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THE TIMING OF MONETARY AND PRICE CHANGES AND THE INTERNATIONAL TRANSMISSION OF INFLATION

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ABSTRACT

This paper presents a theoretical and empirical investigation into timing relationships between variables within and across industrialized countries. In the analysis we highlight the two polar cases of completely closed and open economies and draw some implications for timing between monetary expansion and inflation, inter-country comparisons of inflation rates and interest rates, and comparisons of central bank behavior. The Granger-causality test is applied in a bivariate fashion to these groups of variables.

The main empirical results of our analysis are: (1) Domestic monetary expansion appears to lead inflation in the sense that money Granger-causes prices without feedback, contradicting an implication of the monetary approach to the balance of payments. (2) Hardly any significant timing relationship exists between domestic and foreign rates of inflation during the fixed exchange rate period, providing no evidence for a generalized "law of one price." (3) Some sterilization of official reserve inflows was successfully performed by the non-reserve central banks, except for Canada. (4) U.S. interest rates Granger-cause foreign rates, providing evidence of some international transmission via asset markets.

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I. INTRODUCTION

Our object in this paper is to present evidence on the inflation process in the United States and seven other industrial countries during the period from the late 1950s until the end of 1976. To do so we focus on two issues: the channels through which international factors operated to transmit inflation and the relative contributions to inflation in each of these countries of domestic and of international factors. Our method of statistical analysis is the Granger-causality test. For each country, we apply these tests to a number of relationships, some of which are between purely domestic variables and others of which are between domestic and foreign variables.

The flavor of our approach is monetarist in nature but the spirit in which our study is conducted differs from most studies of inflation. As a rule, other studies have tended to adopt one or the other of two simple monetary models which can be characterized by an extreme degree of international integration or total lack thereof. In one case, what has come to be viewed as the traditional quantity theoretic model, an economy is treated as if it were completely closed. The domestic monetary authorities determine the nominal stock of money supplied and, given a stable demand function for money, ultimately control the price level.

In the opposite polar case, the assumption is that a non-reserve currency (small) economy is fully open and subject to a fixed exchange rate convertible into the reserve currency or a commodity such as gold. Differences between one country's price level and the price level in the rest of the world are eliminated by arbitrage. The nominal quantity of money supplied merely adjusts, via the balance-of-payments, to meet a stable demand for real cash balances.[1]

In the closed economy model, the direction of causation is from domestic money to domestic prices. In the open economy model both are endogenous and the ultimate causative variable is the rest of the world's money or alternatively the reserve currency. In its most extreme form, the open economy model presumes price level differences are instantaneously resolved and the money supply passively adjusts to the real level of cash balances mandated by the rest of the world. Thus, the direction of causation appears to be from domestic prices to domestic money.

A number of problems arise in applying these models in the context of the postwar period, however, because many countries appear to fit neither a fully open nor a fully closed mold. Exchange rates in a number of important instances during the Bretton Woods era underwent substantial changes. The domestic monetary authorities in some cases seemed to pursue policies consistently at variance with those of the world at large. And some governments demonstrated a high propensity to tinker with markets for international goods and capital.

One solution that has been tried in order to circumvent these problems is to estimate slightly more general models that relax some of the limiting assumptions of the polar cases. For the most part, though, the empirical application of such models has been limited. Much of the empirical work is subject to the objection that the emphasis is upon one, or at most a few, of a considerably larger number of potential avenues for the international transmission of inflation.[2]

The merit in our approach is that it attacks the problem of structuring the model in terms of the interrelationships among variables without a priori limiting the range of investigation. Indeed, the tests we apply are intended to provide evidence which will permit us to rule out some previous model-identifying restrictions as being inconsistent with the data. Our method of analysis, therefore, not only serves as a convenient point of departure for constructing and estimating more general models but provides a way of checking models that have been already estimated.[3] A drawback of our approach, however, is that the simple bivariate relationships underlying our tests may themselves be subject to specification bias along the lines of a generalized omitted variable error.

II. THEORETICAL CONSIDERATIONS

To begin our discussion, we review the model underlying the monetary approach to the balance of payments (MABP).[4] We derive expressions for the rates of inflation and of monetary growth in the small open economy and point out the model's implications for the time paths of both. In so doing, we point out what we believe is one of the popular misconceptions surrounding the MABP: the belief on the part of at least some, if not many, researchers that in the most basic model prices will lead rather than lag money. We end by relaxing some of the simplifying assumptions of the model and state the implications these changes have for our study of timing.

The Monetary Approach Model

The simplest expositions of the monetary approach to the balance of payments start with two behavioral equations and an equilibrium condition. The first equation is a money demand function of the standard form, which, if we ignore interest rates, we can write as

$$\text{(1)} \quad \log (M^d/P)_t = k \log y_{pt} ,$$

where M is the nominal stock of domestic money, P the domestic price level, y_p permanent income, and k the income elasticity of demand. The second is a simple purchasing power parity, or if the exchange rate is assumed perfectly rigid, price arbitrage relationship

(2) $P_t = \pi P'_t$,

where P' is the rest-of-world price level and π the (constant) exchange rate. The third is an equilibrium condition relating the nominal stock of money supplied to the nominal stock demanded,

(3) $M_t = M^d_t$.

Taking logarithms of (2) and (3), differencing the results along with equation (1) and making the appropriate substitutions, we arrive at the standard expressions for the domestic rate of inflation

(4) $\dot{P}_t = \dot{P}'_t$,

and for monetary growth

(5) $\dot{M}_t = \dot{P}'_t + k\dot{y}_{pt}$,

where a dot over a variable indicates a rate of change.

Equations (4) and (5) are equilibrium relationships that describe the long-run growth paths of domestic money and domestic prices. This is readily apparent from the assumption of instantaneous adjustment of money demand to supply. This framework avoids focusing on the importance of the role of money as a shock absorber for transitory fluctuations generally expressed as movements in velocity. In much of the literature, however, these dynamic relationships are thought to do more: to have implications also for the time path of the adjustment to equilibrium. As the authors of one recent study using the simple MABP model have put it, "there is a clear presumption to [the] existence and direction" of the leads and lags between domestic money, prices and nominal income in a small open economy under a fixed exchange rate regime [Putnam and Wilford, 1978].

