Velocity:
Money's Second Dimension

By Bryon Higgins

"Money has a 'second dimension, namely, velocity . . . ." Arthur F. Burns in Congressional Testimony.

Understanding the effects of monetary growth on the economy is of crucial importance in formulating monetary policy. Monetary growth that is insufficient to sustain a high level of economic activity can impair economic growth, and monetary growth in excess of the ability to expand real output can intensify inflationary pressures. Although it is generally agreed that the growth in the money supply is an' important determinant of economic performance, there is seldom a consensus regarding the rate of monetary expansion most conducive to attainment of policy goals.

The relationship between the supply of money, the price level, and real output has been the subject of extensive debate among economists, policy analysts, and other observers for well over 100 years. The predominant view prior to the 1930's was that the sole determinant of the aggregate price level was the quantity of money. The belief that the growth rate of the money supply uniquely determines the rate of price inflation was the cornerstone of the quantity theory of money. The simple version of the quantity theory lost favor during the 1930's as a result of worldwide economic turmoil. It was generally believed at the time that policy prescriptions deriving from existing economic theories were inadequate to deal with the problems resulting from the Great Depression.

In the crisis 'atmosphere surrounding policy discussions at the depth of the Great Depression, a new theory of employment and prices was developed by John Maynard Keynes. Keynes alleged that the simple quantity theory of money was deficient in a number of important respects, and he offered an alternative framework for analyzing the relations between money, prices, and economic activity. Policymakers and economic analysts were receptive to Keynes' theory because it offered an explanation for the apparent failure of conventional policies to remedy the dismal economic situation that existed and it proposed alternative solutions. Keynesian economic theory supplanted the quantity theory of money as the predominant method for analyzing aggregate economic relationships.

In the past two decades, however, there has been a resurgence of interest in the quantity theory of money. Beginning with Milton Friedman and his students and colleagues from the University of Chicago, monetarists challenged the validity of a number of the basic tenets of Keynesian economic theory. Recent experience has rekindled interest in the relationship between the growth of the money supply and the rate of inflation, with the monetarists being the chief proponents of the

view that excessive monetary growth is the primary cause of inflation.

Much of the debate about the most useful framework for analyzing aggregate economic relationships has centered on the relationship between aggregate spending and the money supply. The ratio of total spending to the money stock is commonly called the velocity of money. This article analyzes the concept of the velocity of money and discusses the importance of understanding the determinants of velocity. The quantity theory of money is presented, and Keynes' criticism of the quantity theory of money is discussed. Empirical and theoretical considerations relating to the determinants of velocity are reviewed, the postwar rise in velocity is discussed, and the recent behavior of velocity is examined.

VELOCITY AND THE QUANTITY THEORY OF MONEY

The Concept of Velocity

The income velocity of money is defined as the ratio of nominal income (that is, the dollar value of income at current prices) to the money stock.[1] If Y represents the real quantity of goods and services produced and P, the average price paid for these goods and services, then PY is the value of nominal income and V [=PY/M] is the income velocity of money, where M represents the money stock.[1] Income velocity measures the average number of times in a given period each dollar is spent for currently produced goods and services.[1] If the value of current output, PY, is $100 and the money supply is $20, then the income velocity of money is 5 (=$100/$20). In these circumstances, each dollar of money is used to finance an average of $5 worth of currently produced goods and services.[1]

The Equation of Exchange

The concept of the velocity of money was used by proponents of the quantity theory of money to express the relation between the growth rate of the money stock and the rate of inflation. The belief of the quantity theorists that the rate of inflation is determined by the rate of growth of the money supply was based in part on the "equation of exchange," which can be derived from the definition of velocity. Multiplying both sides of the equation defining velocity (V = PY/M) by the money stock yields the equation of exchange, MV = PY.

The equation of exchange itself is merely a convenient way of expressing the identity between the dollar flow of expenditures and the market value of output. Since the two sides of the equation of exchange are merely alternative

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1 For a summary of the literature on the quantity theory, see Edwin Dean (editor), ***The Controversy*** Over ***the Quantig Theory of Money*** (Boston: D.C. Heath and Company, 1965).

2 An alternative measure of velocity was often used by quantity theorists. If T, the total number of purchases financed by monetary exchange, rather than Y is used as the measure of transactions, the transactions velocity of money can be defined as V' = P'T/M, where P' is the average price of all transactions. The focus in this article is on the effect of the money supply on income and economic activity. For this purpose, the income velocity of money, V, is more useful than the more inclusive transactions velocity of money, V'.

3 For simplicity, taxes, depreciation charges, and retained earnings are ignored. Thus, it is implicitly assumed that the value of total output is equal to the level of personal income.

