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Introduction

John F. O. Bilson and Richard C. Marston

In January 1982, the National Bureau of Economic Research held a conference on exchange rates at the Rockefeller Foundation's Bellagio Conference Center on Lake Como in northern Italy. This volume contains the fifteen papers presented at this conference on topics ranging from recent developments in exchange rate theory and policy to the empirical analysis of nominal and real exchange rates.

The theory of exchange rates has evolved quite rapidly in the last fifteen years. At the beginning of the 1970s, most economists had accepted Milton Friedman's conjecture that a system of flexible exchange rates would only be a system of unstable exchange rates if underlying economic conditions were unstable. According to this view, exchange rates would adjust to offset differences in national inflation rates, but these changes would be gradual and predictable. Even after accounting for the crisis leading to the breakdown of the Bretton Woods system and for the instability generated by higher oil prices, however, most economists by the mid-1970s agreed that exchange rates were more volatile than anticipated. Furthermore, it was clear that the existing theoretical and empirical models of the exchange rate were not capable of offering a believable description of the post–Bretton Woods experience. In the period from 1973 to 1975, economists set to work to build new theories of the exchange rate.

Some measure of the extent of this work, and of its remarkable productivity, became evident in the famous conference on flexible exchange rates and stabilization policy held in Sweden in the summer of 1975.[1] This conference witnessed the origins of not one but three new approaches to the economics of exchange rate determination: the overshooting model of Rudiger Dornbusch based on the differential speed of adjustment between the commodity and asset markets; the asset market variants of the monetary approach introduced by

1. The proceedings of the conference were published in the *Scandinavian Journal of Economics* 78, no. 2 (May 1976).

Jacob Frenkel and Michael Mussa; and the current account/portfolio approach developed by Pentti Kouri. Although each of these approaches was based on a distinct view of the way in which the exchange rate is determined, they shared an emphasis on the importance of the integration and efficiency of international asset markets for understanding exchange rate movements. Common to all three approaches was the idea that the anticipated return from holding a currency was an essential element in the determination of its value. This was an important first step in understanding the exchange rate volatility which has been such a striking characteristic of the recent period.

Since the Swedish conference, exchange rate analysis has continued to develop rapidly with interest focused increasingly on exchange rate dynamics, portfolio diversification, and current account adjustment. We asked Michael Mussa to begin the conference by surveying these developments. Three of the other contributors to the Swedish conference, Rudiger Dornbusch, Jacob Frenkel, and Pentti Kouri, served as discussants.

Mussa sets a standard for the rest of the volume with his masterful review of exchange rate theory. This review encompasses both monetary and balance of payments theories of exchange rate determination but extends both theories in interesting ways which highlight the central role played by expectations.

He begins his paper by citing five empirical regularities which have characterized recent exchange rate experience: (1) Monthly changes in exchange rates are large and almost entirely unpredictable. (2) Changes in spot rates correspond fairly closely to changes in expected future spot rates (with spot and forward rates changing together). (3) Monthly changes in nominal and real exchange rates are highly correlated. (4) There is no strong and systematic relationship between movements in nominal or real exchange rates and current account imbalances. (5) Movements in nominal and real exchange rates are not closely related to differential rates of monetary expansion. His study and those that follow in this volume help to explain many of these empirical regularities.

In order to explain both nominal and real exchange rates, Mussa specifies a full-scale model of a small open economy. If wages are flexible and real wealth effects are ignored, an economy can be dichotomized into real and monetary sectors with the monetary sector determining the nominal exchange rate and the real sector the real exchange rate (the inverse of the terms of trade). Mussa develops such a model in stages beginning with an asset market model of the nominal exchange rate. He uses this model to show how new information which alters expectations concerning future economic conditions can induce unexpected changes in exchange rates. Such unexpected changes can dominate actual exchange rate movements. Since new information often causes revision in future expected exchange rates as well as current rates, moreover, the asset market model can explain the high correlation between changes in spot and forward rates.

He organizes his discussion of the real sector around a balance of payments equation to emphasize a link to the more traditional flow model of the exchange rate. This section ties together a number of strands in the literature, from the elasticity and absorption approaches to analyzing the trade balance to the more recent analysis of foreign asset accumulation. The specification of demand behavior is general enough to encompass either the dependent economy model with traded and nontraded goods or the more traditional import-export model with specialization in each country. An important feature of the model is that both the level and the expected rate of change of the real exchange rate affect the current account (the latter through the real interest rate). Thus, as in the case of the nominal exchange rate, the real exchange rate is dependent on expected future conditions.

