.

The popular balance-of-payments view can also be related to an invalid application of the elasticities approach to modeling the balance of payments. Typically, that approach takes the capital account to be predeter-

[3] During the German hyperinflation, for example, relative-price movements swamped all other influences on German exchange rates (see Frenkel, 1976).

[4] Einzig (1970, pp. 142-143) credits the English economist Thomas Mun for persuading his contemporaries that exchange rates are influenced by trade balances.

mined, while treating both imports and exports as functions of the exchange rate and a list of other predetermined variables. Textbook versions of the elasticities model have generally been used to determine the effect on the balance of payments of an exogenous change in the exchange rate, but an inverted form of the model can alternatively be used to analyze exchange-rate behavior in a floating-rate world. Such analysis suggests that an exogenous shift in the current account toward deficit, *ceteris paribus*, will normally lead to exchange-rate depreciation.[5]

Deletion of the word "exogenous" and the *ceteris paribus* assumption distorts this conclusion into the popular balance-of-payments view. Figure 1 shows that this distorted view has not been supported by recent data for the United States. During the past several years, swings in the U.S. trade and current accounts have largely reflected cyclical fluctuations in the relative paces of economic activity in the United States and abroad. Other things were not equal as current accounts shifted. The sharp increase in the U.S. current-account balance between second-quarter 1974 and second-quarter 1975 was accompanied predominantly by dollar depreciation, and the decrease in the U.S. current-account balance from second-quarter 1975 through 1976 was accompanied by dollar appreciation.

Such evidence should not be interpreted to suggest that current-account balances have no systematic influence on exchange rates. The correct conclusion, rather, is that the relationship between current-account balances and exchange rates is more complicated than that suggested by the popular balance-of-payments view. In particular, the effect of current-account imbalances on exchange rates depends critically on aggregate supplies and demands in the markets for financial assets denominated in different currency units. This will be elaborated in Chapter 3.

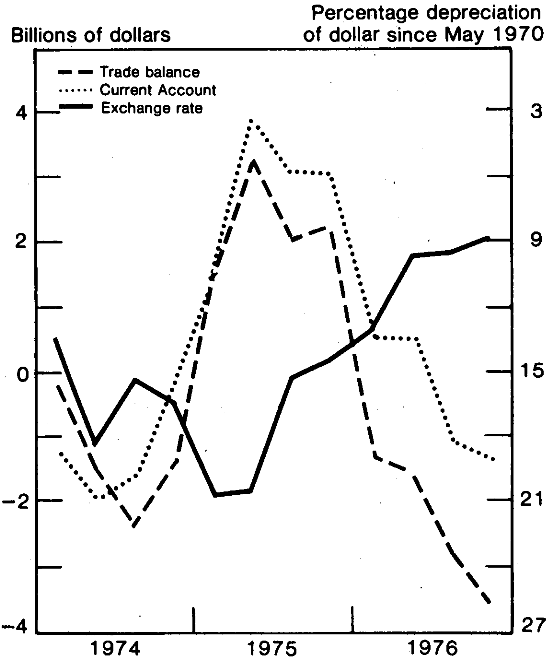
2.3 *Forward Exchange Theory*

Although rudiments appear in the 1890s (see Einzig, 1970, pp. 214-215), Keynes (e.g., 1923) is generally credited with the development of forward exchange theory, sometimes referred to as interest-rate-parity theory. Basically, this theory recognizes that asset holders have a choice between holding domestic-currency assets, which yield the own rate of interest r_d, or assets denominated in foreign currency, which yield the own rate of interest r_f. Thus, an investor with one unit of domestic currency at time 0 should compare the option of accumulating $1 + r_d$ units

[5] Here "normally" means under the stability conditions attributed to Marshall, Lerner, Bickerdike, Robinson, and Metzler (see Haberler, 1949, and Dornbusch, 1975, for elaboration).

FIGURE 1

U.S. TRADE BALANCE, CURRENT ACCOUNT, AND EXCHANGE RATE, 1974-76



Note: Quarterly data, 1974 Q1 through 1976 Q4. Merchandise-trade and current-account balances are official Department of Commerce data. Exchange rates are daily averages, for the second month in each quarter, of the Federal Reserve Board's weighted-average value of the dollar in terms of the currencies of the G-10 countries plus Switzerland.

with the option of converting spot into s units of foreign currency, investing this in foreign assets, and arranging at time 0 to convert back his principal plus interest at a forward exchange rate f (in foreign currency per unit of domestic currency) into $s(1 + r_f)/f$ units of domestic currency for delivery at the end of the interest-payment period. To the extent that investors can accumulate either $(1 + r_d)$ or $s(1+r_f)/f$ units of domestic currency with certainty,[6] arbitrageurs in pursuit of assured profit will move funds in whatever amounts are required to eliminate any discrepancies between these interest factors. Thus, interest-rate parity is a condition of asset-market equilibrium: $(1 + r_d) = s(1 + r_f)/f$, which implies

$$(f - s)/s = (1 + r_f)/(1 + r_d) - 1 = (r_f - r_d)/(1 + r_d) \approx r_f - r_d \,. \quad (2.1)$$

[6] This abstracts from political or confiscation risk and ignores both transactions costs and capital controls.