An Extension of the Basic Model

The following is a typical example of the mechanics of the basic model. Consider a position of dynamic equilibrium in which the reserve-currency country's money stock and prices and the domestic money stock and prices are growing at constant rates, for simplicity all assumed to be equal. Now let monetary growth in the reserve-currency country increase. Its rate of inflation will eventually follow suit. The increase in inflation will, via arbitrage, be transmitted as an instantaneous and equal increase in inflation in non-reserve currency countries. The new rate of inflation, in turn, will mean that domestic real cash balances are now growing more slowly than desired. The rate of hoarding, the inflow of foreign reserves, will increase as a result. Therefore, after the fact, so will the rate of growth of the domestic money supply.

The problem is, however, that this sequence of events does not follow directly from the model. In the model everything takes place within a single period. For the reserve inflow to lag price equalization, actual and desired nominal stocks of money would have to differ. That can be effected within the model fairly simply but it requires replacing equation (3) with some form of stock adjustment relationship like

$$(6a)\quad \log M_t - \log M_{t-1} = \beta(\log M_t^d - \log M_{t-1}) \ ,$$

or equivalently,

$$(6b)\quad \log M_t = \beta(\log M_t^d) + (1 - \beta) \log M_{t-1} \ .$$

Using (1), substituting successively for the lagged actual stock of money and differencing the result, we would then arrive at a new equation in which the current period's monetary growth would be a distributed lag, with geometrically declining weights, of inflation in the reserve currency country and of growth in permanent income:

$$(7) \quad \dot{M}_t = \beta \sum_{i=0}^{\infty} (1 - \beta)^i (k\dot{y}_{pt-i} + \dot{P}'_{t-i}) .$$

Doing that seems reasonable from an empirical standpoint.

Most demand for money studies suggest that lags in the adjustment of actual to desired money balances exist for periods of at least one quarter and perhaps a good deal longer. In a similar vein, other studies cast serious doubt on an instantaneous equalization of price levels or their rates of change. For a more elaborate model, why then should we postulate instantaneous agreement of domestic and world inflation? Furthermore, for the sake of empirical realism, more general rationales for divergence between actual and desired money balances could also be incorporated such as departures from full employment. To derive testable models to answer the questions of how inflation was transmitted internationally and to what extent it was a domestic phenomenon one might want to relax these strong assumptions also.

First let us consider the question of price arbitrage. Here the empirical evidence to date is inconsistent with convergence of overall rates of inflation within a quarter and perhaps even within the period of several years.[5] One reason may be the existence of sizeable non-tradeable goods sectors. In this instance, even if traded goods prices adjust quickly those of non-tradeable goods may adjust only with a substantial lag. And if that is the case, then the domestic inflation equation, (4), and the domestic money growth equation, (5) or (7), would both have to be rewritten to take account of the differences in speeds of adjustment of prices between tradeable and non-tradeable goods across countries.[6] The end result is that the timing relationship between domestic monetary growth and overall inflation becomes less easy to determine. Given a sufficiently slow adjustment of prices of non-tradeable goods, domestic inflation might not be observed to lead domestic monetary growth.

The next logical step would be to relax the implicit assumption that prices, in the reserve currency country, adjust fully and instantaneously to monetary changes. For example, consider the monetary transmission mechanism Friedman and Schwartz [1963] outline for a closed economy. The key element in their view is the series of portfolio adjustments that an unanticipated change in monetary growth engenders.[7]

For example, suppose monetary growth suddenly increases. Initially, market yields on financial assets and equities, and then a whole host of implicit yields on consumer goods of every degree of durability, temporarily fall as money holders desire to rid themselves of excess cash balances and the adjustment proceeds from one sector to another. Spending in all of these areas, therefore, increases and output prices begin to rise more rapidly. Eventually stock equilibrium is reestablished; holdings of real cash balances are lower and inflation is higher.

Suppose we now extend that model to the international realm. Consider, for instance, what happens abroad in a world of fixed exchange rates when monetary growth in the reserve currency country undergoes an unanticipated increase.[8] Initially an excess supply of money in the reserve currency country reflects itself in an excess demand for alternative assets denominated in both the reserve currency and foreign currencies. The prices of those assets rise and their yields fall. The fall in interest rates produces an excess demand for money abroad which, in part, is satisfied by the inflow of reserves as residents of the reserve currency country reduce their excess holdings of money and then increase expenditures on bonds and equities. Eventually the process spreads to the markets for consumption and investment goods in both countries. As expenditures on these goods increase, their prices and the overall price levels in both countries begin to rise more rapidly. At the same time, interest rates on bonds and on equities begin to rise and approach their initial levels.

The final equilibrium position is one in which monetary growth, inflation and the nominal interest rate on bonds both in the reserve currency country and abroad are all higher; holdings of real cash balances are lower and international payments positions are altered. The reserve currency country now has a greater balance of payments deficit and foreign countries have greater balances of payments surpluses or smaller deficits.

If the asset approach is a reasonable expression of the adjustment mechanism, then we have a further reason to suppose that domestic monetary changes in a small open economy would <u>not</u> lag price changes.

We could also relax the implicit assumption in the MABP of full employment, then the transmission mechanism operating through portfolio adjustment provides a further rationale for domestic money actually leading prices. For example, suppose an unanticipated increase in monetary growth induced the portfolio adjustments described above. This would be followed by increased expenditures by reserve currency country residents on foreign goods which would lead to a balance of payments surplus and expansion of aggregate demand and output in the small economy. At the same time, the accumulation of reserves by the small economy's central bank would lead to an expansion of its high-powered money and overall money supply. Initially the bulk of the increase in the nominal income of the small economy would be reflected in output. Only after some time had elapsed would the effect be manifest upon prices alone.

In conclusion, the lead or lag of money over prices, in what appears to be an open economy, is an uncertain guide to settling questions of causation and more importantly the international transmission of inflation. We would view a lead of prices over money and to a lesser extent a coincidence in movements as prima facie evidence of the importance of foreign influences. But a lag of prices behind money is consistent with either domestic or foreign monetary forces being the causative factor.

Other Implications of the Alternative Models

Fortunately these modifications of the explanation of the international transmission of inflation have other empirical implications that can help us differentiate among the alternative models. One testable hypothesis, of course, is derived from the presumed operation of price arbitrage. For a small open economy, if arbitrage were not instantaneous we would expect prices in the rest of the world to lead domestic prices.