4 It should not be inferred that the velocity of money actually corresponds to the number of times individual dollars are used to finance expenditures. Most money (defined in this article to include currency and demand deposits held by the nonbank public) is held in checking accounts, and it is impossible to distinguish one dollar of checking account money from another. Thus, it is impossible to trace each dollar and count the number of times it is used to finance expenditures.

ways of viewing the same transactions, they must be equal by definition. One can derive inferences regarding the causal relationship between inflation and the money supply only by making additional assumptions about the behavior of one or more of the variables included in the equation of exchange. It is the willingness to make certain assumptions about variables in the equation of exchange that distinguishes adherents of the quantity theory of money from those who find the equation of exchange merely a useful device for organizing information about economic relationships.

Quantity theorists assumed that total physical output and the income velocity of money are unaffected by changes in the money stock and can safely be assumed to remain constant in the short run.[5] For given values of Y and V, the equation of exchange indicates that a change in the money stock of a certain percentage must result in a change in the price level of the same percentage. Thus, a necessary inference from the quantity theory assumptions regarding the insensitivity of the level of output and the income velocity of money to changes in the money stock is that the rate of price inflation is determined by the rate of change of the money stock and the "natural" growth rate of real output.[6]

Quantity theorists believed that the level of output in the economy is determined by the availability and productivity of land, labor, and capital and was not affected by the money stock. The view that "money is a veil" that merely disguises the real functioning of the economy was expressed succinctly by a leading proponent of the quantity theory, Irving Fisher:

> . . . except during transition periods, the volume of trade, like the velocity of circulation of money, is independent of the quantity of money. An inflation of the currency cannot increase the product of farms and factories, nor the speed of trains or ships. . . . The whole machinery of production, transportation, and sale is a matter of physical capacities and technique, none of which depend on the quantity of money . . . .[7]

Thus, Fisher assumed that the potential output of the economy is not affected in the short run by changes in the supply of money. In general, proponents of the quantity theory believed that the actual level of output is normally equal to the potential level of output. They denied that a situation in which there were unemployed resources could persist except during "transition periods" to full employment equilibrium. Thus, the quantity theorists' assumption that real output is unaffected by changes in the money supply resulted from their belief that the ability to increase output is at all times constrained by physical capacity. limitations and the existing technology of production.

The assumption that the velocity of money is constant was deemed valid by the proponents of the quantity theory because the rate of turnover of money balances was believed to depend on economic and social relations that are

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5 It should be noted that some of the quantity theorists distinguish between the ultimate impact of a change in the money stock and the temporary effects that characterize the transition to the new equilibrium. The emphasis was always on the long-run effects of changes in the money supply, however.

6 The "natural" growth rate of real output can be thought of as the growth rate that results from increases in the labor force and improvements in productivity, assuming that all productive factors are fully employed at all times.

7 Irving Fisher, The Purchasing Power of Money (New York: The Macmillan Company, 1911), p. 155.

unaffected by changes in the money stock. Again quoting Fisher:

> The average rate of turnover . . . will depend on the density of population, commercial customs, rapidity of transport and other technical conditions, but not on the quantity of money.[8]

Given the various constraints imposed by the economic and social organization, the quantity theorists assumed that there is a fixed relation between total expenditures and the amount of money held to finance those expenditures. Thus, the demand for money was believed to depend only on the level of income and on social customs and institutional relationships.

The Cambridge Version of the Quantity Theory

A number of economists from Cambridge University in England changed the focus of the quantity theory of money without changing its underlying assumptions. The Cambridge version of the equation of exchange focuses on the fraction, k, of income held as money balances. Thus, the Cambridge version can be expressed as $M = kPY$. The k in the Cambridge equation is merely the inverse of V, the income velocity of money balances, in the original formulation of the quantity theory. The Cambridge version of the equation of exchange is important, however, because it directs attention to the determinants of the demand for money rather than the effects of changes in the supply of money. Assuming that total output and the desired fraction of income held as money balances are unaffected by changes in the money stock, the Cambridge version of the equation of exchange indicates that the price level is proportional to the supply of money; with the factor of proportionality being $(1/kY)$. Increases in the money stock in excess of the amount economic units desire to hold at the prevailing price level must lead to equiproportional changes in the price level in order to equate the supply of and demand for money. Thus, the result that the rate of inflation equals the growth in the money supply less the "natural" rate of increase in real output is the same regardless of which formulation of the equation of exchange is used. In both versions,, the result follows inexorably from the assumptions that the velocity of money balances (or equivalently, the desired fraction of income held as money balances) and the rate of growth of real output are independent of changes in the money supply.

