ON COST-PUSH THEORIES OF INFLATION IN THE PRE-WAR MONETARY LITERATURE*

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Recent discussions of inflation have been dominated by two opposing views. On the one side are the *monetarists,* who argue that the basic cause of inflation is excessive monetary growth, i.e., a rate of increase in the money stock substantially in excess of the rate of growth of real output. Competing with the monetarist interpretation is the so-called *cost-push* view, which attributes inflation to a host of non-monetary supply-oriented influences that raise costs and hence prices. Although modern cost-push theorists do recognize the importance of the monetary factor, they generally relegate to monetary growth the passive or accommodating role of ratifying cost increases in order to maintain high levels of production and employment. In the 1950's and 1960's cost-pushers emphasized union wage pressure and monopoly (administered) pricing policies—both underwritten by expansive monetary and fiscal policies—as the principal causes of inflation. Other frequently mentioned sources of cost inflation included the competitive struggle for relative income shares, labor and capital immobilities (and the associated wage/price rigidities), job-information deficiencies, and "ratchet effects" stemming from the downward inflexibility of specific prices to shifts in the composition of demand. Most recently, cost-pushers have blamed so-called *special factors,* i.e., such random non-monetary shocks as crop failures, commodity shortages, and the OPEC-administered increase in the price of oil, for causing the surge of inflation to double-digit levels in 1973 and 1974.

In the course of the debate over inflation, it has become commonplace to refer to cost-push explanations as being of relatively recent origin. More than one analyst has stated that such theories extend back no further than the end of World War II and that they did not begin to flourish until the mid-1950's. Thus, for example, Professor William G. Bowen in his well-known essay "Wage Behavior and the Cost-Inflation Problem" writes that

> The role of wage behavior in the inflationary process has been one of the most hotly debated issues of the post-war years . . . . This is a new development. Prior to the end of World War II most discussions of inflation paid little, if any, attention to wage determination. Inflation was analyzed mainly in terms of changes in the stock of money and in aggregate spending relative to the supply of goods and services . . . . When World War II ended . . . economists in many Western European countries and in the United States began to speak of a 'new' type of inflation, commonly referred to as 'cost inflation.' [2; pp. 78-9]

Similarly, Professor George Leland Bach, in a recent book entitled, significantly enough, *The New Inflation,* states that

> a half century ago . . . most economists saw inflation as basically the result of excessive spending . . . generally based on an excessive creation of money . . . . More recently . . . these beliefs have been challenged. Certain economists see a new inflation—one caused by big unions pushing up costs and big businesses pushing up prices, with or without an excess of total spending. [1; p. 7]

The purpose of this article is to show that the foregoing interpretations are wrong; that, far from being new, cost-push theories were widespread in the 1800's and early 1900's; that such theories were thoroughly analyzed, and in some cases sharply criticized, by such leading neo-classical monetary theorists as Knut Wicksell, Irving Fisher, J. Laurence Laughlin, and John Maynard Keynes (of the *Treatise,* not of the *General Theory*); and, finally, that many of the issues in current and recent debates between cost-pushers and monetarists appeared in the earlier literature dealing with inflation.

The Role of Cost-Push Theories in Classical Monetary Debates Although the main focus of this article is on the neo-classical analysis of cost-push theories, it is not inappropriate to point out

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that such theories predate the neo-classical period. For example, long before Wicksell and Fisher began to write on monetary questions in the late 1800's, cost-oriented explanations of inflation and deflation had already played prominent roles in the three leading monetary controversies of the nineteenth century, namely, the Bullionist, Currency-Banking, and Bimetallism debates.

The first of these controversies concerned the rise in the price of gold and silver bullion, foreign exchange, and commodities in Britain following the suspension of the gold standard during the period of the Napoleonic wars. Like modern monetarists who locate the source of inflation in the central bank, the Bullionists blamed the price increases on excessive monetary expansion by the Bank of England. Their opponents, the Anti-Bullionists, rejected this monetary explanation, attributing the price and exchange rate movements instead to non-monetary causes, notably domestic crop failures, the wartime disruption of foreign trade, and to heavy military outlays abroad. [4; p. 28] The Anti-Bullionists, moreover, laid particular stress on influences directly affecting the prices of individual commodities or groups of commodities, especially grains and other staple foodstuffs. Here is the essence of the cost-push view that general price disturbances stem from non-monetary influences that cause a series of changes in the individual prices of key commodities.

Other cost-push propositions that surfaced during the Bullionist debate include the notions of passive money and reverse causation. The former states that the money stock is an endogenous variable that responds passively to shifts in the demand for it. The latter holds that the channel of influence or direction of causation runs from the level of economic activity to money rather than vice versa. Both ideas appeared in the Anti-Bullionists' real-bills doctrine according to which the stock of money would never be excessive as long as it was issued only against bills of exchange arising from real transactions in goods and services. Here is the origin of the view that the stock of money is demand determined and therefore exerts no independent influence on prices and, moreover, that monetary growth is the result—not the cause—of increases in spending and economic activity.

The second debate in which cost-push theories played a leading role was the Currency-Banking controversy over the principles of regulating the banknote issue as embodied in the celebrated Bank Charter Act of 1844. In opposition to the quantity theory reasoning of the Currency School, leaders of the Banking School, particularly Thomas Tooke, developed non-monetary theories of price movements. Sir T. E. Gregory, in his *Introduction to Tooke and Newmarch's A HISTORY OF PRICES* (1924), writes that Tooke had an intense "preoccupation with the special factors influencing particular prices" which enabled him "to take full account of particular [price] variations" while simultaneously rejecting "the rigid connection between the quantity of money and the state of the price level postulated by the Currency School . . ." [9; p. 21] This preoccupation with special factors influencing particular prices continues to be typical of current cost-pushers, who attribute the rampant inflation of 1973 and 1974 to such random shocks as crop failures, the disappearance of anchovies off the coast of Peru, and the OPEC-imposed quadrupling of the price of oil.