Similarly, if assets markets provide another linkage among countries we would expect there to be a relationship among interest rates in one country and those in the rest of the world during periods of fixed exchange rates. Again, assuming that the effects are not instantaneously felt, we would expect interest rates in the rest of the world, or in the reserve currency country, to lead those in a small open economy. But the possibility that rates of inflation or interest rates are equated across boundaries does not preclude the possibility that those rates are simultaneously determined along with movements in reserves. That is, the rate of inflation and/or interest rate may not be exogenous with respect to the balance of payments.

Analyzing the timing relationships between high-powered money and its counterparts on the asset side of the central bank's balance sheet -- foreign reserves and domestic assets (domestic credit) -- and between those two asset components themselves, may also help to clear up some of the ambiguities that surround the timing relationship between money and prices. Let us consider three cases: the reserve currency country, a completely open small economy and an intermediate case.

In the reserve currency country, e.g. the U.S., the increase in monetary expansion underlying an increase in its inflation and ultimately that of the rest of the world is the result of domestic credit expansion by the reserve country's central bank. Accordingly, domestic assets will be positively related to, and either lead, or be coincident with high-powered money. Indeed, the foreign component of high-powered money is of minor importance for a reserve-currency country. Changes in the balance of payments will be a result rather than a cause of variations in the growth of high-powered money. High-powered money, therefore, will be negatively related to, and either lead or be coincident with the balance of payments.

In a completely open small economy, movements in domestic assets are unimportant as an effective source of monetary change. An overexpansion of domestic assets of the central bank ultimately will be nullified by reserve outflows; underexpansion by reserve inflows. Changes in foreign reserve holdings of the central bank are the channel through which monetary expansion occurs. Therefore, foreign reserves will bear a positive and either coincident or leading relationship to high-powered money. Domestic assets will be unrelated to high-powered money but bear a negative and either coincident or leading relationship to foreign reserves.

The intermediate case is the most difficult to handle. Domestic assets and foreign reserves are both potential sources of monetary changes. Some sterilization of balance of payments movements is likely and at the same time some feedback of domestic credit on foreign reserves will be observed. We would expect, therefore, to see both foreign reserves and domestic assets to bear a leading, or perhaps coincident positive relationship to high-powered money and a negative and bi-directional relationship to each other. Both foreign reserves and domestic assets can influence high-powered money in the intermediate case.

III. Testing Timing Relationships

Timing relationships, for example between money and prices, are a crucial element of a full discussion of the structure of an economic model. We have already described two classes of models, i.e., open- and closed-economy models, which postulate fundamentally different timing relationships for some group of variables, and which imply (cross-model) differences in behavioral relationships among other variables. Here we define a timing relationship as a relationship among a group of variables which demonstrates the temporal precedence of one (or more) variable(s) over another. In this paper, we concentrate on bivariate timing relationships.

To examine timing relationships, we use an incremental prediction criterion introduced by Granger (1969) and developed by Sims (1972) for testing the temporal precedence of the money supply over nominal income explicit in some monetarist models. Granger defines a causal relationship, e.g., between X and Y, on the basis of the usefulness of information on the characterization (probability laws) of one stochastic process, say $\{X_t\}$, for the description of the joint stochastic process, $\{Y_t, X_s\}$. This is usually stated as: series X (Granger) causes series Y if we can better predict Y by utilizing past values of Y <u>and</u> X than by using merely past Y alone. The criterion Granger suggests for making this assessment is a comparison of conditional mean squared errors contingent upon the information sets inclusive and exclusive of series X. Thus, if X helps to predict Y, in the sense of reducing the mean squared prediction error for Y, then X Granger-causes Y.

Sims proves two theorems on (stationary) stochastic processes which are relevant in this context. Sims' analysis begins by recognizing that the stationary processes, Y and X, can be represented as

(8) $Y_t = A(L)u_t + B(L)\varepsilon_t$

(9) $X_t = C(L)u_t + D(L)\varepsilon_t$

where u_t and ε_t are uncorrelated stationary processes and A(L), B(L), C(L) and D(L) are polynomials in the lag operator, L. The first theorem Sims proves is that a necessary and sufficient condition for Y not causing X is that either C(L) or D(L) be identically zero. For example, Y would not cause X if, and only if, equation (9) could be written as

(10) $X_t = D(L)\varepsilon_t$. The second theorem states that the failure of Y to Granger-cause X is a necessary and sufficient condition for treating X as strictly econometrically exogenous with respect to Y.

The import of these two theorems is that once we establish the existence of a particular representation between two variables (or, more accurately, that we cannot refute its existence) there is good reason to treat one variable as exogenous. Of course, one variable, which may be exogenous with respect to another variable in the framework of a bivariate system, may be endogenous with respect to a third variable. Nevertheless, the treatment of certain variables as exogenous lends structure to our economic models. The implied structure permits us to choose a better model from among classes of models each of which has a structure with a particular set of exogenous variables.

The causality tests are conducted by performing regressions of the general form:[9]

(11) $Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j} + U_t.$

There is, of course, a corollary regression to equation (11) which constrains the γj's to be zero identically, namely,

(12) $Y_t = \alpha_o + \sum_{i=1}^{m} \beta_i Y_{t-i} + U_t.$

By comparing the improvement in the explanation of Y obtained from (11) over that derived from the companion regression (12), we can determine whether series X contains information useful in explaining series Y. Then, by reversing the roles of X and Y in regressions (11) and (12), we can establish whether an empirical representation of Y and X implies that one of the series is exogenous. Thus, if we can demonstrate, within reasonable statistical limits, that the following representation is plausible,

$$(13) \quad Y_t = a_1 + \sum_{i=1}^{m} b_i Y_{t-i} + \sum_{j=1}^{m} C_i X_{t-i}$$

and

$$(14) \quad X_t = a_2 + \sum_{i=1}^{m} d_i X_{t-i},$$

then, according to Sims' theorems, Y does not cause X, i.e. X is exogenous. It is important, for the application of Sims' theorems, that both series be stationary.

