MONEY, INCOME, AND PRICES: THE VELOCITY OF MONEY IN NINE MAJOR O.E.C.D. ECONOMIES

by

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CHAPTER 1

INTRODUCTION

The fifteen year period from 1959 through 1973 witnessed a broad spectrum of economic phenomena. Perhaps the single most persistent, disturbing, and ultimately, destructive of governments and established international institutions was that of inflation. For most of the industrialized world inflation was present throughout the period, and from the late 1960's through 1973 it tended to accelerate. A weighted average of prices in nine major OECD countries excluding the United States increased 22.3 percent over the five year period 1965 to 1970, and 21.5 percent from 1970 to 1973, corresponding to an increase of more than sixty percent in the average annual rate of inflation.*

The problem of inflation and its implications for the fixed exchange rate system ultimately became so serious that on August 15, 1971 the United States officially terminated gold convertibility of the dollar. With no relief in inflation rates and with pressures still mounting there was wholesale abandonment of the fixed exchange rate system in early 1973.

Theories attempting to explain this recent round of inflation abound. However, of the many theories which attempt to explain changes in nominal income and the general price level, few enjoy the long and

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*The figures were derived from a weighted average of rates of change in the consumer price index for nine countries. See Meiselman (1975) for details of this and related series.

established tradition of the quantity theory of money. That the central role ascribed to the money stock in the determination of the price level and nominal economic activity should have been recognized clearly over two centuries ago stands as testimony to its power.

> The broad outlines of the quantity theory of money were fully developed by the eighteenth century. The contemporary economist can still read David Hume's essay "Of Money" (1752) with pleasure and profit and find few if any errors of commission. (Friedman 1968: 433)

Consistent with the long recognized proposition that secular changes in prices and nominal income are associated with changes in the money stock are centuries of accumulated evidence. In a recent survey article Schwartz (1973) studied inflations and deflations over the last two and one half millenia and concluded that price changes, virtually without exception, have mirrored monetary changes since records of these phenomena have been kept.

The Quantity Theory

Perhaps the simplest and most familiar statement of the relationship between money, prices, and real income embodied in the quantity theory is captured in the income variant of Fisher's equation of exchange,

$$M V = P y, \qquad (1)$$

where M is the money stock; V is income velocity; P is the general price level; and y is real income (output). The product of P and Y is nominal income, denoted Y.

At the most superficial and naive level of analysis the quantity theory equation represents nothing more or less than a tautology. Ex post, of course, it clearly is no more than an accounting identity. But by making certain assumptions about the behavior of velocity the quantity

theory, as represented by Fisher's equation, becomes a testable proposition stating a specific relationship between money and nominal income.

Ultimately the relevance of the quantity theory rests on the stability of velocity. If, as the Keynesians have maintained, under broadly applicable conditions, velocity were unstable, responding to changes in nominal income, the money stock, or other factors, then the quantity theory is devoid of predictive content. Rather, quantity theorists have variously assumed that velocity is a constant, in the extreme, or a slowly varying quantity determined by other variables outside the quantity theory equation.

At its heart the quantity theory of money is not a theory of nominal income determination, nor is it a theory of the determination of the general price level but a theory of the demand for money.(Friedman 1962:52) Moreover, stability of velocity ultimately derives from the stability of the demand for money. The analytical usefulness of the quantity theory of money in the study of changes in nominal income and in prices depends in the main on a demand for money which in inelastic in its arguments and not " ... a will-o'-the-wisp, shifting erratically and unpredictably with every rumor and expectation." (Friedman 1969:63)

Assuming velocity is stable, then, is tantamount to asserting a tendency toward proportionality between money balances and nominal income,

$$M\,V = Y, \tag{1a}$$

and to asserting a tendency toward proportionality between the price level and the stock of money per unit of output,

$$P = V(M/y). \tag{2}$$

These assertions are made in the form of causal linkages running from changes in the money stock to changes in nominal income, and from changes in the stock of money per unit of output to changes in the general price level.

Extending quantity theory analysis to the recent episode of worldwide inflation Meiselman (1975) argued that this round of inflation was due primarily to excessive monetary growth. Using data based on weighted averages of percentage rates of change in the money stock, consumer price index, and nominal GNP for nine major OECD economies excluding the United States, he found that velocity in the "rest-of-the-world" (as he called this aggregate) was highly stable, having an average annual rate of change of only -0.8 percent over the fourteen year period 1960 to 1973. The associations between the money stock per unit of output and the price level and between the money stock and nominal income were exceptionally close with r-square statistics of .98 and .99 respectively. On the basis of this and other evidence he concluded in part that " ... the evidence is clear that the large increases in nominal expenditures ... in the 'rest-of-the-world' were the result of large increases in money rather than in velocity."

Purpose of the Study

The apparent stability of aggregate velocity reported by Meiselman is suggestive of a further avenue of research. Specifically, it is the purpose of this study to investigate the intra- and international characteristics of the income velocity of money.

Major Earlier Studies

There have been only a few studies into the question of international velocity that have reached the published literature. One of the earliest of these was a study by Ernest Doblin(1951). Doblin studied velocity in a varying number of countries as far back as 1877, depending on data availability. With respect to his observations on the long term movements in velocity he noted that most countries followed the same general trends, tending to decline until World War I, rising until 1930, falling dramatically at the onset of the great depression, and rising thereafter until World War II.

A number of other studies including Ezekiel and Adekunle (1969) and Melitz and Correa (1970) have investigated international differences in velocity but focused on cross sectional variation in velocity. Their results indicate a significant role for interest rates and for the level of economic development in explaining differences in velocity. However, both studies used multiyear averages of data on money and income, and as a consequence, abstracted from intertemporal variation and covariation in international velocity series.

Limitations and Qualifications.

Using annual and quarterly data over the period 1959 through 1973 for the nine countries aggregated by Meiselman, this study investigates the temporal variability of individual velocity series, as well as tendencies toward covariation in velocity among the countries under study. However, it is not the intent of this investigation to explain differences in the level of velocity between countries. To explain the observed

international behavior of prices and nominal incomes within the framework of the quantity theory, it is sufficient to find patterns of stability in velocity, not necessarily identity in the levels of velocity internationally.

The Quantity Theory in Closed and Open Economies

Because the quantity theory is intimately involved with considerations of the supply of, as well as the demand for, money, careful attention must be paid to the influence of institutional settings both with regard to theoretical and empirical conclusions. Typically, quantity theory analysis has been conducted within the implicit framework of a closed economy. Because much of the work of the neo-classical quantity theorists has centered on the United States, there is very little reason to find fault in this assumption. However, when quantity theory analysis is extended to other economies, as is the case with this study, explicit consideration must be given to the effects of openness in the economy on the analysis.

Consider the familiar case of a monetary disturbance in a closed economy. From an initial equilibrium suppose that the money stock is increased through actions of the monetary authority. Since real income and the price level are initially undisturbed, there exists an initial excess supply of nominal money balances. In an attempt to re-establisn individual equilibrium part of the excess balances are exchanged for bonds and goods. However, rather than disappearing, these excess money balances are merely transferred from their initial recipients to others. Thus the monetary disturbance is propogated throughout the economy. Corre-

sponding to the excess supply of nominal balances there is an aggregate excess demand for goods. In the absence of an increase in real output the excess demand must be resolved by an increase in the price level which ultimately clears the goods market as well as decreasing the money stock in real terms until it equals real money demand.

In terms of the quantity theory equation (1) the relationship between the money stock, velocity, prices, and real income is

$$M\,V = P\,y.$$

By taking log derivatives the quantity equation may be transferred into an expression in rates of change(denoted by superscript dots):

$$\dot{M} + \dot{V} = \dot{P} + \dot{y} \qquad (3)$$
$$= \dot{Y}.$$

Assuming velocity is constant, and real income is fixed, equation (3) implies that the relative change in the price level is identical to the relative change in the money stock. To the extent that real income increases the implied change in the price level from a change in the money stock is reduced by the rate of growth in real income. Thus

$$\dot{P} = \dot{V} + \dot{M} - \dot{y}, \qquad (4)$$

which is a transformation of equation (2).

It is not necessary to assume absolute constancy in velocity in order to explain changes in the price level from changes in money and real income. If velocity is rising or falling in some predictable manner such as by a constant rate of change then equations (3) and (4) are no less applicable.

In this closed economy framework the nominal money stock is explic-

itly under the control of the monetary authorities. However, they do not have control over the real money stock, which is determined by conditions of demand. Thus given the level or rate of growth in velocity and, the rate of growth in real income, the rate of growth in nominal income and the price level is ultimately the responsibility of the monetary authority.

In an open economy under fixed exchange rates the assumptions regarding control of the nominal money stock and the mechanism of adjustment to disturbances of equilibrium must be altered. Specifically, under these conditions the general public has the potential for determination of the nominal money stock.

Suppose that from an initial equilibrium the monetary authority increases the money stock. As in the previous case an excess supply of money and corresponding excess demands for goods and bonds are created. The excess demands for goods and bonds imply upward pressure on prices and downward pressure on interest rates. However, the price increase incumbent on imports and non-traded goods, and the downward interest rate pressures on capital markets lead to increases in imports relative to exports and to capital outflows relative to inflows. The net effect on the balance of payments is to move it into a deficit implying an outflow of money until equilibrium is re-established.

In fact this mechanism of adjustment of the nominal money stock to conditions of the demand for money does not necessarily require that money flow internationally. Within the context of an external inflationary disturbance to equilibrium, Johnson(1973: 516) noted:

> Since the public can adjust its money holdings to the level it desires through current and capital transactions with the rest of the world, the choice for the country's monetary authority is not between having inflation and not having it, but between letting the increased money supply ... be created by an inflow of international reserves which it has to hold, and financing it by domestic credit expansion.

The case of an open economy with perfectly flexible exchange rates is essentially identical to the case of a closed economy insofar as control over the nominal money stock is returned to the monetary authorities. Flexible rates preclude disequilibrium in the foreign sector with exchange rate fluctuations offsetting price and interest rate pressures with the result of overall balance of payments equilibrium.

The concepts of open and closed economies and of fixed and flexible exchange rates tend to be idealized in theory. In practice, and as they relate to this study, there are no clear-cut distinctions. The economies under study are not absolutely closed, and the extent of their openness, however quantified, has surely varied over the period covered by this study. Similarly, it is likely that the degree of flexibility in exchange rates has varied.

The effects of economic openness and fixed exchange rates on the analysis of money-income-price level linkages, especially in short-run dynamic analysis, is difficult to specify with precision in the absence of a particular money demand function. However Friedman(1959) suggested a formulation from which certain qualitative results emerge. In particular assume that the demand for money is a function of permanent nominal income (Y_p) and the permanent price level (P_p) so that

$$\frac{M}{P}_p = \gamma\left(\frac{Y_p}{P_p}\right)^{\delta}, \qquad (5)$$

or

$$\frac{M}{P}_p = \gamma\, y_p^{\ \delta}, \tag{5a}$$

where y_p is permanent real income. In terms of the demand for nominal balances, the demand function is

$$M = \gamma\, Y_p^{\delta}\, P_p^{1-\delta} \quad . \tag{6}$$

If the assumption made by Friedman that permanent magnitudes are derived as

$$X_p(T) = \beta \int_{-\infty}^{T} \exp\left[(\beta - \alpha)(t - T)\right] X(t)\, dt \ , \tag{7}$$

is accurate, then it is clear that equation (6) describes a demand function for money involving lagged values of nominal income. By virtue of the analysis of open fixed-rate economies presented earlier, it is clear that such a demand function also implies, to a greater or lesser degree, that the money supply is also a function of these variables.

Given these considerations, it should not be unlikely that the empirical results indicate temporal and, by common implication, causal linkages running from prices and income to money. Such evidence does not refute the proposition that changes in the money stock are of prime importance in explaining changes in the price level or nominal income. It does suggest, however, that a world rather than national money stock may be the relevant variable in a quantity theory framework.

Monetary Structure and Policy

As with the international setting of an economy, so, too, does the particular monetary structure and policy affect the interpretation of the quantity theory as it applies to specific economies. Institutional structure, available monetary policy instruments, and the targets chosen by the monetary authority for active control all affect the degree of endogeneity of the money supply. To the extent that the money stock responds to conditions of demand it may be difficult to discern evidence of the importance of money for the level of nominal economic activity. Further, to the extent that the money stock is subordinated to other policy targets such as interest rates, the amplitude and duration of cyclical economic disturbances may be exaggerated. Thus an understanding of some of the elements of the framework and conduct of monetary policy is essential background for the interpretation of international quantity theory tests.

Belgium. Although commercial banks as a class of institution have long functioned in the Belgian economy, their share of the money stock has historically been rather low relative to other European economies. The ratio of currency to deposits did not fall below unity until 1968, although the currency-deposit ratio has shown a strong secular drift downward. It may in part be due to this late development of sight deposits as the dominant means of payment that the institutions empowered with the traditional instruments of monetary policy emerged only relatively recently, and in a piecemeal fashion.

The central bank, the Banque Nationale de Belgique (BNB), functions

chiefly as the agency of note issue and lender of last resort. Two other agencies, the Institute of Rediscount and Guarantee (IRG) and the Banking Commission, are charged with rediscounting and the imposition of reserve requirements and cover ratios respectively. A fourth agency, the Securities Stabilization fund (SSF), is primarily responsible for open market operations.

Considerations of finance of government activity have frequently contributed to possibly inflationary increases in the money stock. Stabilization of interest rates at artificially low levels to accomodate government finance has been a major policy of the SSF. (Hodgman 1974: 20)

Finally, the principal instruments of monetary policy in Belgium appear to be " ... various forms of direct intervention and quantitive regulation to influence the amount, cost, and allocation of credit." (Hodgman 1970: 23)

Canada. Unlike the Belgian case, Canadian monetary policy has been quite actively engaged in control of monetary aggregates. The Bank of Canada, the central bank, is the agency responsible for the implementation of monetary policy.

The primary instruments of monetary policy appear to be reserve management by changes in reserve requirements, cash management, and moral suasion. The latter two policy tools are significant largely due to the small number of chartered banks in Canada.

The money stock has not been a significant target for Canadian monetary policy. Rather, policy has been oriented to regulation of interest rates and credit availability. (Courchene 1971: 40)

Over the period 1959 to 1973 Canada shifted from floating to fixed rates (1962) and back to floating rates (1970). During the period of fix-rates monetary policy was

> ... almost continuously dictated or constrained by exchange rate considerations ... [and] if the Bank's desire to pursue restrictive measures had not coincided with the policies being pursued in the United States, the ability to pursue monetary restraint would virtually have disappeared. (Pesandro and Smith 1973: 104)

Pesandro and Smith conclude that in general Canadian monetary policy has been " ... conducted in opposition to fiscal policy, in concert with fiscal policy, and in the virtual absence of fiscal policy." (1973: 70)

France. With the exception of Belgium, currency bulks larger in the money stock of France than in any other country under study. As in Belgium sight deposits in banks and the postal checking system have recently constituted a rising proportion of the money stock.

The central bank, the Bank of France, has at its disposal the classic tools of monetary policy. However, until recently qualitative controls have been of major importance, especially selective credit controls. (Dieterlen and Durand 1973: 130)

Open market operations and reserve requirements, as implemented by the French, have been exercised on so small a scale as to be practically ineffectual. (Hodgman 1974) Moreover, although French banks are ostensibly subject to discount ceilings, rediscounting of certain paper is not subject to effective regulation. As a result of the so-called privileged rediscounting the Bank of France has essentially relinquished control over the money stock and " ... the privileged rediscount channels have allowed the money supply to expand in response to the presentation of for

rediscount of the privileged types of credit paper," (Hodgman 1974)

Germany. The German central bank came into existence in 1957. The Deutsche Bundesbank was specifically chartered with the monetary policy instruments of minimum reserve requirements, discount rate and quota determination, and open market operations, and oversees an extensive banking network.

Monetary policy in Germany has traditionally concentrated on reserve requirements and discount policy. (Hodgman 1974: 60) Open market operations are primarily carried out in special Treasury instruments supplied for the purpose of the OMO, a fact which has tended to restrict the size and scope of the operations. (Schlesinger and Bockelman 1973: 180) Thus the German monetary authority has been significantly constrained in its ability to influence market interest rates.

Because of the almost constant balance of payments surpluses run by the Federal Republic of Germany, a significant aspect of their central bank policy has involved neutralization of the monetary effects of these reserve inflows. The major techniques employed have been the partial or complete sterilization of non-resident deposits, and the swap policy implemented by the Bundesbank by which the Bundesbank has offered forward exchange rate cover more favorable than in the open market in an attempt to encourage foreign investment of inflowing foreign exchange.

Italy. Banking concentration is relatively substantial in Italy. Two classes of banks, the banks incorporated under public law and the so-called banks of national interest, while numbering only nine, account for nearly one half of all bank assets in Italy. This concentration, to-

gether with statutory powers of the central bank, allows the Bank of Italy to exercise virtually complete control over financial markets in Italy.

Monetary policy in Italy has typically relied on administrative control of credit markets. Essentially there has been no discount rate policy and the volume of discounts has been the variable of interest. (Hodgman 1974: 93) Similarly minimum reserve requirements have been set with the intent of allocating credit rather than controlling the money stock. (Hodgman 1974: 93) With respect to open market operations there has been no attempt by the central bank to " ... avail itself 'systematically' of such a power in pursuing effective open-market policies." (Ferrari 1973: 222) In the main, Italian open-market operations have been conducted only periodically and with such objectives as the pegging of interest rates.

Japan. The commercial banking system in Japan is remarkably narrow with only seventy-six banks, yet it is evidently quite efficient since the average currency to deposit ratio in Japan over the period 1959 to 1973 was the lowest of the nine countries under study at about thirty percent. Banks are of vitally significant importance to Japanese corporate finance, and heavy corporate borrowing has derivatively produced great reliance of the banking system on the Bank of Japan. As a result monetary policy in Japan has evolved with emphasis on bank borrowing from the central bank.

Open market operations do not constitute an important policy tool for money stock control in Japan. The operations are carried out primar-

ily in long term securities and as a result the possibility of capital gains or losses restrict the extent of operations. (Mikitani 1973: 270)

Discount rate policy has been largely ineffectual because the rate typically remained low enough that rediscounting was the marginally cheapest source of funds. (Keran 1970a: 176) As a consequence rationing in the form of so-called "window guidance" became a major tool of monetary policy.

Using these instruments significant counter-cyclical monetary policy has been pursued in Japan in recent years. In large measure restrictive monetary policy has coincided with periods of inflation and balance of payments deficits. On balance

> the long term aim of Japanese monetary policy has been to foster economic growth by supplying rapidly growing industries with low-cost funds while trying to preserve price stability. (Mikitani 1973: 274)

Netherlands. The Netherlands is a small, relatively open economy in which the monetary authority has the potential for close control over the domestic money supply process. As noted by den Dunnen (1973: 290) the largest three banks control seventy percent of the banking business, and the largest ten control ninety percent.

Close control over monetary aggregates has in fact been exercised by the Netherlands Bank, a not surprising fact given the avowedly quantity theoretical disposition of the Bank.* However, rather than control the money stock, the Netherlands Bank has focused its attention on a broader

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*See Holtrop (1972), a former president of the Netherlands Bank, for an elaboration of the Bank's philosophical viewpoint.

"liquidity" concept (Holtrop 1972). Moreoyer, although the classic tools of money management are at its disposal, the central bank has preferred to use direct credit controls. Indeed, reserve requirements went unaltered from 1963 until the end of 1972, and no open market operations were executed from 1964 until 1971. Hodgman (1974) suggests that the underlying reason for this posture is the extent of openness of the Dutch concern over interest changes stimulating capital flows.

Switzerland. Behind the Netherlands and Belgium, Switzerland is the most open of the economies under study as judged by the ratio of experts to GNP. But this openness is hardly adequate to explain the extraordinary Swiss financial sector. Evidence suggests that the Swiss money stock has its basis virtually entirely in foreign reserves. Lademann (1973) estimated that at the end of 1971 approximately 95 percent of the assets of the Swiss National Bank comprised claims against foreigners. Further, " ... apart from the two reserve currency countries, the United States and United Kingdom, Switzerland's banking system has the biggest foreign liabilities of any country in the world." (1973: 429)

The statutory powers of the Swiss National Bank include discount policy and open market operations. However, the inflow of foreign reserves was such for many years that recourse to discounting was unnecessary. Similarly, the open market operations would ordinarily have been necessary to control money stock expansion due to the foreign inflows. The National Bank, however, was essentially without a portfolio of securities with which to engage in the operations. (Lademann 1973: 439)

Swiss monetary policy has been virtually continuously concerned with

control of the tendencies toward excess liquidity in the banking system. Lacking effectiye statutory powers the National Bank has tended to rely on agreements with the banks on the control of domestic credit expansion. From time to time such agreements have been given the force of law. Yet due to the nature of the Swiss legal structure they cannot be made permanently legally binding. (Lademann 1973). Thus effective Swiss monetary policy has been essentially crisis oriented, and will likely remain so.