Tooke, in his own version of the cost-push theory, stated that general prices were determined by *factor incomes* (wages, rents, profits, etc.) and not by the quantity of money. He did not explain how these price-determining factor incomes themselves were determined but left the question of their origin open to a variety of possible interpretations. His theory of price inflation is therefore suggestive of recent wage-cost-push and structural theories that (1) link inflation to some arbitrary non-monetary element in the institutional environment, e.g., autonomous increases in wage incomes, production bottlenecks, particular supply inelasticities, institutional price rigidities, etc., and (2) stress the inflationary role of the competitive struggle for relative shares in the national income. In any event, since factor incomes are simply the sum of factor service prices, it is obvious that Tooke came perilously close to explaining prices in terms of prices.

Other cost-push doctrines enunciated by the Banking School include the notions of a passive demand-determined money supply and the existence of reverse causation running from income to money rather than vice versa. These notions were embodied in the real-bills doctrine to which the Banking School, like its Anti-Bullionist predecessors, adhered.

Cost theories competed again with the quantity theory during the Bimetallism controversy over the proposed monetization of silver in the latter decades of the nineteenth century. Using the quantity theory, Bimetallists explained the secular price deflation of 1873-1896 as the failure of the money stock to grow as fast as real output. Supporters of the gold standard, however, adhered to cost theories of deflation.

Professor W. W. Rostow, in his *British Economy of the Nineteenth Century* (1948), has summarized these cost-push views. Gold monometallists, he writes,

> . . . mustered enormous evidence attesting to new methods and machines, cheapened transport costs, new raw material sources, and increased competition. They tended to deprecate the alleged monetary forces. They insisted, in short, that individual cost curves had fallen far and shifted to the right: that the average cost of producing a given output had decreased, and that diminishing returns —rising marginal costs—set in at a further point, requiring a higher level of demand to yield rising prices. They found in the case of each market no residual movement to be explained after its unique conditions were examined. No monetary factor was required. Their motto might have been . . . 'Gold has behaved very well.' [15; p. 60]

This completes the review of the role of cost-push theories of price movements in nineteenth century classical policy debates. The following paragraphs consider what such leading neo-classical monetary theorists as Wicksell, Laughlin, Fisher, and Keynes —all writing between 1896 and 1930—had to say about cost-push analysis.

Neo-Classical Views of Cost Inflation: Knut Wicksell Even a cursory examination of Wicksell's work shows how erroneous is the view that cost theories of inflation and deflation are of recent vintage. Thus, in Chapter 3 of his *Interest and Prices* (1898) he refers to such theories as already being "so widespread" that merely to question them "would seem almost paradoxical." He proceeds to describe how these theories have been used to explain "the fall of commodity prices during recent decades."

> The decrease in the cost of production of commodities, the improvements in transport, etc., are often put forward without further explanation as independent causes of the fall in commodity prices . . . . It is as though this kind of explanation replaces every other theory of the value of money. The reasoning is somewhat as follows: Technical progress results in a fall in the cost of production, and so in the price, first of one group of commodities, then of another. The extension of this fall in price to all, or to most, groups of commodities means a fall in the general level of prices . . . . [17; p. 25]

Conversely, when inflation is the problem,

> an explanation is looked for (as in the case of Thomas Tooke and his followers) in bad harvests, in an increase in the demand for particular commodities of which the supply remains unaltered, and in the effect of tariffs and indirect taxes in raising the prices of such commodities. [17; pp. 25-6]

Elsewhere he cites additional "alleged causes of a rise in prices" in which cost-pushers "take refuge." These include "the supposed screwing up of prices by cartels and trusts, the greed of middlemen, trade union claims for higher wages, etc." [18; p. 154]

Wicksell commented extensively on the monetary assumptions underlying cost-push theories. He stated that cost-push models are incapable of generating sustained inflation without an accommodating expansion in the money stock. In his words, inflation "can never be governed by the conditions of the commodity market itself (or of the production of goods)." Rather, it is "in the relations of this market to the *money market*" that one finds the causes of inflation. [17; p. 24] In short, cost-pushers must implicitly assume that cost increases will be automatically validated by permissive expansions of the money stock. As Wicksell put it, cost-push theories typically regard money "as a kind of amorphous, infinitely elastic, or plastic mass which adapts itself without any pressure to any price level and is therefore entirely passive in relation to the pricing mechanism, whilst the latter is regulated only by circumstances concerning the commodities themselves." [18; p. 154] Cost-pushers, he claims, have become so accustomed "to seeing in the modern credit and banking system a means of satisfying any demand whatever on the part of society for a medium of exchange that they cannot conceive of money influencing prices in one direction or the other." [18; p. 154]

Another feature of cost theories, noted by Wicksell, is their tendency to attribute macroeconomic phenomena to microeconomic causes. As Wicksell put it, "The same causes . . . cited to account for a rise or fall in the price of *any single commodity* are put forward . . . as the source of changes in the general level of prices." [17; p. 26]

Wicksell's criticisms of cost-push theories sound remarkably like those of modern monetarists. Cost-push reasoning, he says, "contains an inadmissible generalization; for arguments which are valid only when it is a matter of relative prices are applied to a field in which they no longer possess any meaning, i.e., to the absolute prices of commodities, expressed in money." [18; p. 154] Moreover, cost-pushers tend to ignore the possibility that, with the money stock and total spending both constant, cost-induced rises in the prices of specific commodities may be offset by compensating reductions in the prices of other items. For example, such cost-raising influences as