This is the regression test suggested by Granger; our interpretation of it is, however, somewhat looser than the conventional one. For the most part, we eschew using the word "cause" and instead speak in terms of timing. The reason, which should be clear from the theoretical presentation in Section II, is that in at least one of the areas in which we deal -- the money-price relationships -- leads and lags are a poor guide to the question of causation in economies that have an unknown degree of openness. In terms of the debate over "measurement vs. theory" that has recently been rekindled (see Sims, ed. [1977]) our approach can perhaps best be described as "measurement with some theory."

A related point about methodology that bears mentioning is the potential bias inherent in this type of testing procedure. Commonality of movements in the realizations of the processes analyzed may be captured in the autoregressive terms; these are implicitly disregarded by this method. As several others have pointed out (e.g., Zellner [1977]) this can lead to accepting the null hypothesis of no relationship between the two series when, in fact, one actually exists. In defense of the methodology, we should point out that this bias can also be a blessing. The simple fact of the matter is that in most industrial countries inflation and monetary growth over our sample period rose dramatically and at much the same time. Analyzing innovations in the time series may be the only way to separate the influence of one factor from another.

In almost all instances we transform the data for the purpose of rendering the series stationary. In general, we use natural logs of the levels which mollify the heteroscedastic character inherent in most aggregate economic time series. We then difference the log levels usually once but we also experiment with second differences in some cases. This procedure is intended to eliminate the trend in the mean of a series which is typically encountered in aggregate economic time series. This procedure has the advantage of simply and symmetrically "pre-whitening" the data without the substantial time costs and lost degrees of freedom one typically incurs when applying Box-Jenkins techniques. Moreover, our procedure is not subject to the criticism that too much has been removed since nearly all aggregate economic time series regression analysis must consider the transformation we apply in order to come to terms with the estimation-efficiency question. The one exception to the general transformation procedure was the (net) domestic asset versus (net) foreign asset relationships for certain of the countries for which the net positions took on a negative value. In these exceptional instances, we used arithmetic values of the levels and arithmetic first differences scaled by high-powered money.

IV. EMPIRICAL RESULTS

Our discussion of empirical results is divided into several parts: domestic money and prices, price and interest-rate arbitrage, asset components of high-powered money, and sources of monetary change. In our analysis, we cover periods beginning in 1958:2 and experiment with a variety of lag structures.

Domestic Money and Prices

We summarize the money-price results in Tables 1 and 2. There we report the F statistics for the Granger tests of the relationships between three monetary aggregates, high-powered money, M1 and M2 and two measures of prices, the GNP or GDP deflator (Table 1) and the consumer or other similar retail price index (Table 2) for the eight countries in our sample.[10]

Except for France and Italy, a significant effect of lagged money on prices exists for at least one domestic monetary aggregate. In the case of France, monetary growth proved to have significant effects on consumer price inflation but no effects on the French price deflator. In the case of Italy, the significance of the money-price relationship varied among the combinations of monetary and price variables from period to period. In most countries, however, we find a more pervasive influence than appears in either the French or Italian case; the majority of the relationships prove significant for one and sometimes both definitions of the price level.

The reverse influence, of prices on money, is considerably less visible. A significant effect of prices on money without feedback appears in Italy and the U.K. using high-powered money and in France using the broader (M2) monetary aggregate. However, for the remaining countries, for France using high-powered money, and for the U.K using both M1 and M2, whenever prices appear to influence money there also appears to be significant feedback. That is, there also appears to be some evidence of bi-directional causality.[11] These results can be broadly interpreted as providing evidence that the rate of inflation is not necessarily exogenous in monetary models regardless of the degree to which prices are equalized via arbitrage.[12]

One problem with the results is that in several of the countries the relationships differ markedly depending upon which price variable is used. Britain is the prime example. Using the GDP deflator, we find no influence from lagged high-powered money to prices in Britain and a significant influence, in two of the three periods, running the other way. Using the retail price index, we find almost exactly the opposite. A similar inconsistency exists using M1 and M2.[13] In the regressions with the GDP deflator both monetary variables Granger-cause prices with little relationship the other way; in the regressions with the retail price index prices more often Granger-cause money. For the other countries, the results are considerably more consistent.

The data, therefore, establish a pattern that on the whole is consistent with monetary explanations of the inflation process. They fail, however, to corroborate the popular interpretation of the MABP, in which prices adjust instantaneously but money supply adjusts only with a lag. Either domestic monetary forces by themselves or international forces operating via some combination of a reserve-flow mechanism and central bank reaction function or perhaps both domestic and international forces were important.

Price and Interest Rate Arbitrage

In Table 3 we report the tests of the relationships between domestic prices and rest of world prices and for the seven non-reserve currency countries between domestic prices and U.S. prices. These results are for the period through 1971:3, only, since after that most countries experienced substantial changes in their dollar exchange rate. In all instances, we included six lagged values of the dependent variable in the equation and three of the independent variable.

For the comparisons with the rest of world inflation, the results are mixed. We find some influence from lagged rest-of-world to domestic prices for the period ending 1971:3 in three countries, France, Japan and the Netherlands. When we included the contemporaneous value of the world price index in the equations there was a significant relationship for Canada also. For the U.S., the relationship ran in the opposite direction. Somewhat anomalously, we uncovered a statistically significant reverse influence for France too.

The U.S. versus individual foreign country price comparisons showed significant effects of lagged U.S. prices on German and British prices only and a borderline relationship for Canada, which again became significant when we included the contemporaneous value of U.S. prices. France, Japan and the Netherlands, the countries that exhibited the strongest response to rest-of-world prices, showed no relationship with the U.S.

We summarize the U.S. versus foreign interest rate relationships in Table 4. With the exception of Italy for which we could obtain only a long-term rate, these comparisons are for three-month U.S. Treasury bills and a similar short-term foreign rate. Of all of the arbitrage relationships, these show the most consistency among countries. For all the foreign countries other than Japan, lagged U.S. interest rates have a significant effect. And in most instances -- Canada especially so -- both the magnitude and significance of the effect increase when we include the contemporaneous value of the U.S. rate along with the lagged. For Italy and Germany, however, we also uncovered a reverse influence. For Japan our failure to find any relationship may be largely the result of the nature of the Japanese capital market over much of this period, the fact that the Japanese government exercised substantial direct control over interest rates.