The combined model of nominal and real exchange rates provides a rich framework for analyzing the open economy. But because wages and prices are flexible it can explain deviations from purchasing power parity (PPP) only to the extent that disturbances originate in the real sector. Mussa therefore modifies his model by introducing price dynamics. With prices temporarily sticky, monetary disturbances can lead to temporary deviations from PPP and overshooting of the exchange rate can occur. The model is a long way from the flow models of the 1950s and the monetary models of the 1970s, but with the best of each being retained in a more general setting.

We asked the three discussants of this paper, Jacob Frenkel, Rudiger Dornbusch, and Pentti Kouri, to focus their comments on what they believed to be the main problem areas in exchange rate analysis. They responded to this challenge by describing three quite different areas in which further work needs to be done.

Frenkel discusses several difficult empirical problems which face any researcher trying to explain movements in exchange rates. The first is the "peso problem," where the forward discount on a currency reflects the expectation of some future change in the exchange rate but where in all but one period the spot exchange rate is unchanged. The forward rate may then appear to be a biased predictor of the spot rate. The second problem arises when changes in exchange rates are explained by the innovations in other variables. Since the innovations are unobservable, any empirical analysis depends on the way in which expectations, and hence the unexpected changes in variables, are modeled. Finally, Frenkel cites the difficulty in dealing with innovations when some variables are available at more frequent intervals than others.

Dornbusch cites another empirical problem, the sizable and persistent changes in real exchange rates involving the dollar. If the dollar were simply overshooting its long-run value, an appreciation should be followed by a steady depreciation. Since the dollar has instead stayed at a high level for many months, the overshooting model alone is insufficient to explain its movements. Dornbusch suggests several explanations which involve ques-

tioning the assumption of rational expectations as it is formulated in Mussa's paper and elsewhere. The first involves the possibility of speculative bubbles where the actual exchange rate can move even in a different direction than its "fundamental" value. The second involves the use of an incorrect exchange rate model for forming expectations of future exchange rates. The interesting point here is that it may be difficult for economic agents to discover the error in the model they are using because the autocorrelation in forecast errors may be too small to detect. In both cases, the exchange rate may deviate from its value based on "fundamentals," with all that that implies for trade and financial relationships.

Kouri argues that exchange rate theory has erred by focusing too much on monetary influences on the exchange rate and too little on the balance of payments flows which actually give rise to foreign exchange transactions. According to Kouri, international economists need to pay more attention to S. C. Tsiang's remarkable analysis of the forward exchange market (written in 1959) with its emphasis on how the flow transactions of traders, speculators, and arbitrageurs jointly determine the current exchange rate. This is not to deny that financial factors are dominant in determining the exchange rate. Indeed, Kouri argues that the formation of expectations and the wealth accumulation process are key elements in exchange rate determination. But the model which Kouri has in mind is quite different from the monetary models of the mid-1970s.

Following the paper on new developments in exchange rate theory, William Branson presented an analysis of exchange rate policy including an empirical section on the time series properties of exchange rates, prices, and the current account. Branson's theoretical model combines a balance of payments equation describing the accumulation of foreign assets with a model of short-run equilibrium in the asset market. The asset market is in continuous equilibrium but that equilibrium depends upon the stocks of assets and wealth in the economy; the equilibrium, therefore, changes through time as foreign assets are accumulated. The assumption of perfect foresight ties the current asset equilibrium to the future path of asset accumulation.

For the asset model Branson assumes imperfect substitutability between domestic and foreign bonds. As a result he can distinguish three types of financial operations: open market swaps of domestic bonds for money, exchange market intervention involving swaps of foreign bonds for domestic money, and sterilized intervention involving the swap of foreign bonds for domestic bonds. Branson suggests ways in which these operations can be used to modify the jump movements in exchange rates which follow unanticipated disturbances. In the case of a monetary disturbance, for example, the initial depreciation of the exchange rate could be limited by a discrete open market operation, with the specific form of the policy intervention depending upon whether the disturbance is permanent or not and upon the speed of price adjustment. In the case of a real disturbance, the policy action

could involve the money supply or other asset supplies reacting to unantici-
pated changes in exchange rates, with the authorities leaning against the
wind through their intervention.