> Import duties and taxes on consumption undoubtedly lead to higher prices of the commodities so taxed, but it is by no means certain that other goods will remain unchanged in price and that therefore the general price level will rise. In any case, there is nothing to prevent the possibility of a simultaneous pressure on and fall in the prices of other goods—as the Quantity Theory would lead us to suppose—so that the average price level would remain unchanged unless there existed some monetary cause for the change. [18; p. 156]

These same allegations—the confusion between relative vs. absolute prices, the failure to distinguish between specific prices and the average level of prices—continue to survive and flourish in modern monetarist criticism of cost-push reasoning. Thus Milton Friedman, commenting on the alleged source of the double-digit inflation of 1973-74, writes

> What of [the rise in the prices of] oil and food . . . ? Are they not the obvious immediate cause of the price explosion? Not at all. It is essential to distinguish changes in *relative* prices from changes in *absolute* prices. The special conditions that drove up the prices of oil and food required purchasers to spend more on them, leaving less to spend on other items. Did that not force other prices to go down or to rise less rapidly than otherwise? Why should the *average* level of all prices be affected significantly by changes in the prices of some things relative to others? Thanks to delays in adjustment, the rapid rises in oil and food prices may have temporarily raised the rate of inflation somewhat. In the main, however, they have been convenient excuses for besieged government officials and harried journalists rather than reasons for the price explosion. [8; p. 73]

The basic source of inflation, Friedman contends, "is the faster growth in the quantity of money than in output." [8; p. 73] Neither Wicksell nor Friedman mentions a point emphasized by modern cost-pushers, namely, that with zero monetary growth and sticky (i.e., downwardly inflexible) prices, particular price increases will tend to generate compensating reductions not in other prices but rather in output and employment. Given the government's high-employment objectives, however, such outcomes, cost-pushers argue, will not be permitted to occur. Instead, specific price increases must necessarily be accommodated by whatever monetary expansion is required to maintain output and employment at high levels. Thus, the political constraints imposed by the commitment to full employment enter directly into the process by which individual price increases are translated into general inflationary pressures.

J. Laurence Laughlin If Wicksell was one of the harsher critics of the cost-push theory, then surely one of its strongest proponents was J. Laurence Laughlin, the first chairman of the Department of Economics of the University of Chicago. Today Chicago is identified with the quantity theory. At the turn of the century, however, it was a citadel of anti-quantity theory doctrine with Laughlin as chief expositor of that doctrine.

Laughlin stated his views on inflation first in an article in the 1909 *Journal of Political Economy* and again at the 1910 meetings of the American Economic Association in a session dealing with the causes of rising prices between 1896 and 1909. He starts out by rejecting the monetarist explanation of inflation.

> The old [quantity] theory of Ricardo and Hume no longer holds undisputed sway . . . . There can be no question that the causes for the remarkable rise in prices . . . cannot be looked for in those influences directly affecting gold [i.e., money]. [11; pp. 257, 263]

Instead, the causes of inflation "must be sought in the [real] forces settling particular prices." [12; p. 178] These forces include "progress of invention and increased skill of management, . . . increased wages, higher cost of materials, higher customs-duties, and monopolies, or combinations." [11; pp. 265-6]

Laughlin described several distinct types of cost-push mechanisms, namely, (1) wage-push, (2) administered pricing, and (3) commodity shortages. His description of wage-push, quoted below, highlights the role of ratchet effects and unilateral wage-setting by trade unions. Both phenomena imply the existence of a substantial degree of monopoly power in the labor market. Curiously enough, however, unionized workers constituted only about 6 percent of the labor force when Laughlin wrote the following:

> . . . there has been a marked advance in wages. [Thus] one of the main elements entering into the expenses of production of all kinds of goods has risen in cost, and had its effect in raising prices . . . . Once that a high rate of wages has been granted, it is not easy for employers to force a reduction . . . . The question is . . . whether the rise of wages is one of the causes of the rise of prices or whether the rise of prices has made possible the rise of wages . . . . There seems to be an influence independent of prices which has acted to raise the rate of wages. And this influence undoubtedly is due . . . to the pressure of labor-unions, which have been very active in recent years. [11; pp. 268-9]

Laughlin did not stop at wage-push. Describing the types of inflation stemming from monopoly administering pricing, Laughlin said that "the formation of combinations is unquestionably the strongest force in this period working for higher prices." [11; p. 270] "The whole *raison d'etre* of monopolistic

combinations is to control prices, and prevent active competition. As every economist knows, in the conditions under which many industries are today organized, expenses of production have no direct relation to prices." [12; p. 185]

A third type of cost inflation cited by Laughlin is that due to raw material shortages and crop failures. Commodity shortages affect the rate of inflation directly and also indirectly through their feedback into wage demands. With reference to the latter, Laughlin remarked that the increased price of food resulting from crop shortages "wipes out all the gains of previous increases of wages, and drives laborers to repeat their demands for higher pay, thus working again to increase expenses of production." [12; p. 184]

Irving Fisher The most influential American critic of cost-push doctrines in the pre-war period was Irving Fisher, America's leading quantity theorist. Fisher's comments on cost-push theory are contained in many of his monetary works including his classic *The Purchasing Power of Money* (1911), his remarks at the 1910 AEA session on the causes of inflation, and his *Stabilizing the Dollar* (1920).