Central Bank Behavior and the Balance of Payments

In Table 5, we report the results of the Granger tests of the relationships between changes in foreign reserves and in domestic assets of the monetary authorities of the seven foreign reserves and in domestic assets of the monetary authorities of the seven foreign countries.[14] For the U.S., since it is the reserve currency country, we report results based on the relationship between the balance of payments on an official settlements basis, scaled by high-powered money, and changes in total high-powered money.

By far, the more consistent relationship for the foreign countries is from changes in foreign reserves to changes in domestic credit. France, Germany, Japan, the Netherlands, the U.K. and, to a lesser extent, Italy all show a significant and negative effect of foreign reserves on domestic assets. In Canada, the sums of the coefficients are positive, but not statistically significant at the lag lengths reported in the table. However, when we extend the lag to six periods for the independent variable, the coefficients became significant and their sum remained positive.

The relationships running in the other direction, somewhat surprisingly, are less well defined. Among the foreign countries, Japan and the U.K. are the only ones in which there is a significant and negative influence of domestic on foreign assets. In the Netherlands, the relationship is significantly different from zero in two instances but the sum of the coefficients is positive.

In the U.S., in two of the periods, we find a significant relationship running from high-powered money to the official settlements balance and no effect in the opposite direction.

In all of the foreign countries, therefore, some type of central bank reaction function seems to have existed over the sample period. The monetary authorities in countries other than Canada apparently tried to offset the effects of balance of payments movements on their domestic money stocks. The Bank of Canada, in contrast, seems to have done the opposite. Desirous, perhaps, of maintaining a stable exchange rate with the U.S. dollar, the Canadians appear to have reacted to balance of payments inflows by engaging in some monetary expansion of their own.

The Federal Reserve's actions -- and the results are hardly at variance with what one would expect for the central bank of a reserve-currency country -- appears to have paid little attention to the balance of payments in conducting policy. That policy, however, seems to have been the source of the sometime sizeable U.S. balance of payments deficits during this period.

Sources of Monetary Change

We ran two other series of regressions and performed the associated Granger tests to analyze the sources of monetary growth in the seven foreign countries in the sample from two slightly different perspectives.[15] In one we compared movements in the three domestic monetary aggregates in each of the countries -- with the movements of their counterparts in the U.S. In the other, we compared the movements in each of the domestic aggregates with movements in foreign and domestic assets of that country's monetary authorities.

The first set of results was not terribly satisfactory. Only in the Canadian and the German regressions were there significant positive relationships between the lagged U.S. aggregate and the comparable domestic aggregate. In both countries, moreover, there were somewhat implausible significant reverse influences in several instances.

The foreign asset and domestic asset versus domestic monetary aggregate tests were slightly better. For all the non-reserve currency countries except the U.K., movements in lagged foreign assets made a statistically significant contribution to the explanation of movements in at least one of the monetary aggregates. Domestic assets, however, were a mixed lot. For three of the countries -- Canada, Italy and the U.K. -- domestic assets had no perceptible influence on any of the three monetary aggregates. For the others -- France, Germany, Japan and the Netherlands -- domestic assets had a statistically significant, but negative, effect.

These latter results make no sense as relationships that explain central bank behavior. Presumably they arise because of spurious correlation, which, in turn, raises questions about the more acceptable results obtained with foreign assets.

V. SUMMARY AND CONCLUSIONS

Our purpose in this paper has been to investigate the channels through which inflation has been transmitted internationally. To do so we have focused upon five areas that featured prominently in our theoretical discussion: the relationship between domestic money and prices, the influence of foreign prices on domestic prices, the influence of foreign interest rates on domestic interest rates, the behavior of the central bank, and the relationships between the components of high-powered money and the monetary aggregates.

The results we have obtained have several major implications. One stems from the money-price relationship. In all countries, our tests showed a significant effect of lagged domestic money on domestic prices, which appears to be fairly robust across the specifications we tried. The strength of these relationships suggests that one-shot and transitory phenomena, e.g., money demand shifts and fluctuations in velocity, are not likely to be the major causative factors of the inflation experienced by these countries. That is, such short-term movements have not dominated the fundamental long-run equilibrium relationship between money and prices. Similarly, given the absence of a consistent reverse relationship, i.e., from prices to money, for most countries, an explanation of inflation that attributes it primarily to wage-push accommodated by domestic monetary growth appears doubtful for most if not all of the countries in the sample.

The second set of results, the domestic versus foreign price comparisons, has more negative than positive implications. They provide no evidence of a strong price arbitrage relationship and thus do not suggest that domestic money was purely passive or that foreign central banks were purely silent partners to the U.S. monetary authorities. In this sense, the second set of results do not contradict our other findings. They imply that the potential existed for a number of the non-reserve currency countries to operate an independent monetary policy, at least in the short run.

The way in which the actual transmission process worked was through asset markets. In all countries but Japan, some evidence of interest arbitrage was uncovered. Additionally, in all but the U.K., changes in foreign reserves had a statistically significant effect on at least one of the three monetary aggregates. Furthermore, in Canada and Germany -- the countries that both had very similar price experiences to that of the U.S. in the period prior to 1972 -- U.S. monetary variables had a significant effect on the domestic monetary variables. Thus, when we combine the price comparison results with the interest arbitrage, and the foreign reserve-domestic monetary aggregate results, we obtain a picture of the operation of a self-regulating mechanism preventing long-run monetary independence but allowing some scope for short-term domestic monetary control.

Another set of implications stems from what we have learned from analyses of changes in the asset components of the central banks' portfolios and of their relationships with changes in high-powered money and the two broader monetary aggregates. These are, however somewhat tenuous. In a number of countries -- France, Germany, Japan, the Netherlands and to some extent Italy and the U.K. -- we find evidence of some sterilization of reserve inflows. For Canada, we found a significant positive effect of reserve inflows on domestic assets.

On the whole, these are a priori appealing results that appear to explain some of the differences among countries: low and moderate inflation countries trying to avoid importing inflation from the U.S. and being at least partially successful; Canada seeking to stabilize its price level and exchange rate vis-a-vis the U.S. dollar; and Italy and the U.K. -- the higher inflation countries -- acquiescing in the face of reserve inflows and perhaps, though the data are mostly moot on this point, going the U.S. one step better in the way of monetary expansion.[16]

NOTES

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[1] See Johnson [1976] and the other papers in the volume in which that paper appears for various expositions of the MABP. Friedman and Schwartz [1963a], especially Chapter 2, present a more general monetary model of the open economy.