United Kingdom. It is indicative of the role that the money stock has played in British monetary policy that official money stock series were not gathered and published until 1966. Rather, attention of the Bank of England has focussed on interest rates, debt structure, and credit flows (Hodgman 1971). Hodgman goes on to note that the central bank has preferred to conduct its policy according to the outlines of the Radcliffe Report by which the Bank of England

> ...may simultaneously (1) raise short-term rates for balance-of-payments purposes, (2) keep long-term rates constant so as not to reduce investment or generate debt monetization from expectations of falling gilt-edge prices, (3) finance a budget deficit through the banking system without regard for the growth in money supply and wealth effects that it occasions, and (4) keep down the pressure of aggregate demand by administrative controls over the volume of lending by banks and other financial institutions ... (1971: 775)

These objectives were pursued by the Bank of England in spite of the fact that the instruments of policy were discount rate policy and open market operations. These instruments, as Hodgman (1974: 221) notes, are more appropriate to money stock control than the broader targets adopted by the Bank.

The poor performance of the monetary authority in this respect led, ultimately, to the reforms of 1971. The reforms essentially entailed cessation of support of the gilt-edge market by the Bank, institution of minimum reserve requirements, and the encouragement of price rather than quantity controls in the credit markets. However, the evidence does not tend to support the proposition that these reforms have caused the Bank to exercise greater control over the money stock. In the two years following the reform, the compound annual rate of growth in the British money stock exceeded thirteen percent. Thus, it is not clear whether the British monetary authority has altered in effect its historical liquidity approach to monetary policy.

Chapter 2

DATA USED IN THE STUDY

In undertaking this study of the monetary sources of short-term economic fluctuations in the nine countries selected, one of the major problems encountered was the lack of quarterly GNP series for a majority of the countries. Of the nine countries only Canada, Germany, Japan, and the United Kingdom report quarterly GNP series for the full period. Partial series are available for Belgium and Switzerland covering the periods 1968_I to 1973_{IV} and 1965_I to 1970_{IV} respectively. France, Italy, and the Netherlands report no quarterly GNP. In order to proceed with the study, then, estimates of quarterly GNP are necessary for the five countries in which complete series are unavailable.

In each of the five countries for which complete series are missing there exist related series which may be assumed to contain information closely and significantly related to quarterly GNP. They are: the quarterly consumer price index (CPI); the quarterly index of industrial production (IIP); and annual GNP.

In an earlier study Keran (1970b) encountering the same problem, used a proxy based on the product of the CPI and IIP times the annual GNP figure in the (common) base year of the CPI and IIP. While Keran judged his estimator adequate, the statistical properties of the estimator are completely unknown, the proxy used being basically an ad hoc procedure. Therefore, after reviewing Keran's work, it was decided that a more carefully grounded estimate of quarterly GNP was necessary.

The existing literature on missing observations, while significant, is largely inapplicable to the problem at hand. Afifi and Elashoff (1966)

in a survey article enumerate and discuss several estimation techniques. However, in general, the methods presented are inapplicable to the problem at hand since they represent techniques for estimation of regressions in which the pattern of the missing observations is stochastic and in which no vector is completely absent.

BLUE Estimation of Quarterly GNP

Among the techniques for direct estimation of the missing series the procedure of Chow and Lin (1971) appears to be most general and has been adopted for generation of the missing data in this study. The problem at hand may be stated as follows: given quarterly observations on related series and annual observations on GNP, derive the BLUE (best linear unbiased estimator) of quarterly GNP.

Because the series under consideration is a flow variable rather than a stock variable, the problem is properly one of distribution rather than interpolation. That is, given the value of the flow of income over one year, determine its distribution among the four component quarters.

Denote by X the n by m matrix of quarterly observations on the m related series and by y the n by 1 vector of (missing) observations on quarterly GNP. Assume that y is a linear function in X and a stochastic error term u so that

$$y = X b + u,$$

where

$$E\, u = 0$$

and

$$E\, u\, u' = V.$$

Let C be an n/4 by n matrix which converts the quarterly series to annual series so that

$$C = 1/4 \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & \cdots & & & & & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 0 & \cdots & & 0 \\ & & & & & & & & & & & \\ 0 & \cdots & & & & & & & 0 & 1 & 1 & 1 & 1 \end{bmatrix}.$$

Thus

$$\underline{y} = Cy = C\,X\,b + Cu = \underline{X}b + \underline{u}\,,$$

where the underscore denotes annual data.

It follows that

$$\begin{aligned} E\,\underline{u} &= E\,C\,u \\ &= C\,E\,u \\ &= 0, \end{aligned}$$

and

$$\begin{aligned} E\,\underline{u}\,\underline{u}' &= E\,C\,u\,u'\,C' \\ &= C\,(E\,u\,u')\,C' \\ &= C\,V\,C' \end{aligned}$$

which will be denoted $\underline{V}$.

Chow and Lin provide the following estimator for y:

$$y^* = Xb^* + V\,C'\,\underline{V}^{-1}\,\underline{u}^*$$

where

$$b^* = (\underline{X}'\,\underline{V}^{-1}\underline{X})^{-1}\;\underline{X}'\,\underline{V}^{-1}\,\underline{y}$$

is the vector of coefficient estimates based on the annual data, and

$$\underline{u}^* = \underline{y} - \underline{X}\,b^*$$

is the vector of estimated annual disturbances.*

*The BLUE property of this estimator is easily demonstrated. Note that the estimator may be written

$$y^* = [\, X\,(\underline{X}'\underline{V}^{-1}\underline{X})^{-1}\,\underline{X}'\underline{V}^{-1} + VC'\underline{V}^{-1} - VC'\underline{V}^{-1}\underline{X}\,(\underline{X}'\underline{V}^{-1}\underline{X})^{-1}\underline{X}'\underline{V}^{-1}]\underline{y}$$

$$= Q\,\underline{y}$$

so that it is linear in $\underline{y}$. Unbiasedness implies that $E\,(y^* - y) = 0$. Now

$$E\,(y^* - y) = E\,(Q\,\underline{X}\,\beta + Q\underline{u} - X\beta - u)$$

$$= E\,(X\,\beta + Q\underline{u} - X\,\beta - u)$$

$$= Q\,E\,\underline{u} - E\,u$$

$$= 0.$$

The covariance of the estimator is

$$E\,(Q\,\underline{u} - u)\,(Q\,\underline{u} - u)' = E\,(Q\,\underline{u}\,\underline{u}'\,Q' - Q\,\underline{u}\,u' - u\,\underline{u}'\,Q' + u\,u')$$

$$= Q\,\underline{V}\,Q' - Q\,C\,V - V\,C'\,Q' + V.$$

To show that the estimator is best among linear unbiased estimators let

$$T^*\,\underline{y} = (\,T + Q)\,\underline{y}$$

be an estimator of y. T^* is obviously linear in $\underline{y}$. Unbiasedness requires that $E\,(T^*\underline{y} - y) = 0$. Expanding,

$$E\,(T^*\,y - y) = E\,(T\,\underline{y} + Q\,\underline{y} - y)$$

$$= E\,(T\,\underline{X}\,\beta + T\,\underline{u} + Q\,\underline{X}\,\beta + Q\,\underline{u} - X\,\beta - u)$$

$$= T\,\underline{X}\,\beta + T\,E\,\underline{u} + X\,\beta + Q\,E\,\underline{u} - X\,\beta - E\,u$$

$$= T\,\underline{X}\,\beta\ .$$

Unbiasedness then requires that

$$T\,\underline{X} = 0.$$

The covariance matrix of this estimator is

$$E(T^*\underline{y}-y)(T^*\underline{y}-y)' = E\,(\,T\,\underline{y} + Q\,\underline{y} - y\,)\,(\,T\,\underline{y} + Q\,\underline{y} - y\,)'$$

$$= E\,(\,T\,\underline{X}\,\beta + T\,\underline{u} + Q\,\underline{X}\,\beta + Q\,\underline{u} - X\,\beta - u\,)\,(\,T\,\underline{X}\,\beta + T\,\underline{u} + Q\,\underline{X}\,\beta + Q\,\underline{u} - X\,\beta - u\,)'$$

In order to proceed with the estimation the form of the covariance matrix V must be specified. For the purposes of this study, and due to the likely effect of omitted variables, the quarterly disturbances, u, were assumed to follow a first order auto-regressive structure of the form

$$u_t = r\, u_{t-1} + e_t$$

where

$$E\, e_t = 0,$$

and

$$E\, e_t e_s = \delta_{t,s}\, \sigma^2.$$

Thus the matrix V is

$$V = \begin{bmatrix} 1 & r & r^2 & r^3 & \cdots & r^{n-1} \\ r & 1 & r & & & \\ r^2 & r & 1 & & & \\ \vdots & & & & & \\ & \cdots & & & & r^2 \\ r^{n-1} & & & & r^2 & r \\ & & & & r & 1 \end{bmatrix} \frac{\sigma^2}{1 - r^2},$$

(Cont. from previous page.)

$$= E\,(T\,\underline{u} + Q\,\underline{u} - u)(T\,\underline{u} + Q\,\underline{u} - u)$$

$$= E\,(T\,\underline{u}\,\underline{u}'\,T' + T\,\underline{u}\,\underline{u}'\,Q' - T\,\underline{u}\,u' + Q\,\underline{u}\,\underline{u}'\,T' + Q\,\underline{u}\,\underline{u}'\,Q' - Q\,\underline{u}\,u' - u\,\underline{u}'\,T' - u\,\underline{u}'\,Q' + u\,u')$$

$$= T\,\underline{V}\,T' + T\,C\,V - T\,C\,V + V\,C'\,T' + Q\,\underline{V}\,Q' - Q\,C\,V - V\,C'\,T' - V\,C'\,Q' + V$$

$$= T\,\underline{V}\,T' + Q\,\underline{V}\,Q' - Q\,C\,V - V\,C'\,Q' + V$$

which differs from the covariance of the estimator $Q\,\underline{y}$ by the matrix $T\,\underline{V}\,T'$. However, since $\underline{V}$ is positive definite the diagonal elements of $T\,\underline{V}\,T'$ cannot be less than zero. Hence the estimator $T^*\underline{y}$ can be minimum variance (best) only if $T = 0$, which implies that

$$T^*\,\underline{y} = Q\,\underline{y}.$$

which for the purposes of estimation depends on only one unknown parameter, r, since the term $\sigma^2/1-r^2$ drops out.

The matrix $\underline{V}$,

$$\underline{V} = C\ V\ C',$$

the covariance matrix of the annual disturbances, is of the form

$$\underline{V} = 1/16 \begin{bmatrix} 1 & \lambda/\gamma & r^4\ \lambda/\gamma & r^8\ \lambda/\gamma & . & . & . \\ \lambda/\gamma & 1 & \lambda/\gamma & & & & \\ r^4\lambda/\gamma & \lambda/\gamma & 1 & & & & \\ . & & & & & & \\ . & & & & . \ . \ . & & \\ . & & & & & & \end{bmatrix} \frac{\gamma\ \sigma^2}{1-r^2}$$

Where

$$\gamma = 4 + 6r + 4r^2 + 2r^3,$$

and

$$\lambda = r + 2r^2 + 3r^3 + 4r^4 + 3r^5 + 2r^6 + r^7.$$

Again the matrix $\underline{V}$ depends on only one unknown parameter.*

Estimation Procedure

The estimation was accomplished using an iterative maximum likli-hood procedure, iterating on the auto-regressive parameter r until convergence was obtained in the generalized sum of squares estimate, $\underline{u}^*\ \underline{V}^{-1}\ \underline{u}^{*\prime}$.

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*While $\underline{V}$ is similar in appearance to V, it should be noted that it does not correspond to the covariance matrix of a first-order auto-regressive process.

Convergence was assumed complete when the decrement in the generalized sum of squares from a change in r was less than 10^{-7}. As a further check that the estimate of r obtained by the procedure corresponded to a global rather than local optimum the generalized sum of squares was calculated at values of r ranging from -.95 to +.95 in increments of .05, to verify that there was a singular minimum.

The choice of explanatory variables is largely constrained by the available data. Generally available are the index of industrial production and the consumer price index. The IIP may be thought of as an index of real industrial economic activity. Other components of real GNP are missing. Notably, they are: agricultural production (A); the government sector (G); and services (S). The CPI may be thought of as a general price level index which may be used to convert real economic activity into nominal values. Thus nominal GNP may be closely approximated by

$$\begin{aligned} GNP &= a + P \cdot (IIP + A + G + S) \\ &= a + P \cdot IIP + P \cdot (A + G + S). \end{aligned}$$

As an approximation to the missing term A + G + S the following function of time is used:

$$A + G + S = c_1 t + c_2 t^2 + c_3 t^3.$$

While this approximation does not allow for cyclical variation in the non-industrial segment of GNP, it does allow for a changing proportion of industrial production to total GNP over time.

Because of the sensitivity of industrial production a dummy variable was included where necessary to account for the following strikes:

Belgium in 1961_I ; France in 1963_I and 1968_{II}; and Italy in 1969_{IV}.

Tests of the Estimates

In order to test the accuracy of the estimated quarterly GNP figures, and where quarterly data on GNP were available, regressions of the Chow-Lin estimate on reported GNP were run in levels and first differences.

The results of the regressions run in levels are presented in Table I. Also reported in Table I are the maximum liklihood estimates of the auto-regression parameter, r. T - values for the constant and slope coefficients are reported in parentheses. For the constant term, the null hypothesis is that the parameter is zero. In no case could this hypothesis be rejected at the five percent level of significance. For the slope coefficient the null hypothesis is that the parameter is unity. Only in the case of Belgium is the hypothesis rejected at the five percent level. Belgium, however, merits special consideration since the source of the reported annual GNP series is different from that of the partial quarterly GNP series and in the period of overlap the implied annual rates of flow derived from the quarterly series diverge from the reported annual figures.

The regressions in levels confirm an excellent fit overall with no r-square less than .99. The Durbin-Watson statistics are virtually all within the range in which the hypothesis of no first-order autocorrelation in the residuals cannot be rejected. The single exception is Belgium, which falls within the range of uncertainty on the positive first-order autocorrelation side of the ideal value of two.

The regressions of first differences in estimated GNP are presented

TABLE I

REGRESSIONS OF ESTIMATED QUARTERLY GNP ON REPORTED GNP

	$\hat{r}$	N	Constant	Slope	R^2	D-W
Belgium	.698	24	-8.183	.956	.993	1.35**
			(-.35)	(-2.62)		
Canada	.684	60	.021	1.000	.999	2.08
			(.15)	(-.12)		
France	.642	----------	N/A	----------		
Germany	.744	60	.521	.999	.999	2.29
			(.32)	(-.33)		
Italy	.737	----------	N/A	----------		
Japan	.609	60	.004	.999	.999	1.74
			(.03)	(-.04)		
Netherlands	.725	----------	N/A	----------		
Switzerland	.697	24	1.804	.970	.996	1.96
			(1.90)	(-2.33)		
United Kingdom	.712	60	.051	.998	.999	2.19
			(.36)	(-.38)		

* Coefficient is significantly different from its hypothesized value at the 5% level.

** Durbin-Watson statistic is in the uncertain range.

in Table II. The implied association of the estimates with actual GNP are considerably less appealing than for the same regressions in levels of the data. Constant terms for Canada, Germany, and the United Kingdom are significantly different from zero at the five percent level of significance. For the same three countries the slope coefficient is significantly different from the hypothesized value of unity at the five percent level. The proportion of variance in the reported series varies from twenty-five to eighty-five percent as indicated by the r-square statistics. A tendency toward negative autocorrelation in the residuals is indicated by the Durbin-Watson statistics, although the hypothesis of zero autocorrelation cannot be rejected in any of the six regressions.

Because of the nature of these latter results caution should be exercised in the interpretation of the results of the quarterly data experiments. It is possible that the GNP proxy is still dominated to a significant extent by industrial output.

Money Stock Series

The construction of money stock series, where money is defined as the sum of currency and demand deposits, in the United States is facilitated by the relatively clear dichotomy between demand and time deposits. In the United States checkable deposits may generally be provided by only one class of financial institution and in a rigidly constrained enviroment. But in many other countries the distinctions between deposit classes may not be so clearly delineated, and there may be many types of financial institutions offering a variety of deposit classes of modestly differentiated liquidities which may be similar to demand deposits in the

TABLE II

REGRESSIONS OF FIRST DIFFERENCES OF ESTIMATED QUARTERLY GNP ON FIRST DIFFERENCES OF REPORTED GNP

	Constant	Slope	R^2	D-W
Belgium	-3.070	.985	.249	2.51
	(.22)	(-.04)		
Canada	.300*	.794*	.769	2.30
	(2.72)	(-3.62)		
Germany	4.572*	.629*	.566	1.98
	(4.17)	(-5.16)		
Japan	.188	.903	.840	2.43**
	(1.49)	(-1.88)		
Switzerland	-.021	1.030	.251	2.57**
	(-.04)	(.08)		
United Kingdom	.300*	.544*	.541	1.73
	(4.94)	(-6.72)		

* Coefficient is significantly different from its hypothesized value at the 5% level.

** Durbin-Watson statistic is in the uncertain range.

United States.

As a consequence of this potential for noncomparibility in money stock series among the countries under study, two definitions of money are used. The first, denoted M, corresponds to the narrow (M_1) definition of money as currency outside bank vaults plus demand deposits. The second definition, denoted B, corresponds to base money: currency plus reserves.

Where International Monetary Fund sources are used for the broader money stock definition, the deposit classes included are defined by the IMF to be those "deposits unrestrictedly exchangeable on demand into currency at par without penalty." (Perlman 1970: 301) For the remaining countries the deposit series were based on the respective central bank definitions of sight deposits.

Base money, taken entirely from the IMF, comprises monetary liabilities of the central bank. As such it offers distinct advantages in making international comparisons. A particular advantage is that in general there is less ambiguity in the definition of base money than in the narrow money stock definition. A purely empirical advantage is that, as distinct from deposit data, figures for base money are derived from the central bank's balance sheets only and in principle should, therefore, be more accurate. (Lothian 1972)

Other Data

Complete sources for GNP, money, price, and interest rate data may be found in Appendix A.

CHAPTER 3

ANNUAL VELOCITY

This chapter presents results derived from annual data for the nine countries under study. Each country is discussed individually, followed by results of international velocity comparisons. Preceeding an overview of the annual results is a section devoted to an examination of the period since 1970 in light of the massive upheaval in international monetary arrangements in early 1971 which culminated in the float of 1973.

Belgium

Levels of velocity and related series for Belgium are presented in Table III. Their corresponding index numbers relative to 1965 are contained in Table IV, and the annual rate of change of each series is tabulated in Table V.

Examination of the velocity series in Table III suggests that both series are strongly trended. Base velocity declined in only two years and M_1 velocity in four. The apparent trends are verified in regressions (5) and (6) of Table VI, which estimate linear trends in base and M_1 velocity respectively. Both slope and constant terms are highly significantly different from zero in both regressions, and the adjusted r-square statistics are quite high.

Another approach to Belgian velocity is presented in equations (1) and (2) of Table VI, in which the money stock is regressed on GNP. A close relationship between the money stock and GNP emerges, as suggested by the high r-square statistics. Marginal velocity of both the base

and M_1 money stocks are highly significant. Since the constant terms are both negative and significantly different from zero, there should be a tendency toward increasing average velocity as the money stock increases, a phenomenon which has already been noted in the trend regressions.

Another transformation of the quantity theory equation expresses the price level as a function of money per unit of output. Regressions of this variant are presented in Table VI, equations (3) and (4). Use of the M_1 definition of money produces a high degree of association as reflected in the r-square statistic of .88, but the narrower base definition of the money stock proves to be quite inadequate in explaining variations in the price level. Since the slope coefficient is insignificantly different from zero at the five percent level of significance, the hypothesis that changes in the stock of base money per unit of output do not affect the price level cannot be rejected.

The latter result, rather than constituting a denial of the adequacy of the quantity theory of money in explaining the Belgian price level, probably reflects the inadequacy of high-powered money as a definition of the money stock. Consideration of institutional factors sheds some light on the apparent problem.

As noted in Chapter 1, the proportion of currency to the narrow money stock in Belgium has, historically, been quite high by European standards. However, the currency-to-deposit ratio in Belgium has with one exception declined in every year since 1959. In 1973 the ratio was nearly 44 percent less than its level in 1959. Since base money

comprises currency plus reserves, it is clear that if a broader money stock definition inclusive of sight deposits is the relevant money stock from the standpoint of the quantity theory, then even a constant stock of base money is consistent with a rising M_1 money stock under a fractional reserve banking system in which the demand for currency is falling relative to deposit money. In the Belgian experience, although there was some variation in the ratio of base money to real output, on balance over the 1959 to 1973 period the ratio changed very little as may be seen in either Table III or Table IV. Thus the base grew at virtually the same rate as real output over the period as a whole. This relationship, as noted above, is consistent with growth in the M_1 money stock per unit of output which is greater than zero, and which, under a quantity theory framework, is sufficient to generate a rising price level.