Fisher criticized cost-push theories on at least four grounds. First, he argued that such theories often fail to distinguish between changes in relative prices and changes in absolute prices. The result is confusion, with cost-pushers erroneously ascribing real or microeconomic causes to what is essentially a monetary or macroeconomic phenomenon. In Fisher's own words, cost-pushers "have seriously sought the explanation of a general change in price levels in the individual price changes of various commodities considered separately. Much of their reasoning goes no farther than to explain one price in terms of other prices." [5; p. 176] Elsewhere he listed 41 frequently cited non-monetary causes of inflation and noted that "while some of them are important factors in raising particular prices, none of them . . . has been important in raising the general scale of prices." [6; p. 11] Fisher pointed out that "no explanation of a general rise in prices is sufficient which merely explains one price in terms of another price." [6; p. 14]

Second, Fisher argued that anything that affects the price level must do so through changes in the stock of money, its velocity, or the volume of transactions: if these magnitudes remain constant, the price level cannot change. There is no reason to believe that changes in the specific prices of unionized labor or monopoly products will affect these macroeconomic variables. Therefore, if "trade unions seek to raise prices of labor while trusts raise prices of commodities," the general price level "cannot change." [5; pp. 179-80] The individual prices of union labor and monopoly products might rise, to be sure, but these changes in particular "parts of the price level may occur only at the expense of opposite changes in other parts." [5; p. 180]

Fisher's third criticism referred to the tendency of cost-pushers to resort to ad hoc explanations stressing temporary disturbances, random events, and other special factors. He termed this practice "the error of selecting special cases," and he argued that because such alleged causes of inflation occur only sporadically, are short-lived, and affect only a limited range of commodities they could not explain a sustained rise in the level of all prices. As he expressed it, "special causes working on selected commodities" would not "be general enough to explain the concerted behavior of . . . changes in the *general* scale or level of prices." [6; p. 16] Only excessive monetary growth could account for sustained inflation, or as he put it, "in almost all great and prolonged price movements the chief factor is the quantity of money." [6; p. 52]

The fourth reason for Fisher's opposition to cost-push theories was his belief that they would lead to inappropriate policies, including price controls and incomes policies. Such "vicious remedies," he argued, "are often not only futile, but harmful." [6; pp. 75, 60] He further stated that although incomes policies focus directly on "the problem of the size of our incomes," they are also "expected to solve the second problem too," i.e., the problem of inflation. Unfortunately, however, incomes policies cannot reduce inflation, and the inevitable result is that "disappointment follows their application." In short, "unless a genuine solution" to inflation is found, "a bewildered and infuriated public is apt to keep on trying every sort of alleged remedy, good, bad, or indifferent, often with disastrous results." [6; p. 81]

Finally, mention should be made of Fisher's 1926 contribution—only recently rediscovered [3]—to a topic that is central to current debates between monetarists and cost-pushers. The subject, of course, is what is now known as the Phillips curve trade-off between inflation and unemployment. Using analytical techniques that, in econometric sophistication, rival all but the very latest work in the Phillips curve, Fisher discovered a strong inverse relation between the inflation rate and the level of unemployment. [7] He attributed this relation to the tendency for busi-

ness receipts to rise faster than expenses at the beginning of an unanticipated inflation. He suggested, however, that the trade-off was temporary and would vanish in the long run. Fisher thus became the first economist to distinguish between the short-run downward-sloping Phillips curve and the long-run vertical curve.

J. M. Keynes Cost-push theorizing was not limited solely to Swedish and American economists during the pre-war era. In Britain, John Maynard Keynes formulated a cost-push theory in his *Treatise on Money* (1930). At that time, of course, he still considered himself a neo-classical economist and a member of the Cambridge school with a tradition extending back at least to Alfred Marshall.

In the *Treatise* Keynes distinguished between two types of inflation: (1) profit inflation and (2) income inflation. The first refers to what today is popularly termed demand-pull inflation, i.e., a rising price level propelled by an excess monetary demand for the economy's available output. The second, however, refers to pure cost-push inflation characterized by autonomous (or in Keynes's words, "spontaneous") increases in wages and prices owing chiefly to "the powers and activities of Trade Unions." [10; pp. 167-8]

Keynes's analysis contained at least two contributions that presaged several post-war developments in the theory of inflation. First, he discussed the relationships among wages, prices, and productivity within a framework very similar to the so-called *price equation*, $p = w - q$, employed in modern cost-push models, where p, w, and q represent the percentage rates of change of prices, wages, and productivity, respectively. Second, he discussed the problem of combatting cost- or supply-induced inflation with demand-management weapons, i.e., monetary policy. Included in this latter discussion, incidentally, is a rudimentary treatment of the targets-instruments problem, in which Keynes pointed out that the simultaneous stabilization of prices, wages, and the foreign exchange rate is contingent upon the authorities' having possession of the requisite instruments of control.

Concluding Comments This article has concentrated on the cost-inflation analyses of four leading neo-classical monetary theorists whose work is representative of much of the monetary research conducted in the pre-war period. In doing so, the article has no doubt neglected numerous other economists who also discussed cost-push inflation in the pre-war era. For example, nothing was said about Gardiner Means's work in the 1930's on administered pricing [13], nor of F. C. Mills's analysis of rigidities in the structure of individual prices. [14; pp. 31-2] Both of these studies, of course, had important implications regarding the impact of autonomous increases in costs on price level movements. Nor was mention made of the statistical studies of Carl Snyder, studies that purported to show that over long periods of time all prices undergo roughly equiproportional changes, thus preserving the secular stability of price relationships. Snyder concluded from his findings that movements in the entire set of commodity prices could not be explained by real disturbances that cause random changes in relative prices, but that such price movements must be attributed to changes in the money supply, which affected prices as a whole. [16]