[2] Blejer [1977], Cross and Laidler [1976], Jonson [1976] and Laidler [1978] present models of a quasi-open economy.

[3] The papers by Gandolfi and Lothian (1980) and Darby and Stockman (1980), provide two somewhat different approaches to this problem. The authors of the first paper estimate a reduced form price-equation under the assumption that the eight countries are largely closed. They then go on to "open" the model up, introducing foreign money and price shocks into the equations. The authors of the second paper initially adopt a more open framework, developing an internationally integrated simultaneous equations model with a variety of inter-country linkages. They retain the possibility, however, of the model becoming more "closed" by allowing for neutralization of reserve inflows by domestic central banks.

[4] Johnson's paper in Frenkel and Johnson (eds.) is the classic statement of the monetary approach.

[5]Kravis and Lipsey [1978] among others, present evidence counter to the arbitrage hypothesis.

[6]See Blejer [1977] for a model in which the slower adjustment of prices of non-tradeable than of tradeable goods plays a crucial role.

[7]If the monetary change were fully anticipated, the price response would be immediate. The information set used to form anticipations, therefore, has a crucial bearing on the exact timing relationship.

[8]The papers by Frenkel and Rodriguez and by Girton and Henderson describe models of this general sort. In both, however, the authors confine their analysis to organized asset markets.

[9]Sargent [1976] contains a discussion of this form of the test.

[10]The data we use were compiled from individual country sources by the NBER project on the "International Transmission of Inflation."

[11]British results from much longer-term time series consistent with these findings are reported in Huffman and Lothian and for the postwar period in Williams, Goodhart and Gowland.

[12]This same result was obtained for a broad range of Latin American LDC's in Cassese (1979), Chapter VI.

[13]In the U.K. what we call M2 is what the Bank of England calls sterling M3, but unlike their series, it is exclusive of government deposits.

[14]Blejer [1979] presents results of similar tests for four of the countries in our sample France, Germany, Italy and the U.K. and for Sweden. He, however, finds considerably less evidence of sterlization.

[15]The results that we discuss in this section are for the period ending 1971:3 only. Results for the longer period during which exchange rates were more variable were considerably less satisfactory.

[16]The general thrust of these conclusions is highly similar to that of Connolly and Taylor [1979].

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TABLE 1

Money and Price Deflator

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j}$$

Country	Variable[1] Y	X	F - Statistics for Lags (m,n) and Period Ending:[2] 1971:3 m=6 n=3	1971:3 m=8 n=8	1973:4 m=6 n=3	1973:4 m=8 n=8	1976:4 m=6 n=3	1976:4 m=8 n=8
Canada	PD	H	5.0857**	2.8006*	4.2300**	2.2937*	2.3145+	2.3198*
	PD	M1	1.2176	1.0800	1.9479+	1.9383	3.3748*	3.2819**
	PD	M2	2.6210+	3.3309**	3.3975*	2.9488**	1.6940	2.1065*
	H	PD	0.9001	0.9920	0.3877	0.7326	0.7274	0.8209
	M1	PD	0.9338	1.2448	0.5172	0.8475	0.8610	1.4687
	M2	PD	1.2395	1.5719	2.7234*	1.9840+	2.3919	1.2493
France	PD	H	4.7019**	1.7986+	4.6467**	1.7584+	0.8354	0.7941
	PD	M1	0.5858	0.9226	0.3987	1.0925	0.1559	0.4114
	PD	M2	0.1516	0.6431	0.3631	0.2317	0.6683	0.5199
	H	PD	1.0110	2.6440*	1.0153	1.5907	0.7415	1.2736
	M1	PD	1.1399	0.8372	1.1634	1.0560	0.5488	0.8831
	M2	PD	2.4164+	1.6700+	2.4090+	1.2625	0.4447	0.4643
Germany	PD	H	3.5186*	1.0623	2.4042+	1.0295	0.6435	2.4534*
	PD	M1	0.4479	0.3952	0.4683	0.2100	1.1187	1.3269
	PD	M2	1.7745	1.2036	2.0504+	1.2604	0.9762	0.6737
	H	PD	1.5316	1.0373	1.1161	0.4482	0.2838	0.1091
	M1	PD	0.7794	0.7514	0.9441	0.6567	2.1476+	1.2652
	M2	PD	0.0693	0.2920	0.2636	0.6659	0.4931	1.0815
Italy	PD	H	1.1682	1.1094	1.3511	0.8454	0.9918	0.7573
	PD	M1	1.9426	1.2206	3.0492*	2.0289+	1.7427	1.3796
	PD	M2	0.6455	0.7834	2.2500+	2.3987*	1.0636	1.3427
	H	PD	1.8111	0.7057	2.7941*	1.2006	8.7666**	3.4494**
	M1	PD	0.9739	0.5882	0.5743	0.4037	1.2931	0.8135
	M2	PD	0.5978	0.2149	0.4895	0.2453	2.6562+	1.1188

(CONTINUED)