Regressions of the log of real output, the log of the interest rate, and time on the log of velocity are presented in Table VII. Because of the effects of multicollinearity, it is likely that the t-statistics in the multiple regressions are somewhat understated. However, this should not preclude discussion of coefficients which are economically significant. As previously discussed, the base money stock definition is probably inadequate in the Belgian case, and regressions on base velocity are included only for completeness.

Taken individually, real income, the interest rate, and time are all closely related to velocity. Taken together, the associations are, marginally, even better than individually. The incremental effect of

TABLE III

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR BELGIUM
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	118.52	210.60	74.12	537.80	725.53	4.54	2.55	0.163	0.290
1960	120.69	214.98	74.35	571.50	768.66	4.74	2.66	0.157	0.280
1961	126.66	226.00	75.07	606.40	807.73	4.79	2.68	0.157	0.280
1962	133.55	241.80	76.12	648.10	851.36	4.85	2.68	0.157	0.284
1963	145.93	266.05	77.72	696.00	895.46	4.77	2.62	0.163	0.297
1964	154.90	281.48	81.00	778.30	960.86	5.02	2.77	0.161	0.293
1965	165.90	303.50	84.30	848.90	1007.00	5.12	2.80	0.165	0.301
1966	173.11	322.60	87.82	912.90	1039.45	5.27	2.83	0.167	0.310
1967	176.92	336.60	90.35	978.00	1082.46	5.53	2.91	0.163	0.311
1968	181.63	358.73	92.80	1047.00	1128.23	5.76	2.92	0.161	0.318
1969	184.84	376.08	96.30	1162.00	1206.65	6.29	3.09	0.153	0.312
1970	184.73	397.30	100.03	1297.00	1296.68	7.02	3.26	0.142	0.306
1971	195.58	437.18	104.33	1419.00	1360.17	7.26	3.25	0.144	0.321
1972	216.48	491.63	110.03	1583.00	1438.76	7.31	3.22	0.150	0.342
1973	246.70	553.80	117.68	1795.00	1525.39	7.28	3.24	0.162	0.363

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE IV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR BELGIUM
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	71.44	69.39	87.93	63.35	72.05	88.68	91.30	99.16	96.31
1960	72.75	70.83	88.20	67.32	76.33	92.54	95.05	95.31	92.79
1961	76.35	74.46	89.06	71.43	80.21	93.57	95.93	95.18	92.84
1962	80.50	79.67	90.30	76.35	84.54	94.84	95.83	95.22	94.23
1963	87.96	87.66	92.20	81.99	88.92	93.21	93.53	98.92	98.58
1964	93.37	92.74	96.09	91.68	95.42	98.19	98.86	97.85	97.20
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	104.35	106.29	104.18	107.54	103.22	103.06	101.17	101.09	102.97
1967	106.64	110.91	107.18	115.21	107.49	108.03	103.88	99.21	103.17
1968	109.48	118.20	110.08	123.34	112.04	112.66	104.35	97.72	105.50
1969	111.41	123.91	114.23	136.88	119.83	122.86	110.47	92.98	103.41
1970	111.35	130.91	118.65	152.79	128.77	137.21	116.71	86.47	101.66
1971	117.89	144.04	123.75	167.16	135.07	141.79	116.05	87.28	106.64
1972	130.49	161.99	130.52	186.48	142.88	142.91	115.12	91.33	113.37
1973	148.70	182.47	139.59	211.45	151.48	142.20	115.88	98.17	120.46

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE V

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR BELGIUM
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	1.83	2.08	0.30	6.27	5.94	4.36	4.10	-3.88	-3.65
1961	4.94	5.13	0.98	6.11	5.08	1.11	0.93	-0.13	0.04
1962	5.44	6.99	1.40	6.88	5.40	1.36	-0.11	0.04	1.51
1963	9.27	10.03	2.10	7.39	5.18	-1.72	-2.40	3.89	4.61
1964	6.15	5.80	4.21	11.82	7.30	5.35	5.70	-1.08	-1.40
1965	7.10	7.82	4.07	9.07	4.80	1.84	1.16	2.19	2.88
1966	4.35	6.29	4.18	7.54	3.22	3.06	1.17	1.09	2.97
1967	2.20	4.34	2.88	7.13	4.14	4.83	2.68	-1.86	0.19
1968	2.66	6.57	2.71	7.06	4.23	4.28	0.45	-1.50	2.25
1969	1.76	4.84	3.77	10.98	6.95	9.06	5.86	-4.85	-1.98
1970	-0.06	5.64	3.87	11.62	7.46	11.68	5.65	-7.00	-1.69
1971	5.88	10.04	4.30	9.41	4.90	3.33	-0.57	0.93	4.90
1972	10.68	12.45	5.46	11.56	5.78	0.79	-0.80	4.64	6.31
1973	13.96	12.65	6.95	13.39	6.02	-0.50	0.66	7.49	6.25

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE VI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR BELGIUM ANNUAL DATA, 1959 - 1973

(1)	$Y = -761.42 + 10.41\ B$ $(-6.33)\ (14.90)$	$R^2 = .940$	$D - W = .43$
(2)	$Y = -266.67 + 3.76\ M$ $(-8.99)\ (44.25)$	$R^2 = .993$	$D - W = .87$
(3)	$P = 271.11 - 809.37\ (B/y)$ $(2.91)\ (-1.71)$	$R^2 = .121$	$D - W = .27$
(4)	$P = -86.19 + 571.71\ (M/y)$ $(-5.04)\ (10.29)$	$R^2 = .882$	$D - W = .99$
(5)	$V_B = 3.93 + .22\ t$ $(21.04)\ (10.80)$	$R^2 = .892$	$D - W = .40$
(6)	$V_M = 2.46 + .05\ t$ $(60.21)\ (12.03)$	$R^2 = .911$	$D - W = 1.00$

TABLE VII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR BELGIUM
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	-3.37 (-8.55)	.73 (12.92)			.922	.41
(2) log V_B	-.39 (-1.27)		1.14 (6.84)		.766	.80
(3) log V_B	1.42 (51.24)			.04 (12.46)	.917	.46
(4) log V_B	-3.38 (-5.32)	.74 (4.91)	-.01 (-.02)		.916	.42
(5) log V_B	-5.46 (-.73)	1.05 (.92)	-10.05 (-.02)	-.02 (-.28)	.909	.40
(6) log V_M	-1.43 (-7.45)	.36 (12.99)			.923	.97
(7) log V_M	-.03 (-.28)		.59 (9.45)		.863	.97
(8) log V_M	.91 (68.22)			.02 (12.64)	.919	1.11
(9) log V_M	-1.05 (-3.83)	.25 (3.89)	.20 (1.81)		.934	.74
(10) log V_M	-1.50 (-.46)	.32 (.64)	.20 (1.73)	-.004 (-.14)	.929	.73

time on equation (9) is insufficient to justify the loss of one degree of freedom as judged by the fall in the adjusted r-square statistic from equation (9) to equation (10).

The implied elasticity of demand for real balances with respect to real income is .75 or .68, depending on the exclusion or inclusion of the trend term, which implies that long-term growth in real income may explain the observed secular rise in velocity. The implied interest elasticity of demand for real balances is -.20 in both formulations. Although the interest rate coefficient is not significantly different from zero at the five percent level, it does have the theoretically correct negative sign.

Canada

The Canadian experience was one of slowly declining M_1 velocity from 1959 to 1973 with a compound annual rate of decline of 1.3 percent per year. As the data in Table VIII indicates, however, base velocity has been rising over the period. Neither apparent trend is uninterrupted with five declines in the upward trending base velocity series and seven increases in the downward trending M_1 velocity series. The trend regressions of Table XI indicate that the trend factor explains over 80 percent of base velocity variance whereas only 54 percent of M_1 velocity variance is explained by trend. Slope coefficients in both regression (5) for base velocity and regression (6) for M_1 velocity are highly significantly different from zero.

The linkages between money and nominal income, judging from regressions (1) and (2) of Table XI, are close under both definitions of

the money stock. As regression (1) indicates, average base velocity was below marginal base velocity over the period. Conversely, average M_1 velocity was greater than marginal M_1 velocity. Despite the slippages in average velocity both money series demonstrate close association with nominal income in levels (Table VIII) and index numbers (Table IX).

As in the Belgian case, applying the price level variant of the quantity equation to the Canadian experience suggests that the stock of the broader M_1 money per unit of output explains the price level somewhat better than the stock of base money per unit of output. The r-square statistic in regression (3) where base money is employed is substantially less than in regression (4) where the broader money stock is used.

Table XII presents regressions in logs of the proximate theoretical determinants of velocity and, derivatively, the demand for real balances. For both the base and M_1 velocity series the real income, interest rate and trend terms are highly significant taken individually. Regressions (4) and (9) of Table XII pairing real income and the interest rate appear to give the best results on the basis of adjusted r-square. The addition of a trend term in regressions (5) and (10) adds relatively little while adding to the multicollinearity problem. The implied income elasticity of the demand for base money derived from regression (4) is .81, and the interest elasticity is -.17, which is the theoretically correct sign. From regression (9) the implied income elasticity of the demand for the broader real M_1 money stock is 1.40 with an interest elasticity of -.27.

The inclusion of time as an independent explanatory variable tends to lower the implied income elasticities while leaving the interest elasticities unchanged. It then appears that even when account is taken of

TABLE VIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR CANADA
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	2.73	5.78	75.42	36.85	48.85	13.47	6.37	0.056	0.118
1960	2.74	5.82	76.40	38.36	50.21	14.02	6.59	0.054	0.116
1961	2.87	6.38	77.05	39.65	51.45	13.83	6.21	0.056	0.124
1962	3.04	6.72	78.02	42.93	55.02	14.14	6.39	0.055	0.122
1963	3.15	7.25	79.37	45.98	57.93	14.60	6.34	0.054	0.125
1964	3.34	7.74	80.83	50.28	62.21	15.07	6.50	0.054	0.124
1965	3.59	9.02	82.80	55.36	66.86	15.42	6.14	0.054	0.135
1966	3.87	9.74	85.90	61.83	71.98	15.97	6.35	0.054	0.135
1967	4.23	11.22	88.95	66.41	74.66	15.70	5.92	0.057	0.150
1968	4.33	12.41	92.60	72.59	78.39	16.75	5.85	0.055	0.158
1969	4.73	13.07	96.75	79.82	82.50	16.86	6.10	0.057	0.158
1970	5.00	13.30	100.00	85.68	85.68	17.14	6.44	0.058	0.155
1971	5.56	16.06	102.82	93.31	90.74	16.79	5.81	0.061	0.177
1972	6.38	20.19	107.75	103.49	96.05	16.21	5.13	0.066	0.210
1973	7.34	22.34	116.00	118.90	102.50	16.20	5.32	0.072	0.218

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE IX

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR CANADA
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	76.19	64.07	91.09	66.55	73.06	87.35	103.88	104.29	87.69
1960	76.22	64.48	92.27	69.29	75.09	90.90	107.45	101.51	85.87
1961	79.88	70.75	93.06	71.61	76.95	89.65	101.22	103.80	91.94
1962	84.61	74.42	94.23	77.54	82.28	91.64	104.18	102.83	90.45
1963	87.74	80.39	95.86	83.05	86.63	94.65	103.31	101.28	92.79
1964	92.97	85.73	97.61	90.82	93.04	97.68	105.93	99.93	92.15
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	107.86	107.94	103.74	111.68	107.65	103.53	103.46	100.20	100.27
1967	117.83	124.38	107.43	119.95	111.66	101.80	96.44	105.53	111.39
1968	120.71	137.55	111.84	131.11	117.23	108.61	95.32	102.97	117.33
1969	131.91	144.88	116.85	144.16	123.38	109.29	99.51	106.92	117.43
1970	139.28	147.33	120.77	154.77	128.15	111.12	105.05	108.69	114.97
1971	154.79	177.92	124.18	168.53	135.71	108.88	94.73	114.06	131.10
1972	177.89	223.69	130.13	186.93	143.65	105.08	83.57	123.84	155.72
1973	204.52	247.59	140.10	214.76	153.30	105.01	86.74	133.41	161.51

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE X

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR CANADA
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	0.04	0.64	1.29	4.11	2.78	4.07	3.44	-2.67	-2.08
1961	4.80	9.72	0.85	3.36	2.48	-1.38	-5.80	2.26	7.06
1962	5.92	5.20	1.27	8.28	6.92	2.22	2.93	-0.94	-1.61
1963	3.70	8.01	1.73	7.11	5.29	3.28	-0.84	-1.50	2.59
1964	5.96	6.65	1.83	9.36	7.39	3.20	2.54	-1.33	-0.70
1965	7.56	16.65	2.44	10.11	7.48	2.37	-5.60	0.07	8.52
1966	7.86	7.94	3.74	11.68	7.65	3.53	3.46	0.20	0.27
1967	9.24	15.23	3.55	7.41	3.73	-1.68	-6.79	5.32	11.09
1968	2.45	10.59	4.10	9.30	4.99	6.69	-1.16	-2.42	5.33
1969	9.28	5.33	4.48	9.96	5.24	0.62	4.40	3.83	0.08
1970	5.58	1.69	3.36	7.35	3.87	1.68	5.57	1.65	-2.09
1971	11.14	20.76	2.82	8.90	5.90	-2.02	-9.83	4.94	14.03
1972	14.93	25.73	4.79	10.92	5.85	-3.49	-11.78	8.58	18.78
1973	14.97	10.68	7.66	14.89	6.72	-0.07	3.80	7.73	3.72

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR CANADA ANNUAL DATA, 1959 - 1973

(1)	$Y = \underset{(-4.31)}{-10.57} + \underset{(32.86)}{18.28}\ B$	$R^2 = .987$	D - W = .60
(2)	$Y = \underset{(4.70)}{11.46} + \underset{(24.53)}{4.91}\ M$	$R^2 = .977$	D - W = 1.17
(3)	$P = \underset{(-1.78)}{-34.62} + \underset{(6.39)}{2153.30}\ (B/y)$	$R^2 = .740$	D - W = .31
(4)	$P = \underset{(7.89)}{32.17} + \underset{(14.33)}{385.19}\ (M/y)$	$R^2 = .936$	D - W = 1.44
(5)	$V_B = \underset{(46.29)}{13.49} + \underset{(7.74)}{.25}\ t$	$R^2 = .808$	D - W = .68
(6)	$V_M = \underset{(42.33)}{6.67} - \underset{(-4.15)}{.07}\ t$	$R^2 = .537$	D - W = 1.49

TABLE XII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR CANADA
ANNUAL DATA, 1959 - 1973

	a	log (y)	log(r)	t	R^2	D - W
(1) log V_B	1.47 (9.45)	.30 (8.19)			.825	.68
(2) log V_B	2.00 (19.76)		.41 (7.33)		.790	.71
(3) log V_B	2.61 (138.42)			.02 (7.87)	.813	.66
(4) log V_B	1.63 (8.59)	.19 (2.19)	.17 (1.41)		.837	.59
(5) log V_B	.86 (.43)	.39 (.74)	.17 (1.33)	-.01 (-.39)	.825	.63
(6) log V_M	2.75 (11.85)	-.22 (-4.08)			.527	1.43
(7) log V_M	2.23 (13.09)		-.24 (-2.52)		.277	1.39
(8) log V_M	1.90 (70.21)			-.01 (-4.11)	.531	1.42
(9) log V_M	3.02 (10.78)	-.40 (-3.16)	.27 (1.54)		.573	1.22
(10) log V_M	2.31 (.79)	-.21 (-.27)	.27 (1.46)	-.01 (-.24)	.536	1.22

institutional changes and all other factors which are summarized in the trend element, the income elasticity of demand for M_1 balances remains greater than unity. Referring to Table VIII or IX, Canadian real income increased 109.8 percent from 1959 to 1973. With an income elasticity of demand for real money balances of 1.21, as obtained from Table XII regression (10), predicted velocity in 1973 should be 82.6 percent of its 1959 level or 5.26, whereas in reality it was 83.5 percent of its 1959 level, at 5.32. Relative to actual velocity in 1973, the predicted value is in error by 1.1 percent, which is remarkable accuracy over a span of fifteen years.

France

Annual money, income, velocity, and related data for France are presented in Tables XIII, XIV, and XV in levels, index numbers, and rates of change respectively. As may be seen in Table XIV, French M_1 velocity generally fell until 1966, then tended to rise thereafter. It is not surprising, then, that the trend regression (6) of Table XVI reveals such a poor fit. Base velocity, while demonstrating a similar pattern to that of M_1 velocity, did not vary as greatly as the broader velocity, and the linear trend regression (5) provides a much better fit.

Regardless of the non-uniform trend in both velocity series, the money-income associations tested in regressions (1) and (2) of Table XVI are quite close with r-squares above .95 in both cases.

The price level variants in regressions (3) and (4) show markedly poorer fits than the money-nominal income regressions. In fact they are the poorest associations between money per unit of output and the price level obtained in any country studied.

TABLE XIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR FRANCE
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	36.49	77.63	66.62	272.60	409.16	7.47	3.51	0.089	0.190
1960	38.85	87.17	67.37	301.60	447.64	7.76	3.46	0.087	0.195
1961	44.18	101.54	69.02	328.30	475.63	7.43	3.23	0.093	0.213
1962	49.84	118.64	72.60	367.20	505.78	7.37	3.10	0.099	0.235
1963	56.29	138.48	76.27	412.00	540.15	7.32	2.98	0.104	0.256
1964	61.28	152.55	78.70	456.70	580.30	7.45	2.99	0.106	0.263
1965	65.87	166.26	80.85	489.80	605.81	7.44	2.95	0.109	0.274
1966	70.03	181.09	82.92	532.50	642.15	7.60	2.94	0.109	0.282
1967	74.30	192.28	85.28	574.80	674.05	7.74	2.99	0.110	0.285
1968	78.92	199.98	89.12	630.10	706.98	7.98	3.15	0.112	0.283
1969	83.63	213.45	94.50	723.50	765.61	8.65	3.39	0.109	0.279
1970	82.71	213.78	99.95	809.20	809.60	9.78	3.79	0.102	0.264
1971	90.79	240.94	105.28	899.60	854.52	9.91	3.73	0.106	0.282
1972	104.80	272.81	111.68	1001.90	897.16	9.56	3.67	0.117	0.304
1973	130.37	301.47	119.90	1139.20	950.13	8.74	3.78	0.137	0.317

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XIV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR FRANCE
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	55.40	46.69	82.41	55.66	67.54	100.47	119.20	82.02	69.14
1960	58.98	52.43	83.33	61.58	73.89	104.40	117.44	79.82	70.96
1961	67.07	61.07	85.37	67.03	78.51	99.94	109.75	85.43	77.79
1962	75.67	71.36	89.80	74.97	83.49	99.08	105.06	90.63	85.47
1963	85.45	83.29	94.34	84.12	89.16	98.44	100.99	95.84	93.42
1964	93.03	91.75	97.34	93.24	95.79	100.23	101.62	97.12	95.79
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	106.31	108.92	102.57	108.72	106.00	102.26	99.81	100.30	102.76
1967	112.79	115.65	105.47	117.35	111.26	104.04	101.47	101.38	103.94
1968	119.80	120.28	110.24	128.64	116.70	107.38	106.95	102.66	103.07
1969	126.95	128.39	116.88	147.71	126.38	116.36	115.05	100.45	101.59
1970	125.56	128.58	123.62	165.21	133.64	131.58	128.49	93.96	96.21
1971	137.82	144.92	130.21	183.67	141.05	133.26	126.74	97.71	102.74
1972	159.10	164.09	138.13	204.55	148.09	128.57	124.66	107.44	110.80
1973	197.92	181.33	148.30	232.58	156.83	117.51	128.27	126.20	115.62

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR FRANCE
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	6.47	12.29	1.13	10.64	9.41	3.91	-1.47	-2.68	2.63
1961	13.72	16.48	2.45	8.85	6.25	-4.28	-6.55	7.03	9.63
1962	12.82	16.85	5.18	11.85	6.34	-0.86	-4.28	6.09	9.88
1963	12.93	16.72	5.06	12.20	6.79	-0.65	-3.87	5.75	9.30
1964	8.86	10.16	3.18	10.85	7.43	1.82	0.63	1.33	2.53
1965	7.50	8.99	2.73	7.25	4.40	-0.23	-1.60	2.97	4.40
1966	6.31	8.92	2.57	8.72	6.00	2.26	-0.19	0.30	2.76
1967	6.10	6.18	2.83	7.94	4.97	1.74	1.66	1.07	1.16
1968	6.21	4.00	4.51	9.62	4.89	3.21	5.40	1.26	-0.84
1969	5.97	6.74	6.03	14.82	8.29	8.36	7.58	-2.15	-1.44
1970	-1.09	0.15	5.77	11.85	5.75	13.08	11.68	-6.47	-5.29
1971	9.77	12.71	5.33	11.17	5.55	1.28	-1.36	4.00	6.78
1972	15.44	13.23	6.08	11.37	4.99	-3.52	-1.64	9.95	7.85
1973	24.40	10.51	7.37	13.70	5.90	-8.60	2.89	17.46	4.35

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XVI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR FRANCE
ANNUAL DATA, 1959 - 1973

(1)	$Y =$	-131.98	+ 10.22 B	$R^2 =$	.954	D - W =	.71
		(-2.93)	(17.09)				
(2)	$Y =$	-102.88	+ 3.94 M	$R^2 =$	.953	D - W =	.33
		(-2.34)	(16.93)				
(3)	$P =$	- 33.02	+ 1130.33(B/y)	$R^2 =$	.665	D - W =	.47
		(- 1.47)	(5.37)				
(4)	$P =$	- 9.50	+ 376.76(M/y)	$R^2 =$	.682	D - W =	.24
		(-.55)	(5.58)				
(5)	$V_B =$	6.80	+ .17 t	$R^2 =$	.617	D - W =	.65
		(21.62)	(4.86)				
(6)	$V_M =$	3.02	+ .04 t	$R^2 =$	.182	D - W =	.31
		(18.88)	(2.03)				

TABLE XVII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR FRANCE
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	-.08 (-.19)	.34 (4.89)			.621	.58
(2) log V_B	1.17 (11.25)		.52 (8.97)		.850	1.72
(3) log V_B	1.93 (53.46)			.02 (5.03)	.635	.63
(4) log V_B	1.20 (2.87)	-.007 (-.08)	.52 (4.29)		.838	1.74
(5) log V_B	-.29 (-.05)	.24 (.23)	.54 (3.80)	-.01 (-.24)	.824	1.79
(6) log V_M	.11 (.19)	.17 (1.82)			.142	.29
(7) log V_M	.50 (3.26)		.39 (4.57)		.587	.36
(8) log V_M	1.11 (22.90)			.01 (1.95)	.166	.29
(9) log V_M	2.08 (5.30)	-.36 (-4.18)	.81 (7.01)		.818	1.49
(10) log V_M	9.90 (1.85)	-1.65 (-1.87)	.73 (5.93)	.08 (1.46)	.833	1.47

The apparent explanation of the behavior of French velocity is the behavior of interest rates. As revealed in the log regressions on velocity contained in Table XVII, there is a substantial interest sensitivity of French velocity. This interest elasticity is by far the greatest of any country studied. In regressions (4) and (9) the interest elasticity of base velocity is .52 and the elasticity of M_1 velocity is .81. These elasticities are altered only slightly with the addition of the trend element in regressions (5) and (10).