Nevertheless, the evidence presented is sufficient to provide strong support for the main contention of the article, namely, that cost-push theories, far from being of recent origin, were thoroughly and repeatedly discussed in the pre-war monetary literature. This is not to say, however, that the older and modern theories are identical. On the contrary, modern cost-push doctrine contains a crucial element missing from the older version, namely, the concept of *validation*. The term validation refers to the policy reactions of authorities committed to the goal of high employment. According to the validation doctrine, widespread price inflexibility and the growing public concern over unemployment exert pressure on the policy authorities to validate cost increases with expansive monetary-fiscal policies, thereby transforming specific price increases into generalized inflation. Still, many other contemporary cost-push propositions and criticisms—e.g., the inflationary impact of unions, monopolies, and commodity shortages; the emphasis on price rigidities and noncompetitive market behavior; the appeal to exogenous shocks or special factors; the role of passive monetary growth in accommodating cost increases; the alleged trade-off between inflation and unemployment; the problem of fighting supply-oriented inflation with demand-management policies; and, finally, the wage-productivity-price nexus—all were inherited without serious modification from neo-classical analysts. It follows, therefore, that the analysis of cost-push inflation should be regarded not as a new development but rather as the revival and restatement of long-established ideas thoroughly familiar to earlier economists.

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FACTORS DETERMINING EXCHANGE RATES: A SIMPLE MODEL AND EMPIRICAL TESTS

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This article constructs and tests a simple static equilibrium model of exchange rate determination.[1] The model assumes a regime of freely floating currencies and posits that the exchange rate, by definition the relative price of two national moneys, is determined by the basic factors underlying the demands for and supplies of those national money stocks. Besides the money supply itself, these factors include real income and interest rates—the latter reflecting expectational influences that enter into exchange rate determination.

The article proceeds as follows. First, it discusses the logic and economic content of the individual equations that constitute the major building blocks of the model. Second, it condenses the model to one reduced-form equation that expresses a functional relationship between the exchange rate and its ultimate determinants. Third, it fits the foregoing equation to the statistical data on several foreign exchange rates, assesses the accuracy of the fit, and discusses some problems involved in testing the model.

The Model and Its Elements The model itself consists of two hypothetical national economies represented by a set of equations containing the following variables. Let M be the nominal money stock (assumed to be exogenously determined by the central bank) and m the demand-adjusted rate of growth of that stock, i.e., the difference between the respective growth rates of the nominal money supply and real money demand, this difference by definition being equal to the rate of price inflation. Furthermore, let D be the real demand for money, i.e., the stock of real (price-deflated) cash balances that the public desires to hold, Y the exogenously-determined level of real income, and i and r the nominal and real rates of interest, respectively. Also let X be the exchange rate (defined as the domestic currency price of a unit of foreign currency), P be the price level, and E be the expected future rate of price inflation. Asterisks are used to distinguish foreign-country variables from home-country variables, and the subscript w denotes the entire world economy. The foregoing elements are linked together via the relationships described below.

Monetary Equilibrium Equations The first part of the model consists of monetary equilibrium equations, one for each country

$$(1) \quad P = M/D \text{ and } P^* = M^*/D^*.$$

These equations, which can also be written in the form $M/P = D$, state that the price level in each country adjusts to bring the real (price-deflated) value of the nominal money stock into equality with the real demand for it, thereby clearing the market for real cash balances. This market-clearing price-adjustment process relies chiefly on equilibrating changes in aggregate expenditure induced by discrepancies between actual and desired real balances. For example, if actual balances exceed desired, cash-holders will attempt to get rid of the excess via spending for goods. Given the exogenously-determined level of real output, however, the increased spending will exert upward pressure on prices thereby reducing the real (price-deflated) value of the nominal money stock. Prices will continue to rise until actual real balances are brought down to the desired level. Conversely, a shortfall between actual and desired real balances will induce a cut in expenditure leading to a fall in prices and a corresponding rise in the real value of the money stock. This process will continue until actual real balances are brought into equality with desired balances. To summarize, disequilibrium between actual and desired real balances generates the changes in spending that cause prices to alter sufficiently to eliminate the disequilibrium.

Note that the equations also imply that, given the real demand for money, the price level is determined by and varies equiproportionally with the nominal money supply. This latter result, of course, is the

[1] Variants of the model have been employed by a number of analysts to explain recent exchange rate movements. See in particular the papers by Bilson [1, 2], Frenkel [4], and Putnam and Woodbury [7] cited in the list of references at the end of the article. Much of the relevant empirical work on the model is summarized in the surveys by Isard [5] and Magee [6].

essence of the quantity theory of money. For that reason, the equations could also be called quantity theory equations.

Real Cash Balance Equations National demand for money functions constitute the second part of the model. Written as follows

$$(2) \quad D = KYi^{-a} \text{ and } D^* = K^*Y^*i^{*-a}$$

these equations express the public's demand for real cash balances as the product of a constant K and two variables, namely real income and the nominal interest rate. The income variable is a proxy for the volume of real transactions effected with the aid of money and thus represents the transaction demand for money. By contrast, the interest rate variable measures the opportunity cost of holding money instead of earning assets. The parameter —a, which appears as the exponent of the interest rate variable, is the interest elasticity of demand for money. It measures the sensitivity or responsiveness of money demand to changes in the interest rate and is assumed to be a negative number indicating that the quantity of real balances demanded varies inversely with the cost of holding them. For simplicity the numerical magnitude of the interest elasticity parameter is assumed to be the same for both countries. For the same reason the income elasticity of demand for money, as represented by the exponential power to which the income variable is raised, is assumed to possess a numerical value of unity.