TABLE 1 CONCLUDED

Money and Price Deflator

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j}$$

Country	Variable[1] Y	X	F - Statistics for Lags (m,n) and Period Ending:[2] 1971:3 m=6 n=3	1971:3 m=8 n=8	1973:4 m=6 n=3	1973:4 n=8	1976:4 m=6 n=3	1976:4 m=8 n=8
Japan	PD	H	3.8405*	1.9646+	6.0414**	2.4172*	3.2189*	1.3024
	PD	M1	2.2473+	1.6163	2.2842+	1.8310+	0.9347	1.7369+
	PD	M2	1.1656	1.5835	2.2754+	1.8709+	1.6225	1.4317
	H	PD	1.5237	1.0461	1.3528	0.8219	0.6845	1.0836
	M1	PD	3.0488*	1.2816	1.0183	0.9410	1.8314+	1.5997+
	M2	PD	1.3220	0.9918	1.4421	0.7127	4.2628**	1.4727
Netherlands	PD	H	0.7663	0.6710	0.1439	0.5099	0.2313	0.7476
	PD	M1	2.8542*	2.8115*	3.4698*	2.2073*	1.1498	0.7352
	PD	M2	2.9346*	2.1987*	2.8755*	2.0128+	3.2533*	1.4874
	H	PD	0.1041	0.7291	0.3436	1.1746	0.4657	1.3963
	M1	PD	0.9419	1.0318	0.8451	1.3412	1.7868	1.3853
	M2	PD	0.1341	0.9253	0.8393	1.6698+	0.7360	0.9330
U.K.	PD	H	1.1017	0.9244	1.3687	1.0933	0.2929	1.9991+
	PD	M1	3.5272*	3.6844**	4.2292**	4.1970**	2.1304+	3.9948**
	PD	M2	3.3290*	4.0148**	3.4599*	4.8635**	1.0124	2.3725*
	H	PD	5.9046**	2.3159**	4.2821**	2.8633**	0.6952	1.4133
	M1	PD	0.4415	1.2775	1.5263	1.6117+	2.8020*	2.0691*
	M2	PD	0.2520	1.6050	2.2744+	4.1369**	3.3308*	1.4786
U.S.	PD	H	3.0960*	1.2327	1.1244	0.8451	2.1612+	0.7881
	PD	M1	7.1747**	3.2115**	3.9259*	2.3341*	3.6139*	2.6592**
	PD	M2	5.0927**	2.0143+	2.2580+	1.8163+	2.5727+	2.6491**
	H	PD	1.9995+	2.1232+	2.4702	2.5302*	1.6230	3.6927**
	M1	PD	0.6292	0.3813	0.7209	0.8829	1.0213	0.4108
	M2	PD	0.5870	0.2438	1.3583	0.6631	0.4676	0.5512

1 - All variables are first difference of the natural log; PD is the GNP or GDP deflator, H is high-powered money, M1 is currency plus demand deposits and M2 is currency plus the sum of demand and time deposits.

2 - All regressions start in 1958:2. The null hypothesis is that the γ_j's are as a group equal to zero.

+ - reject null hypothesis at $\alpha = 0.10$
* - reject null hypothesis at $\alpha = 0.05$
** - reject null hypothesis at $\alpha = 0.01$

TABLE 2

Money and Consumer Price Index

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j}$$

Country	Variable[1] Y	X	1971:3 m=6 n=3	1971:3 m=8 n=8	1973:4 m=6 n=3	1973:4 m=8 n=8	1976:4 m=6 n=3	1976:4 m=8 n=8
			F - Statistics for Lags (m,n) and Period Ending:[2]					
Canada	PC	H	1.7304	2.0398+	2.8630*	3.4068**	2.4287+	3.3497**
	PC	M1	0.9011	1.3335	2.3543+	2.6750*	0.9549	1.8960+
	PC	M2	1.8998+	2.3211*	2.1980+	2.4818*	1.7972	1.7089+
	H	PC	0.4004	0.9647	0.7010	0.7435	1.8513+	1.0520
	M1	PC	0.7429	1.2814	0.6568	0.7356	1.1255	0.9205
	M2	PC	1.9417+	1.2898	4.0227**	2.0999*	3.1621*	1.6265+
France	PC	H	3.0838*	1.6784+	5.9429**	2.1667*	2.1861+	1.1267
	PC	M1	0.9035	0.4313	0.8488	0.9236	0.9707	0.7959
	PC	M2	0.9320	0.8640	1.5080	0.6122	1.2368	0.5168
	H	PC	1.0301	1.1479	0.6391	0.8123	1.1896	0.9482
	M1	PC	0.1366	0.7419	0.0794	0.8701	0.6667	1.0880
	M2	PC	0.0472	1.1412	0.4648	1.0315	0.4843	0.8597
Germany	PC	H	0.3373	0.6452	0.7065	0.6828	0.6488	0.7574
	PC	M1	3.6700*	2.0091+	2.2902+	1.1840	0.8899	0.4544
	PC	M2	2.0487+	0.9324	3.6316*	1.4334	2.0873+	1.0248
	H	PC	1.3580	1.5144	0.7117	0.6157	0.1522	0.3870
	M1	PC	0.1615	0.5855	0.2980	0.2447	0.3265	0.1900
	M2	PC	0.0639	0.5631	0.1868	0.6004	0.2075	0.7861
Italy	PC	H	2.0895+	1.7326+	2.2146+	1.4969	0.4835	0.5277
	PC	M1	0.7485	1.1998	0.6685	1.2960	2.5815+	1.4106
	PC	M2	0.0562	1.4058	0.5205	1.9588+	2.6051+	1.9020+
	H	PC	1.6496	1.5617	2.3577+	2.0966+	6.1068**	2.6657**
	M1	PC	1.2290	0.9196	1.0196	0.9489	2.7236*	1.1030
	M2	PC	0.8907	0.4999	1.3936	0.9262	5.1792**	2.2908*

(CONTINUED)

TABLE 2 CONCLUDED

Money and Consumer Price Index

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j}$$

Country	Variable[1] Y	X	F - Statistics for Lags (m,n) and Period Ending:[2] 1971:3 m=6 n=3	1971:3 m=8 n=8	1973:4 m=6 n=3	1973:4 m=8 n=8	1976:4 m=6 n=3	1976:4 m=8 n=8
Japan	PC	H	2.5529+	2.2855*	5.5676**	2.7080*	8.8263**	2.8386**
	PC	M1	0.8923	1.3026	1.3859	2.6490*	0.1656	1.6207+
	PC	M2	1.2829	0.4988	1.7822	0.1308	1.7505	0.5856
	H	PC	1.0003	0.5991	0.5468	0.3308	1.3736	0.9399
	M1	PC	1.2112	1.6718+	0.8157	0.9009	1.6885	1.2710
	M2	PC	0.3674	0.5470	0.1371	0.7524	1.8995+	1.7773+
Netherlands	PC	H	1.4213	0.7616	0.9301	0.6842	0.7642	0.5470
	PC	M1	5.4306**	3.5512**	6.8611**	3.6791**	1.8408+	1.1385
	PC	M2	3.7966*	2.5407*	4.5943**	2.9069**	3.8946*	2.6756**
	H	PC	0.7038	0.6883	0.3858	0.6059	0.6452	0.7099
	M1	PC	1.9109+	0.9570	1.8164	0.8057	1.8521+	0.9979
	M2	PC	0.4137	0.8526	1.5806	1.5429	2.1967+	1.5192
U.K.	PC	H	4.9425**	2.2847*	5.6819**	2.6542*	3.2730*	4.0026**
	PC	M1	1.3392	0.9494	1.6227	1.1369	0.7719	1.8216+
	PC	M2	0.4981	1.1294	2.3374+	1.7292+	1.6433	2.4200*
	H	PC	1.0225	0.7083	0.5323	1.1533	1.2367	2.1754*
	M1	PC	3.2914*	1.8360+	4.4124**	2.9159**	5.7665**	2.5341*
	M2	PC	3.7181*	1.7491+	5.1800**	2.8629**	1.0491	0.7693
U.S.	PC	H	3.3590*	1,6969+	1.3730	1.1135	2.3505+	1.2689
	PC	M1	4.5219**	5.0305**	6.6044**	3.9097**	8.6231**	4.2129**
	PC	M2	0.5545	2.8073*	1.3136	3.1041**	2.4869+	3.2708**
	H	PC	0.1369	0.3614	0.4343	0.3393	0.2956	0.4610
	M1	PC	2.4532+	1.8937+	2.6349+	2.2025*	1.8309	1.5376
	M2	PC	0.9170	1.9163+	1.2794	2.2896*	0.8068	1.9386+