Germany

The German experience in the period 1959 to 1973, as revealed in Tables XVIII and XIX, was one of relatively stable velocity. German M_1 velocity averaged 6.84 over the period with a coefficient of variation of 3.74 percent. Base velocity was only slightly more variable with an average value of 10.26 and a coefficient of variation of 6.74 percent. Table XX indicates that year-to-year changes in M_1 velocity were relatively minor throughout the period until 1970.

The evident stability of German velocity is borne out in the regressions presented in Table XXI. Regressions (2) and (4), both the nominal income and price level variants of the Fisher equation, reveal excellent associations with r-square statistics of .99 in the regression of the broader money stock on nominal income, and .96 in the regression of money per unit of output on the price level. Results using the narrower base money definition are marginally less satisfactory in the case of regression (1) and markedly less in the price level regression.

The trend regressions reveal that while there is a significant trend

TABLE XVIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR GERMANY
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	26.74	41.15	75.42	270.50	358.63	10.11	6.57	0.075	0.115
1960	32.14	44.78	76.45	296.80	388.23	9.23	6.63	0.083	0.115
1961	33.86	48.93	78.22	332.60	425.18	9.82	6.80	0.080	0.115
1962	35.14	54.13	80.57	360.20	447.04	10.25	6.65	0.079	0.121
1963	37.63	57.85	83.00	384.00	462.65	10.21	6.64	0.081	0.125
1964	40.78	62.83	84.93	421.00	495.73	10.32	6.70	0.082	0.127
1965	45.06	68.80	87.77	460.40	524.52	10.22	6.69	0.086	0.131
1966	47.80	71.93	90.88	490.70	539.97	10.27	6.82	0.089	0.133
1967	47.32	74.27	92.20	495.50	537.42	10.47	6.67	0.088	0.138
1968	48.14	80.02	93.87	540.00	575.23	11.22	6.75	0.084	0.139
1969	53.90	88.10	96.35	605.20	628.13	11.23	6.87	0.086	0.140
1970	59.84	93.47	100.03	684.70	684.53	11.44	7.32	0.087	0.137
1971	73.03	104.83	105.18	760.00	722.61	10.41	7.25	0.101	0.145
1972	84.19	119.55	111.20	829.80	746.22	9.86	6.94	0.113	0.160
1973	104.47	126.50	118.90	926.20	778.97	8.87	7.32	0.134	0.162

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XIX

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR GERMANY
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	59.35	59.81	85.93	58.75	68.37	99.00	98.23	86.80	87.48
1960	71.32	65.08	87.10	64.47	74.02	90.38	99.06	96.36	87.93
1961	75.14	71.11	89.12	72.24	81.06	96.14	101.59	92.70	87.73
1962	77.98	78.67	91.80	78.24	85.23	100.32	99.45	91.50	92.31
1963	83.50	84.08	94.56	83.41	88.20	99.89	99.19	94.67	95.33
1964	90.49	91.32	96.75	91.44	94.51	101.06	100.14	95.74	96.62
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	106.08	104.54	103.53	106.58	102.95	100.47	101.95	103.05	101.55
1967	105.01	107.96	105.04	107.62	102.46	102.49	99.69	102.49	105.37
1968	106.82	116.32	106.95	117.29	109.67	109.80	100.84	97.40	106.06
1969	119.61	128.05	109.77	131.45	119.75	109.90	102.65	99.88	106.93
1970	132.78	135.86	113.96	148.72	130.51	112.00	109.46	101.75	104.11
1971	162.07	152.36	119.82	165.07	137.76	101.85	108.34	117.64	110.60
1972	186.84	173.76	126.69	180.23	142.27	96.47	103.72	131.33	122.14
1973	231.83	183.87	135.46	201.17	148.51	86.77	109.41	156.11	123.81

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XX

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR GERMANY
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	20.19	8.81	1.36	9.72	8.25	-8.71	0.84	11.02	0.52
1961	5.35	9.27	2.32	12.06	9.52	6.37	2.56	-3.80	-0.23
1962	3.78	10.63	3.00	8.30	5.14	4.35	-2.11	-1.29	5.22
1963	7.07	6.88	3.01	6.61	3.49	-0.44	-0.26	3.46	3.28
1964	8.37	8.60	2.32	9.64	7.15	1.17	0.95	1.13	1.35
1965	10.51	9.51	3.36	9.36	5.81	-1.05	-0.14	4.45	3.50
1966	6.08	4.54	3.53	6.58	2.95	0.47	1.95	3.05	1.55
1967	-1.01	3.27	1.46	0.98	-0.47	2.01	-2.22	-0.54	3.76
1968	1.72	7.74	1.82	8.98	7.04	7.14	1.15	-4.97	0.66
1969	11.97	10.09	2.64	12.07	9.20	0.09	1.80	2.54	0.82
1970	11.02	6.10	3.81	13.14	8.98	1.91	6.63	1.87	-2.64
1971	22.05	12.14	5.15	11.00	5.56	-9.06	-1.02	15.62	6.23
1972	15.28	14.05	5.73	9.18	3.27	-5.29	-4.26	11.64	10.44
1973	24.08	5.81	6.92	11.62	4.39	-10.05	5.48	18.87	1.36

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR GERMANY ANNUAL DATA, 1959 - 1973

(1)	$Y = 54.13 + 9.15\ B$ (1.75) (16.39)	$R^2 = .950$	D - W = .56
(2)	$Y = -49.52 + 7.56\ M$ (-3.95) (48.25)	$R^2 = .994$	D - W = 1.84
(3)	$P = 24.11 + 752.51\ (B/y)$ (2.60) (7.40)	$R^2 = .793$	D - W = .43
(4)	$P = -22.12 + 851.62\ (M/y)$ (-3.39) (17.52)	$R^2 = .956$	D - W = 1.67
(5)	$V_B = 10.04 + .03\ t$ (26.16) (.66)	$R^2 = .042$	D - W = .68
(6)	$V_M = 6.48 + .05\ t$ (74.74) (4.80)	$R^2 = .612$	D - W = 1.61

TABLE XXII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR GERMANY
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	2.06 (4.21)	.04 (.55)			-.053	.68
(2) log V_B	2.43 (9.85)		-.05 (-.40)		-.063	.62
(3) log V_B	2.31 (60.90)			.002 (.58)	-.050	.69
(4) log V_B	1.51 (2.78)	.25 (1.85)	-.40 (-1.81)		.103	.80
(5) log V_B	2.80 (.73)	.03 (.05)	-.40 (-1.74)	.01 (.34)	.032	.86
(6) log V_M	1.12 (7.59)	.13 (5.45)			.672	1.66
(7) log V_M	1.52 (20.72)		.21 (5 .51)		.677	1.23
(8) log V_M	1.87 (151.66)			.007 (4.87)	.619	1.61
(9) log V_M	1.28 (7.67)	.07 (1.61)	.11 (1.68)		.712	1.42
(10) log V_M	-.44 (-.41)	.36 (1.96)	.12 (1.81)	-.02 (-1.63)	.747	1.44

slope in M_1 velocity, there is no such significant trend in the case of base velocity. As suggested by the negative adjusted r-square, base velocity is probably best described as a constant.

The regressions presented in Table XXII for logs of real income, the interest rate, and velocity reveal uniformly poor results in the case of base velocity. None of the explanatory variables appears to be significantly related to base velocity, independently or taken together.

The Table XXII regressions on M_1 velocity are noticeably better than those on base velocity. With all explanatory variables included the elasticity of velocity with respect to real income is .36, which implies an income elasticity of demand for real balances of .64.

Italy

Velocity of the broader M_1 money stock in Italy behaved remarkably regularly over the entire fifteen year period under study. As indicated in Table XXV, M_1 velocity declined in every year save one. The broader velocity has virtually halved from 1959 to 1973, and the narrower base velocity has declined almost 40 percent. Even more remarkable is the magnitude of velocity in 1973. The M_1 velocity figure implies that almost seven months income is held in money in Italy.

The regressions presented in Table XXVI all are marked by high r-squares indicating close associations between the variables. Regressions (5) and (6) reveal strong trend elements in base velocity, perhaps more so for M_1 velocity. Both price level regressions indicate a strong role for money relative to real income in the determination of the level of prices. Regression (2) for the broader money stock on nominal income reveals a very low 1.45 marginal velocity.

TABLE XXIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR ITALY
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	2.26	5.93	66.73	20.11	30.14	8.90	3.39	0.075	0.197
1960	2.99	6.70	68.27	21.83	31.97	7.31	3.26	0.093	0.210
1961	3.32	7.65	69.67	24.29	34.86	7.31	3.18	0.095	0.219
1962	3.72	9.01	72.97	27.30	37.41	7.34	3.03	0.099	0.241
1963	4.68	10.51	78.37	31.26	39.89	6.69	2.97	0.117	0.264
1964	5.09	11.21	83.00	34.18	41.18	6.71	3.05	0.124	0.272
1965	5.57	12.72	86.72	36.82	42.45	6.61	2.89	0.131	0.300
1966	6.22	14.69	88.80	39.83	44.85	6.40	2.71	0.139	0.328
1967	6.80	16.60	91.67	43.80	47.78	6.44	2.64	0.142	0.347
1968	7.51	18.78	92.82	47.28	50.93	6.30	2.52	0.147	0.369
1969	8.25	21.65	95.27	52.09	54.67	6.32	2.41	0.151	0.396
1970	9.56	26.49	100.05	58.26	58.23	6.10	2.20	0.164	0.455
1971	11.25	32.24	104.85	63.12	60.20	5.61	1.96	0.187	0.535
1972	12.49	38.43	110.95	68.86	62.07	5.51	1.79	0.201	0.619
1973	14.27	46.87	122.40	80.57	65.83	5.64	1.72	0.217	0.712

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXIV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR ITALY
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	40.58	46.63	76.94	54.63	71.00	134.62	117.14	57.15	65.68
1960	53.61	52.69	78.73	59.29	75.31	110.59	112.51	71.19	69.97
1961	59.65	60.14	80.34	65.97	82.11	110.60	109.70	72.64	73.24
1962	66.79	70.86	84.15	74.16	88.13	111.02	104.65	75.79	80.41
1963	83.94	82.63	90.37	84.91	93.95	101.16	102.75	89.34	87.95
1964	91.43	88.14	95.70	92.83	97.00	101.54	105.32	94.26	90.87
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	111.64	115.51	102.39	108.18	105.65	96.90	93.65	105.66	109.33
1967	122.09	130.50	105.71	118.98	112.55	97.45	91.17	108.48	115.95
1968	134.75	147.67	107.03	128.42	119.98	95.30	86.96	112.31	123.08
1969	148.04	170.17	109.86	141.48	128.79	95.57	83.14	114.95	132.13
1970	171.54	208.25	115.36	158.24	137.17	92.25	75.99	125.06	151.82
1971	201.84	253.41	120.90	171.44	141.80	84.94	67.65	142.34	178.71
1972	224.23	302.14	127.93	187.04	146.20	83.42	61.91	153.37	206.66
1973	256.20	368.44	141.14	218.84	155.05	85.42	59.40	165.23	237.62

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR ITALY
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	32.11	13.00	2.32	8.53	6.06	-17.85	-3.96	24.56	6.54
1961	11.26	14.13	2.05	11.27	9.04	0.01	-2.50	2.04	4.67
1962	11.98	17.83	4.74	12.41	7.33	0.38	-4.60	4.34	9.79
1963	25.66	16.61	7.40	14.50	6.61	-8.89	-1.81	17.87	9.38
1964	8.93	6.67	5.90	9.33	3.24	0.37	2.50	5.51	3.32
1965	9.37	13.45	4.49	7.72	3.09	-1.51	-5.05	6.09	10.05
1966	11.64	15.51	2.39	8.18	5.65	-3.10	-6.35	5.66	9.33
1967	9.37	12.98	3.24	9.98	6.53	0.56	-2.65	2.66	6.05
1968	10.36	13.15	1.25	7.93	6.60	-2.20	-4.61	3.53	6.15
1969	9.87	15.24	2.64	10.18	7.34	0.28	-4.39	2.35	7.35
1970	15.87	22.38	5.01	11.84	6.51	-3.47	-8.61	8.79	14.90
1971	17.67	21.68	4.80	8.34	3.38	-7.93	-10.97	13.82	17.71
1972	11.09	19.23	5.82	9.10	3.10	-1.79	-8.49	7.75	15.64
1973	14.26	21.94	10.32	17.00	6.06	2.40	-4.05	7.73	14.98

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXVI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR ITALY ANNUAL DATA, 1959 - 1973

(1)	$Y =$	8.54 (11.01)	+ 5.02 B (50.22)	$R^2 =$ .994	D - W = 1.27
(2)	$Y =$	16.26 (10.08)	+ 1.45 M (19.91)	$R^2 =$ .966	D - W = .24
(3)	$P =$	33.80 (17.53)	+ 396.20 (B/y) (29.67)	$R^2 =$ .984	D - W = 1.73
(4)	$P =$	51.46 (19.69)	+ 102.61 (M/y) (15.47)	$R^2 =$ .944	D - W = .27
(5)	$V_B =$	8.01 (39.70)	- .18 t (-7.89)	$R^2 =$ .814	D - W = 1.46
(6)	$V_M =$	3.59 (60.31)	- .12 t (-17.97)	$R^2 =$ .958	D - W = .50

TABLE XXVII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR ITALY
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	3.68 (19.65)	-.47 (-9.61)			.867	1.72
(2) log V_B	2.97 (11.77)		-.58 (-4.33)		.559	1.51
(3) log V_B	2.09 (82.98)			-.03 (-9.37)	.861	1.57
(4) log V_B	3.70 (18.75)	-.51 (-5.34)	.06 (.46)		.859	1.62
(5) log V_B	3.98 (1.71)	-.59 (-.83)	.07 (.46)	.005 (.12)	.846	1.64
(6) log V_M	4.16 (14.61)	-.84 (-11.29)			.900	.35
(7) log V_M	2,82 (6.14)		-.98 (-4.08)		.528	.73
(8) log V_M	1.33 (39.80)			-.05 (-12.79)	.921	.32
(9) log V_M	4.23 (14.98)	-.99 (-7.29)	.27 (1.32)		.906	.42
(10) log V_M	-1.34 (-.46)	.70 (.79)	.19 (1.00)	-.09 (-1.94)	.923	.41

The log regressions of Table XXVII indicate a strong role for institutional and other changes summarized in the pormanteau time variable of regression (10). While regression (9) indicates a strong -.99 elasticity of money velocity with respect to real income, the addition of the trend element results in a .70 income elasticity. Derivatively, the implied income elasticity of money demand in equation (9) is a very high 1.99, but this figure may be exceedingly misleading in light of the fact that it drops to .3 with the addition of the trend element.

Japan

Annual data for Japan (Tables XXVIII, XXIX, and XXX) indicate a slowly declining velocity of money in Japan using either the base or M_1 money stock definitions. The compound annual rates of change were -1.7 percent in base velocity and -2.5 percent for the broader M_1 velocity.

The regressions of Table XXXL present uniformly good fits for both variants of the Fisher equation. Regressions (1) and (2) for base and broader money stocks on GNP both indicate the tendency toward declining average velocity with growth in the money stock.

The trend regressions (5) and (6) in Table XXXI both contain significant slope coefficients, although the r-square statistics indicate the effects of sharp disturbances in velocity in 1962-3 and in the post-1970 period.