The Purchasing Power Parity Equation The third equation of the model is the purchasing power parity relationship

$$(3) \quad P = XP^*$$

showing how national price levels are linked together via the exchange rate. As indicated by the equation, prices in both countries are identical when converted into a common currency unit at the equilibrium rate of exchange. This means that the exchange rate equalizes such common-currency price levels and, by implication, the buying power of both moneys expressed in terms of a common unit. In other words, exchange-rate adjustment insures that a unit of a given currency commands the same quantity of goods and services abroad when converted into the other currency as it commands at home. This condition of equalized purchasing power is of course necessary if the two national money stocks are to be willingly held and monetary equilibrium is to prevail in both countries. For if the purchasing powers were unequal, people would demand more of the high- and less of the low-purchasing power currency on the market for foreign exchange. The resulting excess demand for the former and the corresponding excess supply of the latter would cause the exchange rate between the two currencies to adjust until purchasing power was equalized and both money stocks were willingly held. Note also that the purchasing power parity equation can be rearranged to read $X = P/P^*$, thus corresponding to the economic interpretation of the exchange rate as the relative price of the two currencies, i.e., as the ratio of the foreign currency's internal value in terms of goods to the domestic currency's internal value in terms of goods. Since the internal value of a unit of currency in terms of a composite market basket of commodities is the inverse of the general price level 1/P, it follows that the relative price of the two moneys is simply the ratio of the national price levels as indicated by the equation.

Nominal Interest Rate Equations The fourth group of relationships in the model are the nominal interest rate equations, one for each country. Written as follows

$$(4) \quad i = r + E \text{ and } i^* = r^* + E^*$$

they define the nominal interest rate as the sum of the real rate of interest and the expected future rate of inflation, the latter variable being the premium added to real yields to prevent their erosion by inflation.

Real Interest Rate Parity Condition The fifth equation expresses the interest-parity condition

$$(5) \quad r = r^* = r_w$$

according to which the real rate of return on capital assets tends to be everywhere the same and independent of the currency denomination of the asset. This equation reflects the model's assumption of a highly-integrated efficient world capital market. In such a world, capital is mobile internationally, i.e., foreigners can purchase domestic securities and domestic citizens can purchase foreign securities. Given these conditions it follows that real yield equalization is necessary if all asset stocks are to be willingly held. Accordingly, the equation states that real interest rates in both countries are the same and are equal to a given constant world rate r_w. Note that equations 4 and 5 taken together imply that international nominal interest rate differentials reflect differences in expected future national rates of inflation. For example, if the market expects the future rate of inflation to be 12 percent in the UK and 5 percent in the

US, then the UK nominal interest rate will be 7 percentage points above the corresponding US interest rate.

Price Expectations Equations Completing the model are price expectations equations that describe how the public forms its anticipations of the future rate of inflation. These inflationary expectations constitute the anticipated future rates of depreciation of money holdings. As such, they enter the foreign and domestic demand for money functions via the nominal interest rate variables and thereby play an important role in exchange rate determination. Written as follows

$$(6) \quad E = m \text{ and } E^* = m^*$$

the price expectations equations state that the expected rate of inflation E is equal to the demand-adjusted rate of monetary expansion m, i.e., the difference between the respective growth rates of the nominal money supply and real money demand.

As written, these equations embody the so-called *rational expectations hypothesis* according to which the public correctly bases its price forecasts on the variable that the model contends actually determines the rate of inflation. This feature insures that the model is internally consistent, i.e., that the equations describing the formation of inflationary expectations are consistent with equations describing how inflation is actually generated. Such consistency is characteristic of the forecasting behavior of rational agents who use knowledge about the actual inflation-generating process in forming expectations of future inflation. Since the model asserts that the actual rate of price inflation is determined by the demand-adjusted growth rate of money (see equation 1), it follows that the expected rate of inflation is determined by that same variable as shown in equation 6.

Linkages and Causation Taken together, the foregoing relationships constitute a simple six-equation model of exchange rate determination. For convenience the model is summarized below.

$$(1) \quad P = M/D \text{ and } P^* = M^*/D^*.$$

$$(2) \quad D = KYi^{-a} \text{ and } D^* = K^*Y^*i^{*-a}.$$

$$(3) \quad P = XP^*.$$

$$(4) \quad i = r + E \text{ and } i^* = r^* + E^*.$$

$$(5) \quad r = r^* = r_w.$$

$$(6) \quad E = m \text{ and } E^* = m^*.$$

The foregoing equations imply two unidirectional channels of influence—one direct. the other indirect —running from money and income (both exogenous variables) to prices to the exchange rate. Regarding the former channel, the model implies that both exogenous variables affect prices and the exchange rate directly through the monetary equilibrium and purchasing power parity equations. As for the indirect channel, the model implies that the rates of growth of the exogenous variables influence prices and the exchange rate indirectly via the price expectations component of the nominal interest rate variable that enters the demand for money function. More specifically, the model postulates the following causal chain:

1. The demand-adjusted money-stock growth rate determines the expected rate of inflation.
2. Given the real rate of interest, the expected rate of inflation determines the nominal rate of interest.
3. The latter variable, together with the given level of real income, determines the demand for money.
4. Given the demand for money, the nominal money stock determines the price level.
5. Finally, the two price levels, foreign and domestic, together determine the exchange rate.

In brief, when the demand-adjusted money growth rate rises, price expectations also rise and so too does the nominal interest rate (the cost of holding money). This reduces the quantity of real cash balances that people desire to hold, i.e., cashholders will want to get out of money and into goods. The resulting increased spending for goods puts upward pressure on the price level and, via the purchasing power parity nexus, also on the exchange rate. Clearly the linkages run from money stocks and real incomes to prices to the exchange rate.[2] Moreover, all variables affecting the exchange rate do so through monetary channels, i.e., through the demand for and supply of money. In this sense, money demand and supply may be said to constitute the *proximate* determinants of the exchange rate. The *ultimate* determinants, however, are the variables that underlie and determine the monetary factors themselves.