Since policy actions can take a variety of forms, determining how policy
has been pursued in practice is a difficult empirical problem. Branson tack-
les this problem by using vector autoregressions to obtain the innovations
in exchange rates and other variables, then investigating the correlations
among these innovations. (A typical vector autoregression relates the United
States effective exchange rate to lagged values of that exchange rate, relative
prices weighted the same way as the exchange rate, as well as the United
States money supply, current account balance, interest rate, and foreign ex-
change reserves.) He draws inferences from these correlations about the ex-
tent of policy intervention in each of four industrial countries. The results
are quite interesting. The theoretical model predicts, for example, two alter-
native relationships between unanticipated changes in exchange rates and
money supplies: a positive correlation if changes in money supplies lead to
changes in exchange rates (even if moderated by intervention) and a nega-
tive correlation if changes in exchange rates induce "leaning against the
wind" monetary policy. The empirical results suggest a distinct pattern of
policy reactions ranging from the domestic-oriented monetary policy of the
United States (where changes in the money supply appear to drive changes
in exchange rates) to the exchange-rate-oriented monetary policy of Ger-
many and the United Kingdom.

Willem Buiter, in his comment on Branson's paper, describes several ex-
tensions of Branson's model which might alter behavior significantly. With
lagged price adjustment, for example, the response to real disturbances
could involve cyclical patterns rather than the monotonic pattern described
in the paper. Similarly, with output endogenous, asset demands would re-
spond directly to the level of transactions, thus altering the dynamic path
toward equilibrium and possibly reversing the usual overshooting pattern.

Branson's empirical analysis comes under criticism both from Buiter and
from Peter Kenen, the second discussant. Buiter questions Branson's choice
of lag lengths based on univariate correlations, giving an example where
such a procedure could lead to the omission of important variables. More-
over, he shows how difficult it is to draw inferences from correlations
among variables without having strong priors on the signs of structural co-
efficients. Kenen focuses on the problem of explaining exchange rates in a
multicountry world. Theoretical models, including Branson's, almost invar-
iably describe small economies with but one exchange rate vis-à-vis the
"foreign currency." Empirical models typically describe bilateral exchange
rates of similar-sized countries or, in Branson's case, effective exchange
rates for one large country relative to the rest of the world. Kenen gives
several examples illustrating why the single country approach might be
seriously misleading in empirical applications.

The second session of the conference provides further insight into the current state of empirical work on exchange rates. The paper by Robert Cumby and Maurice Obstfeld represents the best of one empirical tradition based on conventional econometric techniques, while the papers by Hans Genberg and John Bilson offer new approaches which explicitly reject traditional econometric methods in favor of time series analysis. Genberg analyzes the correlation between the innovations in exchange rates, while Bilson (like Branson in the second session) analyzes vector autocorrelations for exchange rates and other variables.

The Cumby-Obstfeld paper provides a series of sophisticated tests of three basic parity relationships, purchasing power parity and two versions of interest rate parity for nominal and real interest rates, respectively. The results are quite decisive in rejecting each of these parity relationships over the recent period. This evidence is important because most theoretical models of exchange rates rely on one or more of these parity relationships. Once the parity relationships are rejected, however, it is not at all clear how researchers should proceed. Some have sought to estimate alternative (structural) models of the exchange rate allowing for deviations from the parity relationships. Jeffrey Frankel's paper, which was presented in the next session, is in that tradition. Genberg and Bilson prefer instead to draw inferences on the basis of the time series properties of financial variables alone.

Genberg's paper makes imaginative use of data for the innovations in spot and forward rates. He posits a model of the process generating these rates, while remaining uncommitted about the variables in this process. He draws inferences from the term structure of innovations about the specific form of this process. He then specifies an autoregressive process generating the money supply and shows that there is a high correlation between the autoregressive parameter in this process and the pattern of exchange rate innovations. This interesting evidence is consistent with a simple monetary model of the exchange rate, although it is likely that more complex models of the exchange rate could equally well generate such patterns.

Overshooting of the exchange rate may occur in Genberg's model, but such overshooting can be attributed to the time series properties of the underlying variables driving the exchange rate rather than to any nominal rigidities in the economy. Bilson, in contrast, analyzes a simplified form of Dornbusch's celebrated overshooting model based on price rigidities. He does not attempt to estimate this model, but instead examines the time series properties of two financial variables, exchange rates and interest rates. The Dornbusch model offers two testable hypotheses regarding these variables: (1) negative contemporaneous correlation between the exchange rate and the domestic interest rate series and (2) negative autocorrelation within both series. Bilson examines both hypotheses using vector autoregressions. The results are mixed, but the specific form of the Dornbusch model is decisively rejected.