The log regressions of Table XXXII reveal some perverse effects in the relationship between velocity on the one hand, and real income, the interest rate, and the trend term on the other. Regressions (5) implies that base velocity (the demand for base money) rises (falls) with an increase

TABLE XXVIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR JAPAN
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	0.88	2.91	54.60	12.92	23.66	14.71	4.45	0.037	0.123
1960	1.05	3.48	56.52	15.46	27.36	14.74	4.44	0.038	0.127
1961	1.31	4.29	59.57	19.04	31.96	14.55	4.44	0.041	0.134
1962	1.58	5.06	63.62	21.15	33.24	13.42	4.18	0.047	0.152
1963	1.80	6.39	68.40	24.37	35.63	13.54	3.81	0.051	0.179
1964	2.17	7.46	71.02	28.82	40.57	13.29	3.86	0.053	0.184
1965	2.37	8.72	76.47	31.86	41.66	13.43	3.66	0.057	0.209
1966	2.71	10.14	80.30	36.74	45.75	13.55	3.62	0.059	0.222
1967	3.11	11.50	83.47	43.37	51.96	13.94	3.77	0.060	0.221
1968	3.70	13.18	87.92	51.52	58.59	13.93	3.91	0.063	0.225
1969	4.35	15.61	92.70	60.14	64.88	13.83	3.85	0.067	0.241
1970	5.19	18.47	100.00	70.92	70.92	13.66	3.84	0.073	0.260
1971	6.05	23.17	106.18	79.28	74.67	13.10	3.42	0.081	0.310
1972	7.14	28.28	111.05	90.63	81.62	12.69	3.20	0.088	0.347
1973	9.66	35.69	124.10	111.92	90.19	11.59	3.14	0.107	0.396

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXIX

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR JAPAN
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	37.00	33.34	71.40	40.54	56.79	109.58	121.60	65.15	58.71
1960	44.23	39.98	73.91	48.54	65.67	109.75	121.39	67.35	60.89
1961	55.13	49.20	77.90	59.76	76.72	108.40	121.46	71.86	64.14
1962	66.40	58.00	83.20	66.37	79.78	99.95	114.42	83.24	72.71
1963	75.85	73.29	89.44	76.49	85.52	100.83	104.35	88.70	85.71
1964	91.40	85.62	92.87	90.45	97.39	98.95	105.64	93.86	87.92
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	114.21	116.30	105.00	115.30	109.81	100.95	99.14	104.01	105.91
1967	131.11	131.94	109.15	136.13	124.71	103.83	103.17	105.13	105.80
1968	155.79	151.21	114.97	161.69	140.63	103.78	106.93	110.78	107.52
1969	183.21	179.09	121.22	188.77	155.73	103.04	105.41	117.64	115.00
1970	218.82	211.90	130.76	222.59	170.22	101.72	105.05	128.55	124.48
1971	255.08	265.90	138.84	248.84	179.23	97.55	93.58	142.32	148.36
1972	300.98	324.51	145.21	284.47	195.90	94.52	87.66	153.64	165.65
1973	406.91	409.48	162.28	351.29	216.48	86.33	85.79	187.97	189.16

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXX

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR JAPAN
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	19.53	19.93	3.53	19.72	15.64	0.15	-0.17	3.37	3.71
1961	24.65	23.06	5.40	23.13	16.82	-1.23	0.06	6.70	5.34
1962	20.45	17.89	6.80	11.06	3.99	-7.80	-5.79	15.83	13.37
1963	14.23	26.36	7.50	15.24	7.20	0.88	-8.80	6.56	17.88
1964	20.50	16.82	3.84	18.25	13.88	-1.87	1.23	5.81	2.58
1965	9.41	16.80	7.67	10.56	2.68	1.06	-5.34	6.55	13.74
1966	14.21	16.30	5.00	15.30	9.81	0.95	-0.86	4.01	5.91
1967	14.80	13.45	3.95	18.06	13.57	2.84	4.06	1.08	-0.10
1968	18.83	14.60	5.33	18.78	12.77	-0.04	3.65	5.37	1.63
1969	17.60	18.44	5.43	16.75	10.74	-0.72	-1.43	6.19	6.96
1970	19.44	18.32	7.87	17.91	9.30	-1.28	-0.34	9.27	8.25
1971	16.57	25.49	6.17	11.80	5.29	-4.10	-10.91	10.71	19.18
1972	18.00	22.04	4.59	14.32	9.30	-3.11	-6.33	7.95	11.66
1973	35.20	26.18	11.75	23.49	10.50	-8.66	-2.14	22.35	14.19

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXXI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR JAPAN ANNUAL DATA, 1959 - 1973

(1)	$Y =$	4.56	+ 11.87	B	$R^2 =$	.989	D - W =	.67
		(3.15)	(35.30)					
(2)	$Y =$	6.62	+ 3.08	M	$R^2 =$	.987	D - W =	.53
		(4.32)	(32.15)					
(3)	$P =$	16.26	+ 1074.91	(B/y)	$R^2 =$	.973	D - W =	.61
		(5.25)	(22.32)					
(4)	$P =$	24.70	+ 259.89	(M/y)	$R^2 =$	.971	D - W =	.64
		(8.82)	(21.83)					
(5)	$V_B =$	14.68	- .13	t	$R^2 =$	.532	D - W =	.70
		(49.21)	(-4.11)					
(6)	$V_M =$	4.49	- .08	t	$R^2 =$	.761	D - W =	.76
		(41.05)	(-6.74)					

TABLE XXXII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR JAPAN
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	3.02 (28.10)	-.11 (-3.84)			.495	.71
(2) log V_B	2.38 (17.42)		.11 (1.66)		.111	.83
(3) log V_B	2.69 (118.04)			-.01 (-4.03)	.521	.70
(4) log V_B	3.01 (12.84)	-.11 (-3.02)	.002 (.03)		.453	.72
(5) log V_B	-.48 (-.33)	1.14 (2.18)	-.17 (-1.91)	-.12 (-2.39)	.607	.65
(6) log V_M	2.20 (15.00)	-.22 (-5.89)			.706	.82
(7) log V_M	.62 (3.46)		.35 (4.01)		.518	.84
(8) log V_M	1.51 (51.96)			-.02 (-6.65)	.756	.75
(9) log V_M	1.61 (6.31)	-.17 (-4.35)	.18 (2.62)		.797	.62
(10) log V_M	-1.81 (-1.07)	1.06 (1.77)	.01 (.08)	-.12 (-2.05)	.840	.64

in real income. Similar results obtain in regression (10) using the broader money stock definition. Perhaps the most reasonable explanation for this phenomenon is that neither the base not the M_1 definitions of money are sufficiently broad.

If the net effect of institutional changes and improvements in the payments system is to reduce required real liquid balances relative to real income, and if this effect is insufficiently accounted for in an equation of the form of regression (5) or (10) then the apparent income elasticity of the demand for money will appear to be negative. However, this result is technically true only for the most liquid forms of money balances.

The Netherlands

Velocity in the Netherlands displays a generally upward drift as may be seen in Tables XXXIII or XXXIV. Apparent in Table XXXIV, the upward trend is much more pronounced for base velocity than in M_1 velocity. Over the 1959 to 1973 period base velocity rose 74 percent, or at an annual rate of 4 percent, while M_1 velocity rose 23.9 percent at an annual rate of 1.5 percent.

The long term movements in velocity are summarized in regressions (5) and (6) of Table XXXVI. Both slope coefficients are significantly different from zero at the five percent level. Despite the drift in velocity, the money-income linkages are quite strong reflecting a stable trend. Regressions (1) and (2) imply the observed rising average velocity, and the estimated marginal velocities are highly significant. Regressions (3) and (4) reveal another instance in which base money per unit of output provides a markedly less satisfactory explanation of price behavior

TABLE XXXIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR THE NETHERLANDS
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	5.30	10.42	64.57	38.44	59.53	7.26	3.69	0.089	0.175
1960	5.52	10.96	66.32	42.73	64.43	7.73	3.90	0.086	0.170
1961	6.12	11.81	67.03	45.29	67.57	7.40	3.83	0.091	0.175
1962	6.36	12.49	68.62	48.52	70.70	7.63	3.88	0.090	0.177
1963	6.68	13.72	70.97	52.86	74.47	7.92	3.85	0.090	0.184
1964	7.14	14.88	75.00	62.15	82.87	8.71	4.18	0.086	0.180
1965	7.85	16.51	78.75	69.37	88.09	8.84	4.20	0.089	0.187
1966	8.55	17.83	83.00	75.40	90.84	8.82	4.23	0.094	0.196
1967	9.00	19.07	85.92	81.85	95.26	9.09	4.29	0.095	0.200
1968	9.18	20.75	89.12	90.40	101.43	9.85	4.36	0.090	0.205
1969	9.69	22.60	95.75	102.37	106.91	10.56	4.53	0.091	0.211
1970	10.23	24.89	100.00	114.98	114.98	11.24	4.62	0.089	0.216
1971	10.87	29.02	107.55	129.55	120.46	11.92	4.46	0.090	0.241
1972	12.08	34.17	115.95	147.48	127.19	12.21	4.32	0.095	0.269
1973	13.26	36.64	125.23	167.54	133.79	12.63	4.57	0.099	0.274

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXXIV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR THE NETHERLANDS
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	67.46	63.09	82.00	55.42	67.58	82.15	87.84	99.82	93.35
1960	70.38	66.36	84.22	61.60	73.14	87.53	92.83	96.22	90.73
1961	77.91	71.52	85.11	65.29	76.71	83.80	91.28	101.56	93.24
1962	80.97	75.65	87.14	69.94	80.26	86.38	92.45	100.88	94.26
1963	85.05	83.10	90.13	76.20	84.55	89.59	91.69	100.60	98.29
1964	90.93	90.11	95.24	89.60	94.08	98.53	99.43	96.66	95.78
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	108.93	107.99	105.40	108.69	103.12	99.78	100.64	105.63	104.72
1967	114.71	115.49	109.11	117.99	108.14	102.87	102.17	106.07	106.79
1968	116.92	125.68	113.17	130.32	115.15	111.46	103.69	101.54	109.14
1969	123.46	136.87	121.59	147.58	121.37	119.53	107.82	101.72	112.76
1970	130.35	150.72	126.98	165.75	130.53	127.16	109.98	99.86	115.47
1971	138.46	175.76	136.57	186.76	136.75	134.89	106.26	101.25	128.53
1972	153.85	206.90	147.24	212.61	144.40	138.19	102.76	106.54	143.29
1973	168.97	221.88	159.02	241.52	151.89	142.94	108.86	111.24	146.08

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXXV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR THE NETHERLANDS
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	4.32	5.18	2.71	11.16	8.22	6.55	5.68	-3.60	-2.81
1961	10.70	7.78	1.06	5.98	4.88	-4.26	-1.67	5.55	2.77
1962	3.93	5.78	2.39	7.13	4.63	3.08	1.28	-0.67	1.10
1963	5.04	9.85	3.42	8.95	5.34	3.72	-0.82	-0.28	4.28
1964	6.92	8.44	5.67	17.59	11.28	9.98	8.44	-3.92	-2.55
1965	9.97	10.97	5.00	11.61	6.29	1.49	0.57	3.46	4.40
1966	8.93	7.99	5.40	8.69	3.12	-0.22	0.64	5.63	4.72
1967	5.30	6.94	3.52	8.56	4.87	3.09	1.52	0.42	1.98
1968	1.93	8.82	3.72	10.45	6.48	8.36	1.49	-4.27	2.20
1969	5.60	8.90	7.43	13.24	5.41	7.24	3.98	0.18	3.32
1970	5.57	10.12	4.44	12.32	7.54	6.39	1.99	-1.83	2.40
1971	6.22	16.61	7.55	12.67	4.76	6.07	-3.38	1.39	11.31
1972	11.11	17.72	7.81	13.84	5.59	2.45	-3.29	5.23	11.48
1973	9.83	7.24	8.00	13.60	5.19	3.44	5.94	4.41	1.95

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXXVI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR NETHERLANDS ANNUAL DATA, 1959 - 1973

(1)	$Y =$	-56.43 (-9.83)	+ 16.55 (25.46)	B	$R^2 =$	.979	D - W = .42
(2)	$Y =$	-10.58 (-5.39)	+ 4.83 (52.38)	M	$R^2 =$	.995	D - W = 1.65
(3)	$P =$	-255.61 (-2.54)	+3761.70 (3.40)	(B/y)	$R^2 =$	.430	D - W = .63
(4)	$P =$	-28.54 (-4.41)	+ 562.63 (17.95)	(M/y)	$R^2 =$	.958	D - W = 1.08
(5)	$V_B =$	6.26 (25.14)	+ .40 (14.61)	t	$R^2 =$	.938	D - W = .51
(6)	$V_M =$	3.70 (57.50)	+ .06 (8.70)	t	$R^2 =$	.842	D - W = 1.43

TABLE XXXVII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR NETHERLANDS
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	-1.02 (-5.68)	.72 (18.06)			.959	.57
(2) log V_B	1.09 (7.98)	.66 (8.47)			.835	.70
(3) log V_B	1.09 (89.51)			.04 (17.92)	.958	.86
(4) log V_B	-1.08 (-2.93)	.74 (6.01)	-.02 (-.16)		.955	.59
(5) log V_B	.09 (.03)	.45 (.57)	-.01 (-.09)	.02 (.37)	.952	.68
(6) log V_M	.26 (2.11)	.26 (9.58)			.866	1.40
(7) log V_M	.98 (29.30)		.26 (13.71)		.930	1.82
(8) log V_M	1.31 (84.59)			.01 (8.70)	.842	1.41
(9) log V_M	.80 (4.63)	.06 (1.07)	.20 (3.64)		.931	1.87
(10) log V_M	-2.09 (-1.73)	.78 (2.58)	.18 (3.82)	-.04 (-2.40)	.951	1.75

than does the broader money stock.

Table XXXVII contains results of log regressions of potential determinants of velocity for both money stock definitions. Individually, the real income, interest rate, and trend elements are highly significant. In combination regression (9) indicates virtually no importance for real income changes in explaining changes in velocity while the interest rate exhibits only a moderate elasticity. With the addition of the trend element, all coefficients with the exception of the constant term are significantly different from zero at the five percent level. The addition of the trend element reduces the implied elasticity of real money demand with respect to real income from .94 to .22 while the interest elasticity is virtually unchanged. A similar though less drastic reduction is apparent in comparing the base velocity regressions (4) and (5).

Switzerland

Velocity in Switzerland was remarkably stable until 1973. From 1959 through 1972 the compound annual rate of change in Swiss M_1 velocity was .4 percent, while base velocity grew at the moderately higher rate of 1.0 percent per year. Both series were subjected to large shocks in 1973, especially the broader money velocity, as can be seen in any of Tables XXXVIII, XXXIX, or XL.

The modest trends in velocity are reflected in the low slope coefficients and low r-squares of regressions (5) and (6) in Table XLI. Stability of the velocity series are reflected in the results of regressions (1) through (4). The results of regressions (1) and (2) suggest the tentative nature of the trends observed, since in neither regression

TABLE XXXVIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR SWITZERLAND
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	8.89	16.72	71.00	33.80	47.61	3.80	2.02	0.187	0.351
1960	8.79	17.79	72.05	37.10	51.49	4.22	2.09	0.171	0.345
1961	10.46	20.17	73.37	41.50	56.56	3.97	2.06	0.185	0.357
1962	11.18	22.62	76.55	46.10	60.22	4.12	2.04	0.186	0.376
1963	12.00	24.63	79.15	50.40	63.68	4.20	2.05	0.188	0.387
1964	12.83	26.49	81.62	55.50	67.99	4.33	2.09	0.189	0.390
1965	13.57	27.84	84.40	60.00	71.09	4.42	2.16	0.191	0.392
1966	13.99	28.74	88.42	64.60	73.06	4.62	2.25	0.191	0.393
1967	14.65	30.45	92.02	68.80	74.76	4.70	2.26	0.196	0.407
1968	15.57	33.74	94.20	74.20	78.77	4.77	2.20	0.198	0.428
1969	17.48	37.03	96.55	80.90	83.79	4.63	2.18	0.209	0.442
1970	19.38	40.74	100.05	88.90	88.86	4.59	2.18	0.218	0.458
1971	23.24	48.28	106.58	100.80	94.58	4.34	2.09	0.246	0.511
1972	27.03	54.72	113.68	116.10	102.13	4.30	2.12	0.265	0.536
1973	29.13	54.54	123.63	131.10	106.05	4.50	2.40	0.275	0.514

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XXXIX

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR SWITZERLAND
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	65.55	60.07	84.12	56.33	66.96	85.93	93.77	97.89	89.71
1960	64.83	63.90	85.37	61.83	72.43	95.38	96.76	89.50	88.22
1961	77.09	72.44	86.94	69.17	79.56	89.72	95.48	96.89	91.06
1962	82.39	81.24	90.70	76.83	84.71	93.25	94.57	97.26	95.90
1963	88.45	88.47	93.78	84.00	89.57	94.97	94.95	98.75	98.77
1964	94.55	95.17	96.71	92.50	95.64	97.83	97.19	98.85	99.51
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	103.12	103.24	104.77	107.67	102.77	104.41	104.29	100.35	100.46
1967	107.98	109.38	109.03	114.67	105.17	106.19	104.83	102.68	104.01
1968	114.79	121.22	111.61	123.67	110.80	107.74	102.02	103.60	109.40
1969	128.82	133.01	114.40	134.83	117.87	104.67	101.37	109.30	112.85
1970	142.86	146.34	118.54	148.17	124.99	103.71	101.25	114.30	117.08
1971	171.35	173.45	126.27	168.00	133.04	98.04	96.86	128.79	130.37
1972	199.26	196.58	134.69	193.50	143.67	97.11	98.43	138.70	136.83
1973	214.77	195.91	146.48	218.50	149.17	101.74	111.53	143.97	131.33

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XL

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR SWITZERLAND
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	-1.10	6.37	1.48	9.76	8.17	10.99	3.19	-8.57	-1.66
1961	18.91	13.37	1.84	11.86	9.84	-5.93	-1.33	8.26	3.21
1962	6.89	12.15	4.33	11.09	6.48	3.93	-0.95	0.38	5.32
1963	7.35	8.90	3.40	9.33	5.74	1.84	0.39	1.53	2.99
1964	6.89	7.58	3.13	10.12	6.78	3.02	2.36	0.11	0.75
1965	5.77	5.07	3.40	8.11	4.55	2.22	2.89	1.16	0.49
1966	3.12	3.24	4.77	7.67	2.77	4.41	4.29	0.35	0.46
1967	4.71	5.95	4.07	6.50	2.34	1.71	0.52	2.32	3.53
1968	6.30	10.82	2.36	7.85	5.36	1.46	-2.68	0.89	5.18
1969	12.23	9.73	2.49	9.03	6.38	-2.85	-0.64	5.50	3.15
1970	10.90	10.02	3.63	9.89	6.04	-0.91	-0.12	4.58	3.75
1971	19.94	18.53	6.52	13.39	6.44	-5.47	-4.34	12.68	11.35
1972	16.29	13.34	6.66	15.18	7.98	-0.95	1.62	7.69	4.96
1973	7.78	-0.34	8.75	12.92	3.83	4.77	13.31	3.80	-4.02

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XLI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR SWITZERLAND ANNUAL DATA, 1959 - 1973

(1)	$Y =$	-2.78 (-1.11)	+	4.58 (31.03)	B	$R^2 =$	.986	D - W = .70
(2)	$Y =$	-4.71 (-1.66)	+	2.31 (28.11)	M	$R^2 =$	.983	D - W = 1.50
(3)	$P =$	-8.49 (-.88)	+	478.72 (10.36)	(B/y)	$R^2 =$	.884	D - W = .60
(4)	$P =$	-14.13 (-1.78)	+	248.96 (13.27)	(M/y)	$R^2 =$	.926	D - W = 1.33
(5)	$V_B =$	4.04 (34.79)	+	.04 (3.21)	t	$R^2 =$	.399	D - W = .73
(6)	$V_M =$	2.02 (46.54)	+	.02 (3.25)	t	$R^2 =$	.406	D - W = 1.27

TABLE XLII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR SWITZERLAND
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	.72 (3.02)	.17 (3.14)			.387	.79
(2) log V_B	1.19 (15.88)		.20 (3.78)		.487	.84
(3) log V_B	1.39 (52.08)			.01 (3.28)	.410	.78
(4) log V_B	1.31 (2.98)	-.04 (-.27)	.24 (1.56)		.488	.86
(5) log V_B	1.06 (.46)	.02 (.04)	.25 (1.21)	-.004 (-.11)	.398	.89
(6) log V_M	.21 (1.20)	.13 (3.11)			.383	1.24
(7) log V_M	.56 (9.78)		.14 (3.50)		.446	1.12
(8) log V_M	.71 (35.78)			.01 (3.30)	.414	1.24
(9) log V_M	.55 (.04)	.004 (1.17)	.14		.399	1.13
(10) log V_M	1.36 (.78)	-.19 (-.45)	.09 (.55)	.01 (.48)	.358	1.13

is the intercept term significantly different from zero at the five percent level, implying that average and marginal velocity are not significantly different at the same level of confidence. The price level variants of Fisher's quantity equation, regressions (3) and (4), both indicate the stock of money per unit of output is quite important in the determination of the price level.

Regressions in logs presented in Table XLII suggest, as in most other cases investigated, the extent of multicollinearity. Taken singly real income, the interest rate, and trend terms have effects on velocity which are significantly non-zero. In combination none of the explanatory variables is significantly different from zero. Further, none of the r-square statistics is greater than .5. As in many other countries, the low income elasticities of regressions (4), (5), (9), and (10) imply income elasticities of the demand for real balances close to or exceeding unity using both money stock definitions.

The United Kingdom

Britain's velocity series have been rising for most of the 1959 through 1973 period. As Tables XLIII, XLIV, and XLV disclose, the broader velocity series fell in only one year (1972) while the narrower base velocity series fell in three. Most spectacular of the latter was the almost eleven percent fall in 1973 coinciding with an almost thirty percent growth in base money.