Determinants of the Exchange Rate To show the relationship between the exchange rate and its

[2] Note that reverse causality is effectively ruled out by the assumed exogeneity of the money stock and income variables. Therefore, while these variables can affect the exchange rate, the exchange rate cannot influence them—at least not within the context of the model.

ultimate determinants, simply substitute equations 1 - 2 and 4 - 6 into equation 3 and solve for the exchange rate. The resulting "reduced form" expression is

$$(7) \quad X = [K^*/K][M/M^*][Y^*/Y][i/i^*]^a$$

or, since the nominal interest rate i is the sum of the real interest rate r and the expected rate of inflation E—the latter variable itself being equal to the growth rate of money per unit of money demand m—the equation can be alternatively expressed as

$$(7') \quad X = \left[\frac{K^*}{K}\right]\left[\frac{M}{M^*}\right]\left[\frac{Y^*}{Y}\right]\left[\frac{r+m}{r^*+m^*}\right]^a.$$

Disregarding the fixed constants (the K's), equation 7 (or 7') collects the determinants of the exchange rate into three groups, namely relative money supplies, relative real incomes, and relative nominal interest rates comprised of a fixed real rate component and a variable price expectations component. Of these three groups, the first captures purely monetary influences on the exchange rate while the second and third capture real and expectational influences, respectively.

Regarding monetary and real influences, the equation predicts that a country's exchange rate will depreciate (i.e., rise) if its demand-adjusted money stock is growing faster than in the other country. Conversely, a nation will find its currency appreciating on the foreign exchanges when its money stock grows slower and its real income faster than in the other country. Note that the model's conclusion that rapid real growth results in currency appreciation contradicts the conventional balance of payments view of exchange rate determination. According to this latter approach, income growth tends to depreciate a country's currency by inducing a rise in imports and a consequent trade balance deficit. By contrast, the present model depicts real growth as stimulating not imports but rather the demand for money. Given the nominal money stock, this increased real money demand necessitates a fall in the price level to clear the market for money balances. With foreign prices given, the fall in domestic prices requires an equivalent appreciation of the exchange rate to maintain purchasing power parity. In short, the model predicts that growth-induced rises in the real demand for money will raise the internal and therefore also the external value of a currency.

As for expectational influences, the equation predicts that a rise in the expected rate of inflation in one country (as reflected in its interest rate) relative to the other will cause the former's currency to depreciate on the foreign exchanges. The reason, of course, is that when interest rates rise, desired real cash balances fall. Cashholders attempt to get rid of unwanted balances via expenditure for goods thereby putting upward pressure on prices. According to the model, the rise in prices will be relatively greater in the country experiencing the larger rise in interest rates. In this way increasing relative interest rates cause corresponding increases in relative national price levels that must be offset by exchange rate depreciation to preserve purchasing power parity. Note again that the model's prediction of a direct relation between interest rate movements and exchange rate movements runs counter to the conventional balance of payments view. According to this latter approach, a rising interest rate should lower the exchange rate either by attracting capital from abroad (thereby improving the capital account of the balance of payments) or by reducing domestic expenditure for imports and potential exports (thereby improving the trade balance). This cannot happen in the present model where, instead of strengthening the balance of payments, a rising interest rate induces a shift from cash to goods resulting in domestic inflation and exchange rate depreciation. In short, equation 7 predicts that a country will experience currency depreciation when its relative money stock rises, its relative real income falls, and its relative inflationary expectations rise.

Empirical Application This article has constructed a simple economic model that states that the bilateral exchange rate between any two national currencies is determined by relative money stocks, relative real incomes, and relative nominal interest rates—the last variable reflecting relative expectations regarding national inflationary prospects. All that remains is to illustrate how the model can be applied in empirical studies of exchange rate determination. With this objective in mind, an attempt is made below to estimate the model's reduced-form exchange rate equation (equation 7) and to use it to explain the behavior of the US/UK and US/Italy exchange rates, respectively, over the post-1972 period of generalized floating. To do this, it is necessary to transform equation 7 into linear form by expressing the variables as logarithms. This step is required because equation 7 is nonlinear, and nonlinear equations are difficult to estimate directly. The resulting log-linear version of equation 7 is written as

$$(8) \quad \ln X = a_0 + a_1(\ln M - \ln M^*) + a_2(\ln Y^* - \ln Y) + a_3(\ln i - \ln i^*)$$

where ln stands for the logarithm of the attached variable and the a's are coefficients to be estimated

from the statistical data. Note that according to equation 7 the a priori expected values of the coefficients attached to the money and income variables are unity whereas the coefficient attached to the interest rate variables should lie between zero and unity, consistent with previous empirical estimates of the interest elasticity of demand for money.

Equation 8 was estimated for quarterly US/UK and US/Italy data for the period 1973 I through 1976 II. The money supply variable used for each country was M_1. The income variables used were real gross national product for the US and real gross domestic product for the UK and Italy, respectively. As for the interest rate variables, the treasury bill rate was used for each country in the US/UK equation and the rate on medium-term government bonds was used for each country in the US/Italy equation. All data were taken from the IMF's *International Financial Statistics* with the exception of the figures for UK real gross domestic product, which were taken from the OECD's *Main Economic Indicators*.

The results are shown in Table I below.

Table I

REGRESSION RESULTS FOR US/UK AND US/ITALY EXCHANGE RATES

Quarterly Data: 1973 I - 1976 II

I. Dollar/pound exchange rate

$$\ln X = 5.87 + .49(\ln M_{US} - \ln M_{UK}) + .96(\ln Y_{UK} - \ln Y_{US}) + .24(\ln i_{US} - \ln i_{UK})$$
$$(2.79)^* \qquad (2.78)^* \qquad (2.34)^*$$

$R^2 = .87$ $\quad DW = 1.17^1$

II. Dollar/lira exchange rate

$$\ln X = -4.44 + .92(\ln M_{US} - \ln M_{IT}) + .70(\ln Y_{IT} - \ln Y_{US}) + .17(\ln i_{US} - \ln i_{IT})$$
$$(3.93)^* \qquad (1.32) \qquad (1.62)$$

$R^2 = .87$ $\quad DW = 1.24^1$

*Indicates statistical significance at the 5 percent level of confidence. t-statistics are given in parentheses beneath the estimated coefficients.