At the same time that the macroeconomic literature on exchange rates was developing, a quite distinct literature emerged on the microeconomics of portfolio choice under uncertainty. In the third session of the conference, the paper by Jorge de Macedo, Jeffrey Goldstein, and David Meerschwam showed how far this literature has progressed. Their paper derives an optimal portfolio for a "national investor." one who deflates returns by the consumer price index of a particular nation, and an "international investor" who uses a weighted average of many countries' CPIs as a deflator. The framework is quite general with asset prices as well as the CPIs treated as stochastic. They decompose the optimal portfolio into three elements, the first two of which constitute the minimum variance portfolio: a capital position, a (zero net worth) inflation hedge, and a (zero net worth) speculative portfolio. The empirical section then provides estimates of each of these portfolios. One particularly interesting result is the high percentage of the minimum risk portfolio invested in the national asset by investors from each country. This result indicates what an inhibiting influence exchange risk has on international portfolio diversification.

In the second paper of the session, Jeffrey Frankel estimates a variety of structural models of the exchange rate ranging from the flexible and sticky price versions of the monetary approach to portfolio models derived from microeconomic behavior. But he finds all of them wanting. The failure of monetary models has been attributed to many factors, including shifts in money demand and in the long-run terms of trade, as well as to changes in risk premiums. But, as Frankel observes, shifts in money demand and the terms of trade are more a manifestation than an explanation for the failure of the monetary models. As for risk premiums, Frankel shows that portfolio models fare as poorly as do the monetary models in explaining the exchange rate. The picture that emerges from his and other studies is a bleak one. Even though parity relationships are decisively rejected in studies like that of Cumby and Obstfeld, we have yet to replace them with structural models which fit recent exchange rate experience.

In the last paper of this session, Paul Krugman attempts to clarify many of the puzzling features of an international currency. According to Krugman, the importance of economies to scale explains why one currency may become the dominant international currency. Which currency assumes this role depends on a number of factors difficult to quantify, but once a currency becomes dominant its use may persist long after the factors responsible for its emergence have changed. Krugman shows how unstable a currency's position is in such a case. Some event may then precipitate the wholesale substitution of that currency for another with potentially disruptive effects on the financial system during the transition period.

Recent models of the exchange rate generally fall into two categories, those that focus on traded goods differentiated by country and those that have only one traded good but focus on the interaction between that good

and a nontraded good specific to the country. Louka Katseli, in contrast, provides a general framework for analyzing both nontraded goods and differentiated traded goods. This framework is essential for the purpose at hand, which is to study competitiveness in the major industrial countries. But it is also very useful for showing how tenuous are many of the conclusions based on one or the other model alone. Katseli distinguishes between measures of the real exchange rate associated with the two models. When there are differentiated traded goods, the real exchange rate is naturally defined as the inverse of the terms of trade, while in models with nontraded goods, the real exchange rate is defined as the relative price of traded to nontraded goods. Katseli provides a comparative analysis of each of these series which shows just how much they vary relative to one another. This is followed by an extensive empirical analysis of the time series properties of prices and exchange rates from which inferences are drawn about the adjustment process.

In the second paper of this session, Francesco Giavazzi and Charles Wyplosz investigate the real exchange rate in a different type of model where the dynamic adjustment to a long-run steady state is explicitly analyzed. They actually specify two different models, both of which illustrate two important properties of dynamic models: the multiplicity of steady states and the dependence of the long-run equilibrium on the adjustment path. The second property is particularly interesting. In many models of the exchange rate, such as Dornbusch's overshooting model, the impact effects of disturbances depend on the speed of adjustment. The steady state properties typically are unaffected by the characteristics of the adjustment path. Giavazzi and Wyplosz, however, show in two different models, which illustrate the adjustment of capital and labor, respectively, how the parameters which set the speed of adjustment of the model have a permanent effect on the economy.