In Britain, as in virtually every country studied, the quantity theory equations appear to be strongly supported by the evidence. The regressions of Table XLVI confirm the close associations between the stock of money and nominal income, and between money per unit of output and the

TABLE XLIII

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR THE UNITED KINGDOM
ANNUAL DATA, 1959-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	2.53	6.32	66.55	21.16	31.80	8.35	3.35	0.080	0.199
1960	2.65	6.55	67.22	22.58	33.59	8.51	3.45	0.079	0.195
1961	2.76	6.60	69.50	24.22	34.85	8.77	3.67	0.079	0.189
1962	2.79	6.53	72.43	25.30	34.93	9.05	3.87	0.080	0.187
1963	2.91	6.83	73.87	26.88	36.39	9.25	3.93	0.080	0.188
1964	3.07	7.30	76.32	29.08	38.10	9.49	3.99	0.080	0.192
1965	3.31	7.52	79.97	31.03	38.79	9.37	4.13	0.085	0.194
1966	3.59	7.79	83.05	32.77	39.45	9.13	4.21	0.091	0.197
1967	3.77	8.01	85.15	34.43	40.43	9.13	4.30	0.093	0.198
1968	3.94	8.41	89.15	36.55	41.00	9.27	4.35	0.096	0.205
1969	4.04	8.41	94.00	38.58	41.04	9.54	4.59	0.099	0.205
1970	4.25	8.91	100.15	42.79	42.72	10.07	4.80	0.099	0.208
1971	4.50	10.03	109.45	48.29	44.12	10.73	4.82	0.102	0.227
1972	4.64	11.70	117.23	53.83	45.92	11.61	4.60	0.101	0.255
1973	5.97	12.84	127.98	61.67	48.19	10.34	4.80	0.124	0.267

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XLIV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR THE UNITED KINGDOM
INDEX NUMBERS OF ANNUAL DATA, 1959-1973
(1965 = 100)

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1959	76.54	84.05	83.21	68.21	81.97	89.11	81.15	93.38	102.54
1960	80.14	87.19	84.06	72.79	86.59	90.83	83.48	92.54	100.69
1961	83.41	87.80	86.90	78.06	89.82	93.59	88.91	92.86	97.75
1962	84.43	86.90	90.56	81.53	90.03	96.57	93.82	93.78	96.52
1963	87.77	90.94	92.37	86.64	93.79	98.71	95.28	93.58	96.95
1964	92.60	97.08	95.44	93.73	98.21	101.22	96.55	94.28	98.84
1965	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1966	108.45	103.58	103.84	105.61	101.70	97.38	101.96	106.64	101.85
1967	113.90	106.57	106.47	110.97	104.22	97.43	104.13	109.28	102.25
1968	119.07	111.91	111.47	117.80	105.68	98.94	105.27	112.67	105.90
1969	122.13	111.90	117.54	124.33	105.78	101.81	111.11	115.45	105.78
1970	128.42	118.49	125.23	137.90	110.12	107.38	116.38	116.62	107.60
1971	135.93	133.41	136.86	155.66	113.74	114.51	116.67	119.51	117.30
1972	140.08	155.71	146.58	173.48	118.36	123.85	111.41	118.35	131.56
1973	180.28	170.89	160.02	198.78	124.22	110.26	116.32	145.12	137.57

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XLV

MONEY, PRICES, GNP, AND DERIVED RATIOS FOR THE UNITED KINGDOM
ANNUAL PERCENTAGE RATES OF CHANGE, 1960-1973

YEAR	B	M	P	Y	Y/P	Y/B	Y/M	B/(Y/P)	M/(Y/P)
1960	4.70	3.73	1.01	6.71	5.64	1.93	2.88	-0.90	-1.81
1961	4.08	0.70	3.38	7.24	3.73	3.04	6.50	0.34	-2.92
1962	1.23	-1.02	4.21	4.46	0.24	3.18	5.53	0.99	-1.25
1963	3.95	4.64	2.00	6.26	4.18	2.22	1.55	-0.21	0.45
1964	5.50	6.75	3.32	8.18	4.71	2.55	1.34	0.75	1.95
1965	7.99	3.01	4.78	6.69	1.82	-1.21	3.57	6.06	1.17
1966	8.45	3.58	3.84	5.61	1.70	-2.62	1.96	6.64	1.85
1967	5.02	2.89	2.53	5.08	2.48	0.05	2.13	2.48	0.39
1968	4.54	5.01	4.70	6.16	1.40	1.55	1.09	3.10	3.57
1969	2.57	-0.01	5.44	5.54	0.10	2.90	5.55	2.47	-0.11
1970	5.15	5.89	6.54	10.91	4.10	5.48	4.75	1.01	1.72
1971	5.85	12.59	9.29	12.87	3.28	6.64	0.25	2.48	9.01
1972	3.05	16.72	7.10	11.45	4.06	8.15	-4.51	-0.97	12.16
1973	28.70	9.75	9.17	14.58	4.96	-10.97	4.40	22.62	4.57

NOTE THAT THE FOLLOWING ABBREVIATIONS HAVE BEEN USED:
B: MONETARY BASE
M: MONEY STOCK
P: CONSUMER PRICE INDEX
Y: GROSS NATIONAL PRODUCT

TABLE XLVI

REGRESSIONS OF ALTERNATIVE FORMS OF THE QUANTITY EQUATION AND VELOCITY TRENDS FOR UNITED KINGDOM ANNUAL DATA, 1959 - 1973

(1)	$Y =$	-10.07	+ 12.43	B	$R^2 =$ .962	D - W = 1.48
		(-4.06)	(18.85			
(2)	$Y =$	-14.92	+ 6.08	M	$R^2 =$ .976	D - W = .79
		(-6.93)	(23.91)			
(3)	$P =$	-41.77	+ 1416.61	(B/y)	$R^2 =$ .898	D - W = 1.40
		(-3.58)	(11.17)			
(4)	$P =$	-63.00	+ 726.71	(M/y)	$R^2 =$ .848	D - W = .42
		(-3.70)	(8.90)			
(5)	$V_B =$	8.18	+ .17	t	$R^2 =$ .722	D - W = 1.22
		(33.13)	(6.12)			
(6)	$V_M =$	3.35	+ .10	t	$R^2 =$ .946	D - W = 1.16
		(55.24)	(15.74			

TABLE XLVII

REGRESSIONS OF LOGS OF REAL INCOME, INTEREST RATES, AND TIME ON VELOCITY FOR UNITED KINGDOM
ANNUAL DATA, 1959 - 1973

	a	log (y)	log (r)	t	R^2	D - W
(1) log V_B	-.14 (-.38)	.65 (6.60)			.752	1.27
(2) log V_B	1.65 (12.41)		.31 (4.54)		.584	1.29
(3) log V_B	2.11 (88.88)			.02 (6.57)	.751	1.16
(4) log V_B	-.42 (-.59)	.76 (2.92)	-.06 (-.47)		.737	1.20
(5) log V_B	1.67 (.63)	.19 (.26)	-.14 (-.85)	.02 (.82)	.729	1.30
(6) log V_M	-2.06 (-6.78)	.95 (11.48)			.903	.95
(7) log V_M	.49 (4.11)		.48 (7.88)		.814	.65
(8) log V_M	1.22 (76.50)			.03 (14.53)	.938	.89
(9) log V_M	-1.59 (-2.71)	.77 (3.58)	.11 (.94)		.902	.85
(10) log V_M	2.59 (1.43)	-.37 (-.73)	-.05 (-.46)	.04 (2.40)	.930	1.01

price level. The trend regressions confirm the observed upward drift in both velocity series.

The log regressions of Table XLVII reveal somewhat closer associations between real income, the interest rate, and velocity of the broader money stock than the narrower velocity series. Excluding the trend element, the income elasticity estimated in regressions (4) and (9) imply quite low income elasticities of the demand for money on both money stock definitions. Respectively these implied elasticities are .24 and .23 for base and M_1 money stocks. The addition of the trend term significantly alters the estimated income elasticities. The implied elasticity with respect to the base money stock rises to .81 while the broader money stock, at 1.37, is shifted past unit elastic. A perverse interest elasticity obtains in the case of base velocity, and by implication the demand for real balances on that definition. While it is not significantly differ- from zero, both regressions (4) and (5) imply a theoretically wrong sign for the interest elasticity of demand. With the addition of time to regression (9), regression (10) implies the same result for the broader money stock demand.

International Velocity

As the previous sections have demonstrated, there have been a variety of velocity experiences in the nine countries studied. Some series trend up, others down. Still others show no marked trend. This section investigates the extent to which, taken together, the nine velocity series for each definition of the money stock demonstrate similar behavior patterns.

The velocity series are reproduced in Tables XLVIII and XLIX in the form of annual rates of change. Data in Table XLVIII are for base velocity while the broader M_1 velocity data are tabulated in Table XLIX. Distinct patterns are difficult to discern in either presentation. However, there is a suggestion of covariation upon close scrutiny. Most countries show very large increases in 1960 with some exhibiting large negative changes. In 1964 in most of the countries,and for both velocity series,a relative maximum rate of growth was reached. Again in the late 1960's most velocities reached relative maxima in their growth rates. The years 1971 and 1972 were in general years of declining velocity, although not without exception.

Thus casual observation suggests that there may be a tendency toward covariation in velocity. In order to test this suggestion summary descriptive statistics were calculated for the two velocity concepts in levels, percentage deviations from linear trend, and rates of change. The results of these summary calculations are reproduced in Tables L - LV.

Tables L and LI reveal that the most variable series, as measured by their coefficients of variation, are those series with the most obvious trends. Despite the broad range of average values and variability, the correlation matrices in Tables L and LI indicate relatively substantial intercorrelations among countries in both base and,especially, M_1 velocity series. The only systematically low correlations appear to involve the German base velocity series, which is highly stable.

Tables LII and LIII summarize velocity data in percentage deviations from trend. For both velocity definitions the average values are very

TABLE XLVIII

ANNUAL PERCENTAGE RATES OF CHANGE IN BASE VELOCITY FOR NINE COUNTRIES
ANNUAL DATA, 1959 - 1973

YEAR	BEL	CAN	FR	GER	IT	JA	NE	SW	UK
1960	4.36	4.07	3.91	-8.71	-17.85	0.15	6.55	10.99	1.93
1961	1.11	-1.38	-4.28	6.37	0.01	-1.23	-4.26	-5.93	3.04
1962	1.36	2.22	-0.86	4.35	0.38	-7.80	3.08	3.93	3.18
1963	-1.72	3.28	-0.65	-0.44	-8.89	0.88	3.72	1.84	2.22
1964	5.35	3.20	1.82	1.17	0.37	-1.87	9.98	3.02	2.55
1965	1.84	2.37	-0.23	-1.05	-1.51	1.06	1.49	2.22	-1.21
1966	3.06	3.53	2.26	0.47	-3.10	0.95	-0.22	4.41	-2.62
1967	4.83	-1.68	1.74	2.01	0.56	2.84	3.09	1.71	0.05
1968	4.28	6.69	3.21	7.14	-2.20	-0.04	8.36	1.46	1.55
1969	9.06	0.62	8.36	0.09	0.28	-0.72	7.24	-2.85	2.90
1970	11.68	1.68	13.08	1.91	-3.47	-1.28	6.39	-0.91	5.48
1971	3.33	-2.02	1.28	-9.06	-7.93	-4.10	6.07	-5.47	6.64
1972	0.79	-3.49	-3.52	-5.29	-1.79	-3.11	2.45	-0.95	8.15
1973	-0.50	-0.07	-8.60	-10.05	2.40	-8.66	3.44	4.77	-10.97

TABLE XLIX

ANNUAL PERCENTAGE RATES OF CHANGE IN MONEY VELOCITY FOR NINE COUNTRIES
ANNUAL DATA, 1959 - 1973

YEAR	BEL	CAN	FR	GER	IT	JA	NE	SW	UK
1960	4.10	3.44	-1.47	0.84	-3.96	-0.17	5.68	3.19	2.88
1961	0.93	-5.80	-6.55	2.56	-2.50	0.06	-1.67	-1.33	6.50
1962	-0.11	2.93	-4.28	-2.11	-4.60	-5.79	1.28	-0.95	5.53
1963	-2.40	-0.84	-3.87	-0.26	-1.81	-8.80	-0.82	0.39	1.55
1964	5.70	2.54	0.63	0.95	2.50	1.23	8.44	2.36	1.34
1965	1.16	-5.60	-1.60	-0.14	-5.05	-5.34	0.57	2.89	3.57
1966	1.17	3.46	-0.19	1.95	-6.35	-0.86	0.64	4.29	1.96
1967	2.68	-6.79	1.66	-2.22	-2.65	4.06	1.52	0.52	2.13
1968	0.45	-1.16	5.40	1.15	-4.61	3.65	1.49	-2.68	1.09
1969	5.86	4.40	7.58	1.80	-4.39	-1.43	3.98	-0.64	5.55
1970	5.65	5.57	11.68	6.63	-8.61	-0.34	1.99	-0.12	4.75
1971	-0.57	-9.83	-1.36	-1.02	-10.97	-10.91	-3.38	-4.34	0.25
1972	-0.80	-11.78	-1.64	-4.26	-8.49	-6.33	-3.29	1.62	-4.51
1973	0.66	3.80	2.89	5.48	-4.05	-2.14	5.94	13.31	4.40

TABLE L

SUMMARY STATISTICS AND INTERCORRELATIONS FOR LEVELS OF BASE VELOCITY
ANNUAL DATA, 1959-1973

	MEAN	STD.DEV.	COEF. OF VAR	MAX	MIN
BELGIUM	5.70	1.05	18.33	7.31	4.54
CANADA	15.48	1.22	7.91	17.14	13.47
FRANCE	8.15	0.94	11.49	9.91	7.32
GERMANY	10.26	0.69	6.74	11.44	8.87
ITALY	6.61	0.86	13.03	8.90	5.51
JAPAN	13.60	0.80	5.90	14.74	11.59
NETHERLANDS	9.45	1.84	19.48	12.63	7.26
SWITZERLAND	4.37	0.28	6.31	4.77	3.80
UNITED KINGDOM	9.51	0.86	9.07	11.61	8.35

	BELGIUM	CAN	FR	GER	IT	JA	NE	SW
CANADA	0.821							
FRANCE	0.936	0.737						
GERMANY	0.112	0.507	0.208					
ITALY	-0.818	-0.843	-0.677	-0.113				
JAPAN	-0.678	-0.502	-0.443	0.261	0.726			
NETHERLANDS	0.986	0.842	0.882	0.076	-0.850	-0.741		
SWITZERLAND	0.464	0.832	0.310	0.458	-0.695	-0.323	0.523	
UNITED KINGDOM	0.892	0.675	0.824	0.012	-0.828	-0.757	0.892	0.295

TABLE LI

SUMMARY STATISTICS AND INTERCORRELATIONS FOR LEVELS OF M_1 VELOCITY
ANNUAL DATA, 1959-1973

	MEAN	STD.DEV.	COEF.OF VAR	MAX	MIN
BELGIUM	2.90	0.25	8.73	3.26	2.55
CANADA	6.10	0.43	6.99	6.59	5.13
FRANCE	3.31	0.33	9.85	3.79	2.94
GERMANY	6.84	0.26	3.74	7.32	6.57
ITALY	2.65	0.54	20.25	3.39	1.72
JAPAN	3.84	0.41	10.71	4.45	3.14
NETHERLANDS	4.19	0.30	7.11	4.62	3.69
SWITZERLAND	2.15	0.10	4.83	2.40	2.02
UNITED KINGDOM	4.19	0.48	11.49	4.82	3.35

	BELGIUM	CAN	FR	GER	IT	JA	NE	SW
CANADA	-0.662							
FRANCE	0.663	-0.426						
GERMANY	0.887	-0.470	0.743					
ITALY	-0.959	0.802	-0.604	-0.836				
JAPAN	-0.760	0.754	-0.259	-0.619	0.867			
NETHERLANDS	0.921	-0.502	0.413	0.776	-0.854	-0.729		
SWITZERLAND	0.572	-0.493	0.142	0.501	-0.608	-0.618	0.719	
UNITED KINGDOM	0.949	-0.621	0.436	0.823	-0.939	-0.833	0.945	0.624

TABLE LII

SUMMARY STATISTICS AND INTERCORRELATIONS FOR RELATIVE DEVIATIONS FROM TREND OF BASE VELOCITY
ANNUAL DATA, 1959-1973

	MEAN	STD.DEV.	MAX	MIN
BELGIUM	0.12	6.03	9.32	-7.53
CANADA	-0.01	3.18	4.87	-5.91
FRANCE	0.02	6.70	10.93	-6.96
GERMANY	-0.00	6.57	10.32	-15.21
ITALY	0.03	4.87	13.49	-6.34
JAPAN	-0.00	3.97	4.86	-8.40
NETHERLANDS	0.13	5.11	9.62	-7.75
SWITZERLAND	-0.00	4.69	7.13	-6.87
UNITED KINGDOM	0.01	4.34	10.51	-5.76

	BELGIUM	CAN	FR	GER	IT	JA	NE	SW
CANADA	-0.315							
FRANCE	0.921	-0.011						
GERMANY	-0.215	0.806	0.061					
ITALY	0.400	-0.121	0.237	0.109				
JAPAN	0.188	0.648	0.407	0.635	0.129			
NETHERLANDS	0.864	-0.315	0.748	-0.384	0.380	-0.002		
SWITZERLAND	-0.677	0.735	-0.508	0.441	-0.290	0.356	-0.601	
UNITED KINGDOM	0.392	-0.507	0.401	-0.293	-0.254	-0.341	0.376	-0.726

TABLE LIII

SUMMARY STATISTICS AND INTERCORRELATIONS FOR RELATIVE DEVIATIONS FORM TREND OF M_1 VELOCITY
ANNUAL DATA, 1959-1973

	MEAN	STD.DEV.	MAX	MIN
BELGIUM	0.01	2.50	4.81	-4.36
CANADA	-0.01	4.77	10.94	-9.51
FRANCE	0.02	8.71	14.75	-11.17
GERMANY	0.00	2.21	4.26	-3.15
ITALY	-0.12	4.36	5.76	-7.73
JAPAN	0.00	5.17	9.23	-6.77
NETHERLANDS	-0.00	2.65	4.03	-5.42
SWITZERLAND	0.00	3.50	6.64	-6.10
UNITED KINGDOM	-0.01	2.47	4.23	-4.57

	BELGIUM	CAN	FR	GER	IT	JA	NE	SW
CANADA	0.298							
FRANCE	0.783	-0.092						
GERMANY	0.698	0.344	0.661					
ITALY	-0.301	0.523	-0.659	-0.411				
JAPAN	0.618	0.359	0.397	0.300	0.172			
NETHERLANDS	0.320	0.763	-0.118	0.138	0.710	0.491		
SWITZERLAND	-0.291	0.024	-0.280	-0.088	0.335	-0.086	0.362	
UNITED KINGDOM	0.114	0.749	-0.294	0.273	0.406	0.252	0.433	-0.177

close to zero, in general. There appears to be no appreciable reduction in the heterogeneity of the dispersion terms, however. Yet with a few exceptions the extreme deviations fall within the range of two standard deviations on either side of the mean value, and none exceed the three standard deviation range.

The intercorrelations are somewhat reduced with approximately one-third exceeding the .497 five percent significance level. However, such a finding should not be disturbing. If velocity is internationally stable in the sense that from country to country velocity is either constant or trending at a constant rate subject to a stochastic error term, then zero or insignificant correlations between detrended series essentially suggest the independence of the error terms. Such evidence can only constitute a suggestion of independence, however, since while independent series are necessarily uncorrelated, uncorrelated series are not necessarily independent.

Tables LIV and LV present summary statistics for the rate of change in base and M_1 velocity for the nine countries. The descriptive statistics again suggest a broad heterogeneity in average values and dispersions.

As in the previous case, the intercorrelations are relatively low with one-fourth to one-third significant at the five percent level. There appear to be a much larger proportion of significant correlations in the M_1 velocity data than in the base velocity data, with four significant in the former and twelve in the latter case.

Given the close international association of levels of velocity series noted earlier in this section, it is desirable to test directly the prop-

TABLE LIV

SUMMARY STATISTICS AND INTERCORRELATIONS FOR RATES OF CHANGE IN BASE VELOCITY
ANNUAL DATA, 1960-1973

	MEAN	STD.DEV.	MAX	MIN
BELGIUM	3.49	3.60	11.68	-1.72
CANADA	1.36	2.82	6.69	-3.49
FRANCE	1.25	5.29	13.08	-8.60
GERMANY	-0.79	5.54	7.14	-10.05
ITALY	-3.05	5.32	2.40	-17.85
JAPAN	-1.64	3.32	2.84	-8.66
NETHERLANDS	4.10	3.70	9.98	-4.26
SWITZERLAND	1.30	4.40	10.99	-5.93
UNITED KINGDOM	1.63	4.62	8.15	-10.97

	BELGIUM	CAN	FR	GER	IT	JA	NE	SW
CANADA	0.120							
FRANCE	0.905	0.326						
GERMANY	0.209	0.330	0.258					
ITALY	0.012	-0.284	-0.248	0.427				
JAPAN	0.273	0.255	0.445	0.331	-0.286			
NETHERLANDS	0.510	0.391	0.511	-0.153	-0.205	-0.032		
SWITZERLAND	-0.144	0.563	-0.055	-0.255	-0.377	0.015	0.216	
UNITED KINGDOM	0.310	-0.218	0.428	0.197	-0.273	0.181	0.179	-0.469

TABLE LV

SUMMARY STATISTICS AND INTERCORRELATIONS FOR RATES OF CHANGE IN M_1 VELOCITY
ANNUAL DATA, 1960-1973

	MEAN	STD.DEV.	MAX	MIN
BELGIUM	1.75	2.64	5.86	-2.40
CANADA	-1.12	5.78	5.57	-11.78
FRANCE	0.63	4.92	11.68	-6.55
GERMANY	0.81	2.91	6.63	-4.26
ITALY	-4.68	3.31	2.50	-10.97
JAPAN	-2.37	4.46	4.06	-10.91
NETHERLANDS	1.60	3.46	8.44	-3.38
SWITZERLAND	1.32	4.18	13.31	-4.34
UNITED KINGDOM	2.64	2.81	6.50	-4.51

	BELGIUM	CAN	FR	GER	IT	JA	NE	SW
CANADA	0.533							
FRANCE	0.621	0.454						
GERMANY	0.446	0.661	0.555					
ITALY	0.252	0.309	-0.211	0.041				
JAPAN	0.592	0.346	0.420	0.346	0.455			
NETHERLANDS	0.688	0.732	0.369	0.443	0.616	0.542		
SWITZERLAND	0.043	0.354	0.048	0.384	0.222	0.127	0.510	
UNITED KINGDOM	0.360	0.573	0.120	0.589	0.264	0.258	0.343	0.086

osition that velocity is stable across countries directly. However, one of the most direct tests of this proposition, involving one-or-two-way analysis of variance, requires the assumption of homogeneous variance across the sample. This assumption must be rejected out of hand on the basis of F-ratios calculated for all variants of velocity discussed.