[1]The reported Durbin-Watson statistics are in the inconclusive region in testing for serial correlation. Correcting for serial correlation using the Cochrane-Orcutt method did not significantly alter the results.

In general the empirical results are consistent with the theoretical model. According to the estimated equations, fully 87 percent of the variation of both the dollar/pound and dollar/lira exchange rates are explained by variations in the money stock, real income, and interest rate variables. In both cases the coefficients on the explanatory variables have the expected positive signs. All coefficients are statistically significant at the .05 level except for those on the US/Italy income and interest rate variables. Moreover, the coefficient on the US/Italy money stock variable is close to its expected (theoretical) value of unity, as is the coefficient on the US/UK income variable. The interest rate coefficients in both equations are also consistent with previous empirical estimates of the interest elasticity of demand for money.[3] These results are perhaps better than one might expect considering the extreme simplicity of the model, the degree to which floating rates are managed instead of free, the limited number of observations (14), and the fact that short-run data are used to test a long-run equilibrium model.

In sum, the equations reported above provide at least modest empirical support for the theoretical model developed earlier in the article. One should not make too much of these results, however. Just as one swallow does not make a summer, two regression equations do not prove a theory. In particular, equation 8 may not fit the data well for other countries and other time periods. In fact, an attempt was made to test the equation against recent data for Canada, Japan, and Germany, as well as for data pertaining to the UK during the early 1920's when that country was off the gold standard. For the first three countries, the equation performed poorly. For the UK from 1920-1924, however, it was at least partially successful. As shown in Table II, the equation performed adequately except for the coefficient on the income variable, which bears the wrong sign. This of course may be due to the unreliability of UK income data for that period rather than to shortcomings inherent in the model.[4] Nevertheless, the fact that the equation does not work well for all countries is reason to interpret the results reported here with caution.

Table II

REGRESSION RESULTS FOR US/UK EXCHANGE RATES

Quarterly Data: 1920 I - 1924 IV

Dollar/pound exchange rate

$$\ln X = -.17 + .55(\ln M_{US} - \ln M_{UK}) - .16(\ln Y_{UK} - \ln Y_{US}) + .10(\ln i_{US} - \ln i_{UK})$$
$$(4.48)^* \qquad (-1.55) \qquad (2.77)^*$$

$R^2 = .76$ $\quad DW = 1.31$

*Indicates statistical significance at the 5 percent level of confidence. t-statistics are given in parentheses beneath the estimated coefficients.

Problems in Testing the Model In closing this article, it may be appropriate to consider why the data did not exactly fit the model like a

[3] Boorman [3] reports that recent empirical studies of the demand for money suggest an interest elasticity of about —0.2 for short-term rates, quite close to the estimates appearing in Table I.

[4] Since quarterly national income figures are not available for this period, the Federal Reserve's Index of Industrial Production was used as a proxy for US real income. No such official index is available for the UK. Therefore a quarterly industrial production index constructed in 1927 by Rowe [8] was used as a proxy for UK real income. However, the reliability of this index is open to question.

glove. Regarding this question, at least three likely explanations come to mind. First, the model assumes that exchange rates are permitted to float freely while in fact governments still intervene in foreign exchange markets from time to time in order to achieve a managed float. This suggests that there may be some reverse causality running from exchange rates to money, at least in the short run. In brief, the model may not be a completely accurate description of existing exchange rate regimes.

Second, quarterly data may not be suitable for testing what is essentially a model of long-run equilibrium. Quarterly data are short-run data. As such they may be dominated by transitory dynamic adjustment phenomena that are absent in long-run static equilibrium. Annual (or longer) data are more appropriate for testing an equation that is based on assumptions of purchasing power parity, interest rate parity, monetary equilibrium, real income exogeneity, and unidirectional causality between money and exchange rates—all propositions about long-run equilibrium. Unfortunately, the post-Bretton Woods era of floating rates is only four years old, and the number of annual observations is insufficient to test these propositions. Even the number of quarterly observations is distressingly low.

An alternative solution would be to augment the model with additional equations and variables to represent dynamic adjustment processes. While this might permit the specification of short-run influences affecting the exchange rate, it would unduly complicate the model, contrary to the objective of keeping it simple. Note, however, that this latter feature may constitute a third reason for the model's failure to conform exactly to the data, i.e., the model may be far too simple to capture all the influences on the exchange rate. This does not necessarily mean that the model is conceptually unsound. The underlying theory may be correct even though its empirical form is inadequate to fit the facts. Thus the model can be faulted on the grounds that its empirical money demand equations are too simple, that it lacks dynamic adjustment mechanisms, and that it arbitrarily constrains the elasticity coefficients to be the same for each country. These considerations should be kept in mind when interpreting the results of the regression analysis.

Summary This article has developed and estimated a simple model of exchange rate determination. The model states that exchange rate movements are determined by shifts in relative money stocks, relative real incomes, and relative inflationary expectations as manifested in relative interest rate movements. Although the model receives some empirical support from post-1972 data for the dollar/pound and dollar/lira exchange rates, it does not perform well when applied to data for other countries and other time periods. One is therefore advised to take an agnostic attitude regarding the validity of the model until all returns are in. In short, additional experience with floating exchange rates, together with the application of empirical techniques of greater sophistication than those employed here, will be necessary to establish conclusively the validity or invalidity of the model.

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