In the fifth session of the conference, on foreign exchange intervention, Dale Henderson offers a comprehensive and definitive assessment of intervention which incorporates recent insights into the role of policy under rational expectations. He uses a stochastic two-country model to analyze two types of foreign exchange intervention: (1) nonsterilized intervention where one country's money supply is increased and the other's is decreased and (2) sterilized intervention where relative bond supplies are varied. The second type of intervention is effective as long as the two countries' bonds are imperfect substitutes, and is the optimal form of intervention in the presence of portfolio shifts between these bonds. For other types of disturbances, Henderson compares two types of policies: an aggregates-constant policy where all asset supplies are held fixed and a rates-constant policy where interest rates and the exchange rate are held fixed. The results are reminiscent of those obtained by Poole for a closed economy. If disturbances in the market for the home good predominate, an aggregates-constant policy

results in less variation in employment than a rates-constant policy. The opposite is the case in the presence of financial disturbances. Henderson goes on to expand this analysis to consider the effects of indexation and of contemporaneous feedback rules. The section on feedback rules is particularly interesting: If the authorities can base their intervention policy on whatever partial information about current disturbances they can glean from financial variables, then output variability can be reduced below that of either regime discussed above.

In the second paper of this session, Richard Marston examines intervention in a three-country setting where flexible rates are compared with an exchange rate union between two of the countries. As in Henderson's analysis, the desirability of a union depends upon the types of economic disturbances (monetary or real) typically encountered as well as the sources of the disturbances (domestic or foreign). But equally important are the degrees of wage indexation at home and abroad and the relative importance of trade between the potential partners in a union. These are factors which had figured in informal discussions of exchange rate unions but had never been formally analyzed before. The analysis of these factors yields several counterintuitive results which show how difficult it is to make an unambiguous case for a union. The case for a union is not necessarily stronger when the home country trades primarily with other countries in the union, nor is it necessarily stronger when disturbances originate primarily outside the union. In each case, the variability of output, for at least some disturbances, is greater in the union than under flexible rates.

The European Monetary System, which ties together the mark, franc, lira, and other European currencies, is the foremost example of an exchange rate union. Giorgio Basevi and Michele Calzolari estimate a multilateral model of exchange rates to analyze this union. The model is a multicountry version of Dornbusch's sticky price model with equations for the demand for money, aggregate demand, and a modified Phillips curve. The countries studied are Germany, France, and Italy (all members of the EMS), the United Kingdom, and the United States. This model is to be used in future work to analyze monetary policy within the EMS as well as the effects of shocks originating outside the EMS (for example, in the United States) on countries in the system.

One such shock which has dominated policy debates in the past few years is the shift toward monetary restraint in the United States beginning in 1980. The problems which this shift in policy caused for one major European country, the Federal Republic of Germany, are the subject of Jacques Artus's paper in the last session of the conference. Artus uses an econometric model of the German economy to trace the effects of United States policy on the DM/$ rate and macroeconomic conditions in Germany. Simulations of this model show that the impact of United States monetary policy depends crucially on whether or not other countries keep their real exchange rates

constant vis-à-vis the dollar. Even more important, however, is the monetary policy response of the German authorities. If German money growth remains unchanged, the depreciation of the mark causes a significant increase in the German inflation rate. Alternatively, if the German authorities match United States monetary restraint with an equivalent policy, German output declines sharply, basically because in Artus's model nominal wages are slow to adjust. The simulations thus graphically describe a policy dilemma facing the German authorities: they can choose between higher prices or lower output through their choice of intervention policy.

The second paper in this session, by Stanley Black, investigates the link between methods of monetary control adopted in the leading industrial countries and exchange rate regimes. In general, countries choosing to control credit directly also prefer pegged exchange rates, while those relying on control of bank reserves typically adopt floating exchange rates. Black describes in detail why countries with credit controls often require extensive foreign exchange controls to prevent access to foreign loans from undermining credit measures. And if interest rates are also controlled, credit rationing is needed to limit the demand for loans to the available supply. In such a country, pegged exchange rates are a natural extension of this panoply of controls on financial transactions.

The view of exchange rates which emerges from this volume is markedly different from that of Milton Friedman and others prior to 1970. Many theoretical and empirical puzzles remain to be resolved, no doubt, but we believe this volume is an accurate reflection of the high quality and breadth of recent research on exchange rates.

The success of the conference owed much to the strong encouragement and support given by the director of the International Studies Program at the NBER, William Branson. We owe a deep debt of gratitude to the Ford Foundation for committing itself to the project at an early stage and to the Rockefeller Foundation for providing such an elegant setting, surrounded by the Italian and Swiss Alps, for contemplating exchange rates.