An alternative and less direct though more sophisticated test is discussed by Dhrymes (1970: 60-1). Suppose that the nine velocity series were perfectly collinear such that each was a linear transformation of any other. In short, assume that the rank of the covariance matrix of velocity time series was one. In that case only one characteristic root could be extracted from the covariance matrix. On the other hand, if no series were a linear combination of the others, then the covariance matrix would be of full rank. Clearly, if the former results obtained it would constitute strong evidence, in combination with earlier results, in support of the hypothesis that velocities tend to move together internationally. Dhrymes notes that the extraction of nine (in this case) non-zero roots ipso facto confirms that there are nine individual components to the velocity series. However he does suggest that it is reasonable to inquire how many components substantially account for the observed variation in the velocity series.

Specifically, Dhrymes suggested testing the hypothesis that the last 9 - k (ordered) roots of the covariance matrix, A, of the velocity series are identical and small. Thus

$$H_0 : r_{k+1} = r_{k+2} = \ldots = r_9 = r$$

where r_i denotes the i^{th} characteristic root of A. The test is, to

$O(1/n^2)$, chi-squared with degrees of freedom

$$df=(1/2)(11-k)(8-k),$$

as applied to this problem. Defining q to be

$$q = 9-k,$$

the chi-square test variable is

$$X^2 = \left[n-1-k-\left(\frac{1}{6}\right)\left(2q+\frac{2}{q}+1\right) + L^2\sum_{1}^{k}\frac{1}{(r_i - L)^2}\right] \cdot \left[-\ln\left(\frac{\det A}{\prod_{1}^{k} r_i}\right) + q\ \ln(L)\right]$$

where the calculated values of r_i and the estimated covariance matrix are used, and where

$$L = \frac{\mathrm{tr}A - \sum_{1}^{k} r_i}{q} .$$

Table LVI summarizes the results of the principal components inquiry into the sources of variation in international velocity. A variance target of ninety percent was chosen and the components were added until the target level was attained or exceeded.

The analysis of levels of velocity indicate three components accounting for substantially all of the variation in base and M_1 velocity. Relative deviations from trend require four components to exceed the ninety percent level and the actual amount of variation explained in both cases exceeds ninety-five percent. Finally, five components are necessary to explain approximately ninety-four percent of the variation in rates of change in velocity. In all cases the

TABLE LVI

PRINCIPAL COMPONENTS ANALYSIS OF LEVELS, PERCENTAGE DEVIATIONS FROM TREND, AND PERCENTAGE RATES OF CHANGE IN BASE AND MONEY VELOCITY IN NINE COUNTRIES
ANNUAL DATA, 1959-1973

LEVELS

	BASE	MONEY
Number of components	3	3
Percentage of variance explained	96.3	96.5
Chi-square statistic (d.f.)	15.8(20)	12.7(20)

PERCENTAGE DEVIATIONS FROM TREND

	BASE	MONEY
Number of components	4	4
Percentage of variance explained	95.4	95.3
Chi-square statistic (d.f.)	5.6(14)	4.6(14)

PERCENTAGE RATE OF CHANGE

	BASE	MONEY
Number of components	5	5
Percentage of variance explained	94.1	93.9
Chi-square statistic (d.f.)	2.7(9)	1.3(9)

chi-square variable, calculated using Dhrymes formulation above, was insufficient to reject the hypothesis that the remaining components were identical and of little additional explanatory power.

In sum, although the nine velocity series studied exhibited a wide range of behavior, only three components were required to explain substantially all of the variation. Thus rather than a dimensionality of nine, it appears that the nine velocity series exhibit a dimensionality of three.

Post - 1970 Velocity

World monetary affairs reached a crisis in 1971. The U.S. balance of payments deficits reached critical proportions in the first quarter of 1971 and worsened throughout the year until in August, 1971, the U.S. officially terminated gold convertibility and support for the crumbling fixed rate system. In 1973 the major European economies abandoned the fixed rate system and floated their exchange rates (See Meiselman 1975: 98-112).

During the collapse of the fixed rate system in the post-1970 era, national money stocks grew at extraordinary rates. Meiselman (1975) attributes this inordinate growth rate to the release of dollar reserves, the demand for which is presumed to have fallen as a result of the crisis in the fixed exchange rate system. For whatever reason, however, it is clear that the growth rates were unusually large. In most countries the rates were in excess of twelve percent per year in 1971 and 1972, and for virtually every country the monetary growth was the highest in a decade. At the same time velocity in 1971 and

1972 appears to have fallen in nearly every country studied, and continued to fall in some countries through 1973.

In an attempt to ascertain whether these declines in velocity were significant, regressions were run on the 1959 through 1973 period with separate slope estimates and a dummy variable introduced in the 1971-1973 period to account for possible shifts in the intercept. These regressions are presented in Tables LVII and LVIII for regressions of the base on GNP and M_1 on GNP, respectively. In these tables the 1959-1970 marginal velocity is tested against 1971-1973 marginal velocity for significant differences.

The results in Table LVII indicate that in Canada, France, Germany, Japan, and the United Kingdom both the intercept, affecting average base velocity, and the slope coefficient (marginal base velocity) were significantly different in the post-1970 period. Of the remaining countries only Italy showed evidence of structural change with a shift in average but not marginal velocity.

The regressions in Table LVIII present evidence of structural change in M_1 velocity for Canada, Italy, Japan, and the United Kingdom. In these four cases both the intercept and slope coefficients shifted in the post-1971 era. No other structural changes were significant.

These conclusions must, however, be regarded as highly tentative due to the limited extent of the post-1970 data. These tests certainly reflect the magnitude of post-1970 velocity changes relative to earlier experience. They do not constitute evidence that the changes are permanent shifts or temporary aberrations. It appears that only the

TABLE LVII

REGRESSIONS OF THE BASE ON INCOME AND SIGNIFICANCE TESTS FOR POST-1970 STRUCTURAL SHIFTS
ANNUAL DATA, 1959 - 1973

	$a_{1959-1973}$	$a_{1971-1973}$	$b_{1959-1970}$	$b_{1971-1973}$	t	R^2/D-W
Belgium	-562.35	551.34	9.01	7.33	.71	.958
	(-3.83)	(1.09)	(9.66)	(3.35)		1.05
Canada	-21.01	33.79	21.27	14.38	7.22	.998
	(-13.66)	(5.86)	(51.34)	(16.75)		2.94
France	-110.83	475.83	9.74	5.97	2.10	.971
	(-2.13)	(2.60)	(11.94)	(3.73)		1.24
Germany	-99.73	482.86	12.86	5.22	8.43	.993
	(-4.42)	(6.98)	(24.71)	(7.04)		1.46
Italy	6.59	-9.45	5.43	5.82	-1.12	.998
	(11.57)	(-2.20)	(56.24)	(17.37)		2.66
Japan	.39	25.34	13.63	8.96	12.86	.999
	(.75)	(10.18)	(74.59)	(28.55)		1.24
The Netherlands	-42.23	-1.01	14.53	15.86	-.47	.987
	(-6.63)	(-0.03)	(17.79)	(5.89)		.96
Switzerland	-12.68	-4.02	5.38	5.01	.63	.994
	(-4.43)	(-.28)	(25.54)	(9.33)		1.88
The United Kingdom	-6.54	21.81	11.21	7.82	2.48	.987
	(-2.87)	(3.39)	(16.38)	(6.60)		2.42

TABLE LVIII

REGRESSIONS OF THE MONEY STOCK ON INCOME AND SIGNIFICANCE TESTS FOR POST-1970 STRUCTURAL SHIFTS
ANNUAL DATA, 1959 - 1973

	$a_{1959-1973}$	$a_{1971-1973}$	$b_{1959-1970}$	$b_{1971-1973}$	t	R^2/D-W
Belgium	-267.44	270.98	5.76	5.23	1.25	.995
	(-5.80)	(1.34)	(24.53)	(8.12)		1.18
Canada	3.35	26.57	5.86	3.86	3.12	.990
	(1.28)	(2.27)	(21.19)	(6.67)		2.17
France	-20.61	-37.68	3.33	3.94	-.52	.967
	(- .43)	(-.12)	(11.05)	(-.46)		.95
Germany	-40.60	35.79	7.41	7.21	.19	.993
	(-2.05)	(.29)	(25.28)	(6.89)		2.04
Italy	10.73	12.95	1.90	1.20	3.93	.992
	(9.23)	(2.01)	(24.26)	(7.54)		1.10
Japan	1.68	15.94	3.70	2.63	6.06	.998
	(1.99)	(3.42)	(44.20)	(16.93)		1.00
The Netherlands	-16.40	6.17	5.21	4.76	1.03	.999
	(-6.71)	(.44)	(36.16)	(11.48)		2.47
Switzerland	-5.54	-64.25	2.35	3.54	-1.64	.984
	(-1.33)	(-1.72)	(15.85)	(5.00)		2.18
The United Kingdom	-26.44	27.55	7.66	4.64	4.45	.991
	(-9.20)	)3.90)	(19.92)	(8.32)		1.73

passage of time will confirm the nature of the observed shifts.

CHAPTER 4

QUARTERLY VELOCITY

The use of annual data to describe average velocity and to estimate marginal velocity assumes a certain behavioral relationship between money and income. In particular, the use of annual data assumes that the economic decision processes underlying the quantity theory of money operate on a year-to-year basis, and not on a shorter period or continuous basis.

Assume that the relevant decision processes do operate on a quarterly basis so that income this quarter is a multiple of the current money stock

$$y_t = vm_t,$$

where lower case letters refer to quarterly magnitudes, and income is measured at an annual rate. Then if the model is aggregated,

$$Y_T = \frac{1}{4}(y_t + y_{t-1} + y_{t-2} + y_{t-3})$$

$$= v \quad (m_t + m_{t-1} + m_{t-2} + m_{t-3}) \ /4 \quad ,$$

so that an estimate of velocity (v) based on the ratio of annual income, Y_T, to the average money stock is accurate.

However, if one of myriad other models describes behavior then the approach may be flawed. For example, assume that

$$y_t = v(m_t + m_{t-1}) \ /2$$

so that

$$Y_T = \frac{1}{4}(y_t + y_{t-1} + y_{t-2} + y_{t-3})$$

$$= \frac{v}{4}(m_t + 2m_{t-1} + 2m_{t-2} + 2m_{t-3} + m_{t-4}) \,/2$$

$$= \frac{v}{2} M_T + \frac{v}{8}(m_{t-1} + m_{t-2} + m_{t-3} + m_{t-4}),$$

and the usual estimate of velocity is biased if the money stock is non-stationary:

$$\hat{v} = \frac{Y_T}{M_T} = (\frac{v}{2}) + (\frac{v}{2}) \frac{m_{t-1} + m_{t-2} + m_{t-3} + m_{t-4}}{m_t + m_{t-1} + m_{t-2} + m_{t-3}}$$

In particular, assume that the money stock is growing at the constant quarter to quarter rate g. Then

$$\hat{v} = v\,(1 + g^{-1})\,/2$$

and estimated average annual velocity is biased upward.

In view of these results and without judging the merits of the behavioral assumptions underlying the approach to velocity based on relationship of yearly money and income aggregates, it seems desirable to investigate the quantity theory within a shorter period framework, and especially to allow for dynamic adjustment of income to money.

Regression Method and Strategy

Concern with distributed lag models has evolved a number of techniques for their estimation in the recent past. Among these approaches are the Koyck approach and the related partial adjustments and adaptive expectations methods, the Almon Lagrangian polynomial technique, and the Hannan frequency domain estimator.

The Koyck approach implies a relatively rigid structure to the

pattern of lag weights and was deemed too rigid to account for the possibly wide variety of behavior patterns under study. The Almon and Hannan techniques, while more flexible, are much more complicated. Moreover, a recent study indicated that in simulation studies, "OLS out performs either the Hannan or Almon estimators." (Cargill and Meyer 1974: 1043) On the basis of these results, then, it was decided that estimation of dynamic international money-income linkages would employ the simpler ordinary least squares estimator.

Because the number of possible lag structures is practically infinite, an approach to the estimation of lag structures that allows the greatest flexibility was deemed necessary. In particular, the approach employed involved the specification of a maximum lag length. The full lag was then estimated, and the most distant term was deleted if insignificant and the regression re-estimated. Proceeding in this fashion, the process was stopped when the most distant term entered with a coefficient significantly different from zero. This procedure is equivalent to testing the significance of the increment in the explained sum of squares resulting from the addition of the distant term. (Johnston 1972: 144) Since it is not unreasonable that a particular lag distribution involves a delay of one or more periods before, in this case, a change in money has an effect on income, or that the distribution of weights oscillate about zero, the procedure employed has the advantage of greater discriminatory power than a sequential method proceeding from the shortest to longer lags.

The following sections describe the results of the lag estimates

on a country by country basis for first differences in income and money. Due to considerations discussed in Chapter 1, estimates also allowed for the possibility of current income affecting the money stock in the future, and the use of both base and M_1 money stocks is continued.

Belgium

Analysis of discrete leads and lags of base money on GNP for Belgium indicates a substantial two quarter lag from changes in GNP to changes in base money:

$$GNP_t = \underset{(6.87)}{15.05} + \underset{(4.43)}{2.64}\ B_{t+2} \qquad R^2 = .27,\ DW = .71$$

The addition of lagged terms to contemporaneous changes in the base does not match the explanatory power of the base-leading equation above. Thus

$$GNP_t = \underset{(6.79)}{17.52} - \underset{(-.08)}{.08}\ B_t + \underset{(2.20)}{2.05}\ B_{t-1} \qquad R^2 = .09,\ DW = .77$$

Allowing for a fuller lag structure running from GNP to the base,

$$GNP = \underset{(5.39}{13.68} + \underset{(2.02)}{2.12}\ B_{t+4} \underset{(-1.72)}{-2.52}\ B_{t+3} + \underset{(3.41)}{5.12}\ B_{t+2}$$

$$\underset{(-1.90)}{-3.15}\ B_{t+1} + \underset{(1.32)}{1.59}\ B_t \qquad R^2 = .29,\ DW = .79$$

These results strongly suggest that current GNP is more closely related to future base money than past base money. However, the situation is somewhat more ambiguous in the case of the broader M_1 monetary aggregate. The results of discrete leads (lags) between GNP and money

reveal

$$GNP_t = \underset{(3.54)}{8.76} + \underset{(6.33)}{1.94}\ M_{t+2}$$

$R^2 = .44$
$DW = 1.19$

and

$$GNP_t = \underset{(3.45)}{8.68} + \underset{(6.22)}{2.30}\ M_{t-1}$$

$R^2 = .43$
$DW = 1.07$

Allowing for a lag from money to GNP,

$$GNP_t = \underset{(2.04)}{7.69} + \underset{(1.01)}{.47}\ M_t + \underset{(4.03)}{1.97}\ M_{t-1}$$

$R^2 = .43$
$DW = 1.05$

and leading results indicate

$$GNP_t = \underset{(2.83)}{7.60} + \underset{(2.99)}{1.46}\ M_{t+2} + \underset{(1.24)}{.63}\ M_{t+1} + \underset{(.11)}{.06}\ M_t$$

$R^2 = .44$
$DW = 1.11$

One interpretation of these results, discussed in Chapter 1, acknowledges the evident openness of the Belgian economy. If the demand for real balances increases, for instance, from an increase in real income, then Belgian exports would tend to increase relative to imports with a consequent tendency for the balance of payments to move into surplus. The incoming foreign exchange reserves tend to augment base money and consequently lead to an expansion of the money stock. If these adjustments do not occur instantaneously, and there is little

reason to believe they would in reality, then it is quite possible that current increases in income lead to future increases in the stock of base money, and hence to the money stock itself.

Canada

The Canadian evidence is considerably different from the Belgian evidence just discussed. Regressions of leading and lagging base money on GNP suggest that the contemporaneous base is most highly correlated with income with

$$\underset{t}{GNP} = \underset{(5.02)}{.75} + \underset{(5.50)}{7.91}\ B_t$$

$$R^2 = .37$$
$$DW = 1.74$$

By incorporating additional lagged values of the base the explanatory power is increased to approximately fifty percent with an estimated regression of

$$\underset{t}{GNP} = \underset{(3.13)}{.49} + \underset{(2.77)}{5.88}\ B_t - \underset{(-.18)}{.52}\ B_{t-1} + \underset{(1.34)}{5.08}\ B_{t-2}$$

$$\underset{(-1.35)}{-5.17}\ B_{t-3} + \underset{(2.84)}{7.27}\ B_{t-4}$$

$$R^2 = .48$$
$$DW = 1.94$$

Allowing for a distributed effect running from income to the base,

$$\underset{t}{GNP} = \underset{(3.49)}{.54} + \underset{(2.58)}{4.84}\ B_{t+2} \underset{(-.47)}{-1.20}\ B_{t+1} + \underset{(3.24)}{6.47}\ B_t$$

$$R^2 = .46$$
$$DW = 1.88$$

The apparent income influence on money vanishes, however, when lagged base money terms are included with the leading terms, and no leading

term contributes to a significant variance reduction with the four lagging base money terms included.

Changes in the broader money stock are most closely associated with income changes three quarters following the change in money with an estimated association of

$$GNP_t = \underset{(7.87)}{1.00} + \underset{(4.84)}{1.41}\, M_{t-3}$$

$$R^2 = .31$$
$$DW = 1.69$$

Allowing for distributed effects running from money to income,

$$GNP_t = \underset{(5.65)}{.77} + \underset{(2.00)}{.60}\, M_t - \underset{(-.16)}{.05}\, M_{t-1} + \underset{(.35)}{.12}\, M_{t-2}$$

$$+ \underset{(2.19)}{.77}\, M_{t-3} + \underset{(2.49)}{.87}\, M_{t-4}$$

$$R^2 = .42$$
$$DW = 1.85$$

Investigation of evidence of potential simultaneous lags and leads in the effect of money stock changes on GNP yielded no significant effect running from GNP to money.

Thus, quite the opposite of the Belgian case, evidence from the Canadian experience suggests no feedback effects from income to money in the broader sense, and only a suggestion of an income effect on the narrower base money stock.

France

The French evidence suggests that the best income-base association is with base money leading changes in income by one quarter,

$$GNP_t = \underset{(4.17)}{10.27} + \underset{(2.54)}{3.38}\, B_{t-1} \qquad R^2 = .10, \quad DW = 1.97$$

No evidence supporting distributed lags in the effect of base money on GNP could be found. Similarly no significant evidence of changes in GNP leading to changes in the base money stock was discovered. On balance the linkages between base money and income were exceedingly poor with no r-square above .10, and with many r-squares less than zero due to the degrees of freedom adjustment.

The evidence from the broader money stock definition is much more supportive of quantity theory assertions than that discussed above. The closest single lead/lag relationship between changes in M_1 and changes in GNP is

$$\underset{t}{GNP} = \underset{(3.05)}{7.00} + \underset{(4.52)}{2.04}\ \underset{t-1}{M}$$

$$R^2 = .28$$
$$DW = 1.70$$

Allowing for possible distributed lags in the effect of the broader money stock on GNP, a two quarter lag emerges with

$$\underset{t}{GNP} = \underset{(3.86)}{10.33} - \underset{(-1.00)}{.48}\ \underset{t}{M} + \underset{(5.12)}{2.62}\ \underset{t-1}{M} - \underset{(-1.96)}{1.00}\ \underset{t-2}{M}$$

$$R^2 = .33$$
$$DW = 1.58$$

Further experiments revealed no tendency for changes in GNP to lead to changes in the broader M_1 money stock.