1- All variable are first difference of the natural log; PC is the consumer price index, H is high-powered money, M1 is currency plus demand deposits and M2 is currency plus the sum of demand and time deposits.

2 - All regressions start 1958:2. The null hypothesis is that the γ_j's are as a group equal to zero.

\+ - reject null hypothesis at $\alpha = 0.10$
* - reject null hypothesis at $\alpha = 0.05$
** - reject null hypothesis at $\alpha = 0.01$

TABLE 3

Price Arbitrage

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j}$$

Country	Variable[1] Y	Variable[1] X	F-statistic[2] m=6 n=3	Variable Y	Variable X	F-statistic m=6 n=3
Canada	PD	PDw	1.6741	PD	PDus	1.6765
	PDw	PD	3.4386*	PDus	PD	0.5394
France	PD	PDw	3.0056	PD	PDus	0.9744
	PDw	PD	3.9842**	PDus	PD	0.4912
Germany	PD	PDw	0.2701	PD	PDus	3.9752*
	PDw	PD	0.8389	PDus	PD	1.1123
Italy	PD	PDw	1.1179	PD	PDus	0.3129
	PDw	PD	1.3534	PDus	PD	1.1805
Japan	PD	PDw	2.3618+	PD	PDus	0.6907
	PDw	PD	0.6436	PDus	PD	1.4863
Netherlands	PD	PDw	1.2523	PD	PDus	1.3365
	PDw	PD	0.9483	PDus	PD	0.3511
U.K.	PD	PDw	0.3151	PD	PDus	2.0759+
	PDw	PD	0.3744	PDus	PD	0.4319
U.S.	PD	PDw	1.4831	PD	PDus	
	PDw	PD	2.4181+	PDus	PD	

1 - All variables are the first differences of the natural log. PD is the GNP or GDP deflator, PDw is the rest-of-world deflator and PDus is the GNP deflator for the United States.

2 - All regressions 1958:2 to 1971:3. The null hypothesis is that the γ_j's as a group are equal to zero.

\+ - reject null hypothesis at α = 0.10.
* - reject null hypothesis at α = 0.05
** - reject null hypothesis at α = 0.01.

TABLE 4

Interest Arbitrage

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j}$$

Country	Variable[1] Y	X	F-statistic[2] m=6 n=3
Canada	IS	ISus	3.3243*
	ISus	IS	1.6404
France	IS	ISus	2.7322*
	ISus	IS	0.8850
Germany	IS	ISus	3.6046*
	ISus	IS	4.9406**
Italy	IL	ILus	3.9248*
	ILus	IL	1.4547
Japan	IS	ISus	0.2948
	ISus	IS	1.4438
Netherlands	IS	ISus	5.9041**
	ISus	IS	1.0401
U.K.	IS	ISus	3.8546*
	ISus	IS	0.8776
U.S.	IS	ISus	
	ISus	IS	

1 - The interest rates are in first difference form. IS is the short-term interest rate for each country except Italy for which the long-term interest rate is used. ISus is the short-term interest rate for the United States.

2 - All regressions 1958:2 to 1971:3. The null hypothesis is that the γ_j's as a group are equal to zero.

\+ - reject null hypothesis at $\alpha = 0.10$.
* - reject null hypothesis at $\alpha = 0.05$.
** - reject null hypothesis at $\alpha = 0.01$.

TABLE 5

Domestic Credit and the Balance of Payments

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j}$$

Country	Variable[1] Y	X	F - Statistics for Lags (m,n) and Period Ending:[2] 1971:3 m=3 n=3	1973:4 m=3 n=3	1976:4 m=3 n=3
Canada	FH	DH	1.2185	1.4081	1.6945
	DH	FH	0.8582	1.0134	1.0938
France	FH	DH	0.1140	0.4690	0.1017
	DH	FH	3.8398**	2.7887*	2.4045+
Germany	FH	DH	0.2463	0.6432	0.4089
	DH	FH	2.2295+	3.3784*	3.9930**
Italy	FH	DH	0.1142	0.4898	1.0168
	DH	FH	0.8010	1.0569	2.2833+
Japan	FH	DH	0.8563	1.9006+	1.5299
	DH	FH	2.4706+	2.9194*	1.9233+
Netherlands	FH	DH	0.9079	2.7864*	2.7909*
	DH	FH	4.6111**	4.3709**	6.0623**
U.K.	FH	DH	0.3949	0.8334	1.4041
	DH	FH	0.1568	2.4819+	2.5390+
U.S.	BP	H	0.5770	2.0949+	2.6524+
	H	BP	1.2728	1.1110	1.0156

1 - The variables for Canada, Germany, Italy and Japan are first difference of the natural log. The variables for France, Netherlands, U.K. and U.S. are arithmetic first differences scaled by high-powered money. FH is official reserve assets, DH is domestic credit, BP is the U.S. official settlements balance and H is high-powered money.

2 - All regressions start in 1958:2. The null hypothesis is that the γ_j's are as a group equal to zero.

+ - reject null hypothesis at $\alpha = 0.10$
* - reject null hypothesis at $\alpha = 0.05$
** - reject null hypothesis at $\alpha = 0.01$