Germany

The German experience is suggestive of strong feedback effects of income on either money stock definition. Using the base money stock definition, the highest correlation occurs between GNP and the base money stock one quarter hence, estimated as

$$GNP_t = \underset{(5.93)}{8.40} + \underset{(3.64)}{2.08}\ B_{t+1}$$

$R^2 = .20$
$DW = 2.26$

When changes in income are allowed to distribute over several future quarters of base money the relationship estimated is

$$GNP_t = \underset{(3.95)}{6.07} + \underset{(3.17)}{2.15}\ B_{t+4} \underset{(-1.76)}{-1.56}\ B_{t+3} + \underset{(1.45)}{1.43}\ B_{t+2}$$

$$+ \underset{(.27)}{.28}\ B_{t+1} + \underset{(1.67)}{1.62}\ B_t$$

$R^2 = .31$
$DW = 2.43$

Moreover, when lagged values of base money are included,

$$GNP_t = \underset{(4.07)}{6.52} + \underset{(2.43)}{1.93}\ B_{t+4} \underset{(-.35)}{-.34}\ B_{t+3} + \underset{(1.12)}{1.11}\ B_{t+2} + \underset{(.50)}{.52}\ B_{t+1}$$

$$+ \underset{(.88)}{1.19}\ B_t + \underset{(1.05)}{1.52}\ B_{t-1} \underset{((-.92)}{-1.44}\ B_{t-2} + \underset{(1.36)}{2.20}\ B_{t-3}$$

$$\underset{(-2.70)}{-3.72}\ B_{t-4}$$

$R^2 = .36$
$DW = 2.41$

Evidence from the broader M_1 money stock reveals that income and money three quarters earlier are most closely related with

$$GNP_t = \underset{(2.59)}{5.29} + \underset{(3.59)}{4.21}\ M_{t-3}$$

$R^2 = .19$
$DW = 2.14$

The use of lagged money terms results in

$$GNP_t = \underset{(1.62)}{3.77} + \underset{(1.02)}{1.39}\ M_t + \underset{(.93)}{1.31}\ M_{t-1} \underset{(-.51)}{-.77}\ M_{t-2} + \underset{(2.06)}{3.08}\ M_{t-3}$$

$R^2 = .20$
$DW = 2.29$

But allowing for simultaneous feedback from GNP to money, the relationship is estimated as

$$GNP_t = \underset{(.59)}{1.55} + \underset{(2.18)}{1.92}\, M_{t+4} - \underset{(-.69)}{.70}\, M_{t+3} - \underset{(-.60)}{.85}\, M_{t+2}$$

$$+ \underset{(1.32)}{1.91}\, M_{t+1} + \underset{(.68)}{.99}\, M_t + \underset{(.78)}{1.10}\, M_{t-1} - \underset{(-.82)}{1.23}\, M_{t-2}$$

$$+ \underset{(2.22)}{3.26}\, M_{t-3}$$

$$R^2 = .26$$
$$DW = 2.51$$

Although the German economy is not as open as the Belgian economy as measured by the ratio of exports to gross domestic product, an hypothesis similar to that advanced in the Belgian case above may account for the observed German experience.

Italy

Base money in Italy is most closely associated with income four quarters before with an estimated relationship of

$$GNP_t = \underset{(4.14)}{.43} + \underset{(7.17)}{2.48}\, B_{t+4}$$

$$R^2 = .50$$
$$DW = 2.11$$

Current and lagged values of base money perform relatively poorly with

$$GNP_t = \underset{(2.42)}{.39} + \underset{(3.00)}{2.13}\, B_t - \underset{(-.81)}{.70}\, B_{t-1} + \underset{(2.46)}{1.68}\, B_{t-2}$$

$$R^2 = .25$$
$$DW = 1.43$$

whereas allowance for a distributed effect of income on base money results in

$$GNP_t = \underset{(1.82)}{.24} + \underset{(3.80)}{2.11}\, B_{t+4} - \underset{(-.25)}{.19}\, B_{t+3} + \underset{(1.82)}{1.54}\, B_{t+2}$$

$$- \underset{(-1.39)}{1.10}\, B_{t+1} + \underset{(1.83)}{1.10}\, B_t$$

$$R^2 = .54$$
$$DW = 1.95$$

When account is taken of lagged effects of base money on income with allowance for feedback effects of income on GNP, the estimated relationship is

$$GNP_t = \underset{(2.25)}{.30} + \underset{(4.16)}{2.18}\, B_{t+4} - \underset{(-.46)}{.32}\, B_{t+3} + \underset{(2.23)}{1.79}\, B_{t+2}$$

$$- \underset{(-1.88)}{1.52}\, B_{t+1} + \underset{(2.95)}{2.41}\, B_t - \underset{(-2.57)}{2.06}\, B_{t-1}$$

$$+ \underset{(2.75)}{1.98}\, B_{t-2} - \underset{(-2.43)}{1.37}\, B_{t-3}$$

$$R^2 = .59$$
$$DW = 1.90$$

The association is remarkably close for regression in first differences with almost sixty percent of the variation in differences in GNP explained in the estimated regression.

The results of the experiments using the broader M_1 money definition are somewhat poorer than the base money results as judged by r-square statistics. The best money-income association is contemporaneous with

$$GNP_t = \underset{(4.55)}{.47} + \underset{(6.80)}{.79}\, M_t$$

$$R^2 = .47$$
$$DW = 1.95$$

In experiments designed to allow for leads only, lags only, and

simultaneous leads and lags, the only distributed relationship with significant non-contemporaneous monetary coefficients was

$$GNP_t = \underset{(5.43)}{.54} - \underset{(-2.90)}{.64\ M_{t+1}} + \underset{(6.09)}{1.35\ M_t}$$

$$R^2 = .54$$
$$DW = 2.18$$

The negative leading coefficient for Italian money probably reflects to a large extent the inflationary growth rate of the Italian money stock. The growth in the ratio of money per unit of output exceeded six percent in virtually every year since 1959. Such excessive growth undoubtedly placed almost continuous excess demand pressure on goods and, consequently, deficit pressure on the balance of payments leading to reserve outflows and contractionary pressure on the money stock. In fact, International Monetary Fund statistics indicate an annual deficit in every year covered by this study.

Japan

The closest association between leading and lagging base money and income in Japan is unusually good for first differences with

$$GNP_t = \underset{(3.13)}{.44} + \underset{(10.56)}{8.72\ B_t}$$

$$R^2 = .69$$
$$DW = 2.47$$

Moreover, no other combination of leading and/or lagging terms in regressions of the base money stock on GNP could be found with significant coefficients.

The best association between GNP and lagging values of the M_1 money stock was found to be

$$GNP_t = \underset{(4.77)}{.78} + \underset{(6.94)}{1.33}\ M_{t+2}$$

$R^2 = .49$
$DW = 1.56$

When lagged distributions were estimated a five quarter lag structure was found in

$$GNP_t = \underset{(3.08)}{.56} + \underset{(3.06)}{1.01}\ M_t - \underset{(-.82)}{.48}\ M_{t-1} - \underset{(-.02)}{.01}\ M_{t-2}$$

$$+ \underset{(.61)}{.39}\ M_{t-3} + \underset{(2.39)}{1.29}\ M_{t-4}$$

$R^2 = .55$
$DW = 1.71$

Testing for one sided distributions from income to money settled on money two quarters following income with

$$GNP_t = \underset{(3.92)}{.66} + \underset{(2.25)}{.75}\ M_{t+2} + \underset{(.64)}{.24}\ M_{t+1} + \underset{(1.75)}{.64}\ M_t$$

$R^2 = .52$
$DW = 1.57$

However, the leading money coefficients lost significance when lagging money terms were introduced.

In sum, the Japanese evidence confirms a strong lag in the effect of changes in the money stock on changes in GNP.

Netherlands

The Dutch evidence suggests that the highest income-base correlation is with the base following income such that

$$GNP_t = \underset{(6.52)}{1.61} + \underset{(3.73)}{3.91}\ B_{t+1}$$

$R^2 = .21$
$DW = .95$

No significant lags from base to income emerge while there appear to be forward effects from income to base money with

$$GNP_t = \underset{(1.88)}{.58} + \underset{(3.37)}{2.96}\ B_{t+4} + \underset{(.78)}{.73}\ B_{t+3} + \underset{(2.60)}{3.48}\ B_{t+2} + \underset{(2.12)}{3.05}\ B_{t+1} + \underset{(.47)}{.72}\ B_t$$

$$R^2 = .44$$
$$DW = 1.13$$

Using the broader M_1 money stock, close association remains with money following income by one quarter,

$$GNP_t = \underset{(4.67)}{1.04} + \underset{(7.03)}{2.29}\ M_{t+1}$$

$$R^2 = .49$$
$$DW = 1.43$$

Consideration of one-sided distributions from money to income led to the estimation of

$$GNP_t = \underset{(2.59)}{.65} + \underset{(.86)}{.37}\ M_t + \underset{(1.82)}{.98}\ M_{t-1} + \underset{(.52)}{.29}\ M_{t-2} + \underset{(1.15)}{.69}\ M_{t-3} + \underset{(2.02)}{1.24}\ M_{t-4}$$

$$R^2 = .52$$
$$DW = 1.79$$

while one sided distributions from income to money estimated

$$GNP_t = \underset{(3.73)}{.87} + \underset{(4.97)}{1.89}\ M_{t+1} + \underset{(1.95)}{.77}\ M_t$$

$$R^2 = .52$$
$$DW = 1.45$$

Incorporating leading and lagging terms for money relative to income, the structure that emerged was

$$GNP_t = \underset{(2.41)}{.56} + \underset{(2.16)}{.61}\, M_{t+4} - \underset{(.004)}{.001}\, M_{t+3} - \underset{(-.53)}{.20}\, M_{t+2}$$

$$+ \underset{(2.80)}{1.14}\, M_{t+1} + \underset{(.89)}{.41}\, M_t + \underset{(3.38)}{1.41}\, M_{t-1}$$

$$R^2 = .62$$
$$DW = 1.64$$

Since the Dutch economy is quite open using the ratio of exports to gross domestic product as a yardstick, the last equation is most likely a reflection of a money supply response to changes in GNP.

Switzerland

Switzerland, another relatively open economy, exhibits the closest money-income associations estimated. Using the base money stock, the best single period correlation estimated was for

$$GNP_t = \underset{(10.53)}{1.33} + \underset{(5.17)}{1.00}\, B_{t-2}$$

$$R^2 = .34$$
$$DW = .78$$

The estimation of a full one sided distribution from base money to income yielded

$$GNP_t = \underset{(8.85)}{.75} + \underset{(3.93)}{.48}\, B_t + \underset{(3.09)}{.40}\, B_{t-1} + \underset{(6.61)}{.82}\, B_{t-2}$$

$$+ \underset{(2.74)}{.37}\, B_{t-3} + \underset{(4.27)}{.54}\, B_{t-4}$$

$$R^2 = .81$$
$$DW = 1.04$$

and estimation from income to base money yielded

$$GNP_t = \underset{(6.56)}{.98} + \underset{(3.76)}{.71}\, B_{t+2} + \underset{(1.76)}{.34}\, B_{t+1} + \underset{(3.93}{.74}\, B_t$$

$$R^2 = .42$$
$$DW = .59$$

Further investigation revealed that in combination both structures remained intact with

$$GNP_t = \underset{(8.09)}{.56} + \underset{(2.48)}{.22}\, B_{t+3} + \underset{(2.88)}{.28}\, B_{t+2} + \underset{(3.07)}{.32}\, B_{t+1}$$

$$+ \underset{(3.00)}{.34}\, B_t + \underset{(3.66)}{.41}\, B_{t-1} + \underset{(6.22)}{.65}\, B_{t-2} + \underset{(4.09)}{.41}\, B_{t-3}$$

$$+ \underset{(4.55)}{.43}\, B_{t-4}$$

$$R^2 = .90$$
$$DW = 1.50$$

Estimation using the M_1 money stock was no less encouraging with the best single period money-income association estimated as

$$GNP_t = \underset{(6.80)}{.75} + \underset{(10.90)}{1.26}\, M_{t-3}$$

$$R^2 = .70$$
$$DW = 1.18$$

Allowing for one sided distributions from money to income and income to money, and for both, the only regression retained was

$$GNP_t = \underset{(4.94)}{.40} + \underset{(2.48)}{.25}\, M_t + \underset{(3.51)}{.42}\, M_{t-1} + \underset{(.86)}{.11}\, M_{t-2}$$

$$+ \underset{(4.10)}{.50}\, M_{t-3} + \underset{(3.59)}{.49} M_{t-4}$$

$$R^2 = .88$$
$$DW = .98$$

The final distributed lag structures estimated for base money and for the broader M_1 money stock are exceptionally close fits. The multiple correlation coefficients for these regressions are .96 and .95 respectively, which are extraordinary for regressions estimated in first difference form.

United Kingdom

The association between base money and income in the United Kingdom is best, on a discrete lag (lead) basis when changes in base money lag changes in income with

$$GNP_t = \underset{(5.56)}{.53} + \underset{(3.03)}{2.43}\ B_{t+2}$$

$$R^2 = .14$$
$$DW = 1.56$$

The only distributed lag structure retained was

$$GNP_t = \underset{(4.10)}{.44} + \underset{(2.17)}{2.58}\ B_{t+4} - \underset{(-1.35)}{2.46}\ B_{t+3}$$

$$+ \underset{(2.43)}{4.81}\ B_{t+2} - \underset{(-1.69)}{3.52}\ B_{t+1} + \underset{(1.32)}{2.28}\ B_t$$

$$R^2 = .17$$
$$DW = 1.66$$

The results using the M_1 money stock reiterated the evidence for one sided distributions from income to money with the discrete lag providing the closest association between income and money, implying a two quarter lag from income to money estimated as

$$GNP_t = \underset{(4.09)}{.39} + \underset{(4.89)}{2.37}\ M_{t+2}$$

$$R^2 = .31$$
$$DW = 2.24$$

One sided structures running from money to income and income to money were retained with

$$GNP_t = \underset{(4.24)}{.40} + \underset{(.82)}{.63}\ M_t + \underset{(2.41)}{1.88}\ M_{t-1}$$

$$R^2 = .29$$
$$DW = 2.15$$

and

$$GNP_t = \underset{(3.95)}{.38} + \underset{(2.48)}{1.93}\, M_{t+1} + \underset{(.80)}{.62}\, M_t$$

$$R^2 = .29$$
$$DW = 2.08$$

However, no two sided lag structure was retained.

Overview

No systematic patterns in the structure of lag weights are evident in the quarterly regressions. Some structures tend to oscillate, and some rise or decline regularly. Two countries, Belgium and Italy, had no lagged money coefficients entering significantly. In Canada, France, Japan, and Switzerland leading money coefficients were not significant. Finally, Germany and the Netherlands revealed lag patterns running from leading to lagging money.

There was no clear-cut association between the degree of openness and the lag structure. This lack of systematic evidence may be due to the varying degrees to which the various governments resisted exchange-rate pressures, the extent to which the various economies resisted the direction of world economic movements. While governments may be able to resist external pressures in the short-run, it is not likely that they can pursue such policies as reserve sterilization and credit controls for more than a short time. To the extent that the attempt is made, the empirical evidence may be clouded by the varying periods over which such policies can be successfully conducted before they break down.

The evidence is far from conclusive but there is a suggestion in the quarterly data that control of the money stock is not entirely in

the hands of the monetary authorities in an open economy with fixed exchange rates. That significant coefficients for monetary changes following income changes were found suggests that this is the case.

The explanatory power of the distributed lag regressions varied considerably from country to country. Germany, France, and the United Kingdom had the lowest r-square statistics, while in Switzerland the distributed lag equation estimated had by far the best r-square, explaining nearly ninety percent of the variance of changes in nominal income. The remaining countries clustered around a fifty percent variance explanation not untypical of results for the United States.

Too great an emphasis on these results should be avoided, particularly with respect to Belgium, France, Italy, the Netherlands, and Switzerland insofar as the GNP series used were estimates based on the procedure outlined in Chapter 2. Similarly, the results may be clouded if the M_1 definition of the money stock is not the most appropriate to the country under study.

In sum, the quarterly evidence suggests that the quarterly model as applied to nominal income changes provides a reasonable explanation of short term nominal economic fluctuations.

CHAPTER 5

SUMMARY

Recent worldwide inflation has been a source of popular and political unrest. It was the purpose of this study to investigate empirically one long-established framework within which this inflationary phenomenon can be explained. Meiselman (1975), on the basis of aggregate data for a group of nine major O.E.C.D. countries and the United States, asserted that the episode of worldwide inflation which began in the late 1960's can be explained in terms an acceleration in the growth of "world" money. The evidence presented in this paper suggests that Meiselman's conclusions are supported by the experience of the component countries he aggregated.

Annual data revealed that for each of the nine countries studied, the association between nominal income and the money stock, and between the price level and the stock of money per unit of output were, in general, very close. Further evidence suggested that while the nine velocity series displayed a wide variety of behavior patterns including upward and downward trends, substantially all of the variance in this set of velocity series could be explained by only three (unidentified) principal components.

Evidence from the quarterly data indicated that, in

general, substantial variation in changes in income could be explained by leading and lagging changes in the stock of money. The lag patterns estimated showed a wide diversity in character, varying in shape and length. The evidence from the quarterly data also tended to confirm, at least for some countries, the hypothesis that the nominal stock of money is in part determined by the general public, and not, as is often assumed, under the exclusive control of the monetary authorities.

The evidence uncovered in this study, tending to affirm the quantity theory's relevance to nine separate countries, also has implications for world monetary structure. In particular, the evidence suggests that because in open fixed-rate economies the general public has control over the nominal money stock, it may be impossible for governments to pursue domestic policies at odds with the rest of the world. It may be impossible for individual countries to resist inflation rates in the rest of the world substantially in excess of those they deem desirable so long as they operate within a fixed exchange rate environment.

Limitations and Qualifications

While this study tended to confirm the quantity theory model in the nine countries studied, there are evident or potential inadequacies in the data which merit attention. In

particular the quarterly income figures used for Belgium, France, Italy, the Netherlands and Switzerland were estimates. Although based on a BLUE procedure developed by Chow and Lin which yielded very precise estimates in test regressions on levels of quarterly GNP, the evidence suggested that the association in first differences was considerably less than perfect.

While the precise effect on the regressions discussed in Chapter 4 is unknown, it is possible that the use of the proxy quarterly GNP series systematically or unsystematically biased the estimated coefficients in the distributed lag regressions. Thus while the pattern of lag distribution weights observed in the regressions using estimated GNP series were consistent with the theory, their magnitudes may be subject to considerable error.

Another potential problem with the data employed in this paper is the appropriateness of the money stocks to the theory underlying the empirical tests. The quantity theory, at its heart, is, as discussed in Chapter 1, a theory of the demand for money. While its implications may be true for a specific monetary aggregate, there is no guarantee that it is true for any arbitrary aggregate.

In particular, the evidence, especially that of Chapter 3, suggests that while the stock of base money may be an accurately reported and statistically desirable monetary

aggregate, it may not be directly relevant to the determination of nominal income and the price level. If the stock of base money is proportional to the theoretically relevant money stock, then little damage is done in its use empirically. However, if the linkage between base money and the relevant monetary aggregate is variable, then the empirical results from its use are of questionable value. The results of regressions of the stock of base money per unit of output in Chapter 3 suggest that for some countries the latter may be the case.

Moreover, evidence from numerous studies in the United States suggests that a broader monetary aggregate inclusive of time deposits may be preferable to the use of the narrower M_1 definition of money. This may, of course, be true of other countries as well, and, especially, of those studied here, since all have a well developed financial structure. The search for the "best" money stock in these nine countries is, however, a monumental task owing both to the diversity of deposit classes and institutions, and to the lack of available data.

Extensions

A number of possible avenues for future research have suggested themselves in the course of this study:

(1) Investigate improved techniques for estimates of

quarterly GNP for these countries lacking reported series;

(2) Systematically investigate the usefulness of money stock concepts other than those employed here;

(3) Apply systems techniques to the quarterly data in order to investigate the structural behavior of money supply, money demand, and their interactions.

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APPENDIX

With the exception of interest rates and base money, most series used were obtained from the data bank of the Federal Reserve Bank of St. Louis. The exceptions include: GNP for Canada to 1965_{IV} which was obtained from the Annual Supplement to Section 1, Canadian Statistical Review of August, 1973; GNP for Germany in 1959 which was obtained from Deutsches Institut Für Wirtschafts Forschung of August, 1974; and GNP for Japan to 1966_{III} which was obtained from the Japanese Economic Planning Agency's Annual Report on National Income Statistics for 1972.

Interest rates and base money were taken from the International Monetary Fund's IFS data tape. The interest rate series used were government bond yields with the exception of Japan. The only extensive interest rate series available for Japan was a call money rate.

The base money series correspond to the reserve money series in the IFS tape.

All series not seasonally adjusted at the source were adjusted using a ratio-to-moving average method.

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MONEY, INCOME, AND PRICES: THE VELOCITY OF MONEY IN NINE MAJOR O.E.C.D. ECONOMIES

by

William Thomas Rule II

(ABSTRACT)

The widespread growth of nominal income and the price level in many countries in the late 1960's and early 1970's added to interest in the quantity theory of money. Most earlier work centered on the United States. This study investigates the applicability of some simple quantity theory hypotheses to a group of nine major non-U.S. O.E.C.D. economies.

After a brief discussion of the quantity theory with attention to its applicability under regimes of fixed and floating exchange rates, there is a discussion of the estimation of quarterly GNP for countries not reporting full series, using related quarterly and annual data by generalized least squares methods.

Analysis of the relationship between money and income is conducted using annual and quarterly data. Regressions of two measures of the money stock on nominal income, and of money per unit of output on the price level are estimated for annual data. Using quarterly data, distributed lags of money on nominal income are estimated.

While there was found to be considerable variation in the closeness of the money-income relationship, the evidence suggests the broad

applicability of the quantity theory within a wide range of monetary arrangements and exchange rate regimes.