KEYNES' CRITICISMS OF THE QUANTITY THEORY

One of the most important criticisms of the validity of the assumptions underlying the quantity theory was made by John Maynard Keynes, an economist whose name had once been associated with the "Cambridge school" of economists that reformulated the quantity theory. Keynes alleged that the quantity theory framework was too rigid for analyzing the effect of changes in the money supply on expenditures and the price level. He proposed a more complex theoretical framework for analyzing aggregate economic relationships.

Keynes developed his theory during the early 1930's, a period when policymakers and economists alike were becoming increasingly disenchanted with a theory based on the assumption that unemployment could persist only during temporary transition periods to the "normal" conditions of full employment equilibrium. With massive unemployment and

[8] Fisher, p. 153.

declining real output in most industrial nations, the economics profession and the public at large were receptive to a new economic theory that seemed more consistent with observed phenomena.

Liquidity Preference and Velocity

Keynes rejected the notion that households and businesses want to hold a constant fraction of their incomes in cash balances. Instead, Keynes said, the income velocity of money depends on "many complex and variable factors," and analysis based on the presumption of constant velocity merely disguises the "real character of the causation."[9] Keynes identified three distinct motives for holding money balances:

> (1) to bridge the gap between receipt of income and planned expenditures—the transactions motive;
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> (2) to provide a reservoir of purchasing power that can be used to finance unanticipated expenditures—the precautionary motive; and
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> (3) to satisfy the desire to hold wealth in the most liquid form if one expects interest rates on ,alternative assets to rise, thereby causing capital losses—the speculative motive.

Keynes adopted the traditional Cambridge view that money held to finance expenditures, including both transactions and precautionary balances, is a constant fraction of the level of income. However, Keynes believed that money is held for purposes other than as a medium of exchange. The speculative motive for holding money is not directly related to expenditures, according to Keynes, but depends instead on the "liquidity preference" of asset holders. The amount of money held in speculative balances, Keynes hypothesized, depends on the anticipated direction and magnitude of prospective changes in market interest rates. If individuals believe that market interest rates are likely to increase in the future, they have an incentive to hold their wealth in the form of liquid assets in order to avoid the capital losses on long-term assets that would accompany the expected increase in interest rates. Those who hold money because they believe the yield on money balances will exceed the yield on alternative assets are said to exhibit liquidity preference.[10] Keynes hypothesized that more individuals expect a future increase in market interest rates when the current level of interest rates is low than when the current level of interest rates is high. Thus, liquidity preference and the speculative demand for money are hypothesized to be inversely related to the current level of interest rates.

Keynes' liquidity preference theory cast doubt on the quantity theory assumption of a constant income velocity of money. If money is held as a store of value as well as a medium of exchange, there need not be a fixed relation between the money stock and the level of expenditures. The determinants of the demand for money held to satisfy liquidity preference—the degree of risk aversion and the expected yield on alternative financial

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9 John Maynard Keynes, The General Theory of Employment, Interest, and Money (New York: Harcourt, Brace and World, 1964), p. 299.

10 In this context, the total expected yield on an asset is equal to the interest payment minus the expected capital loss, each expressed as a percentage of the market price of the asset.

assets—are not directly related to expenditures or income. It is possible, therefore, that the income velocity of money could change from one period to the next because of changes in expectations of future interest rate movements or attitudes toward risk. Moreover. Keynes argued. changes in the money supply can themselves lead to changes in velocity. The initial effect of an increase in the money supply. according to Keynes, is a drop in interest rates. The fall in interest rates leads to an increase in liquidity preference and a consequent decline in the velocity of money.

Keynes' original formulation of the theory of liquidity preference implies an "all-or-nothing" choice between money and other financial assets. An investor could maximize the expected return on his portfolio of financial assets by holding only long-term bonds if he expects market interest rates to fall and by holding no long-term assets if he expects market interest rates to increase, provided the increase in rates is sufficiently large to make the expected yield on long-term assets less than the yield on money. It is generally believed, however, that most investment portfolios include a wide variety of financial assets, each with a different yield and term to maturity.

James Tobin offered an alternative theory of liquidity preference that is more nearly consistent with observed portfolio behavior.[11] Tobin assumed that investors are concerned both with the expected yield and the riskiness of alternative assets and that most investors are willing to accept a somewhat lower yield on their portfolio if, by doing so, they can also reduce its risk. Even if the expected yield on money balances is less than the expected yield on alternative assets, investors may choose to hold part of their financial wealth in cash balances as a means of reducing the risk on their total portfolio of assets. The higher are the expected yields on alternative assets, however, the more costly it .is to obtain a reduction in the riskiness of a portfolio by holding money balances. Thus, Tobin's theory of liquidity preference predicts portfolio diversification, with the fraction of financial wealth held in money balances being inversely related to the .expected yield on alternative financial assets.

Keynes' Analysis of the Relation Between Output and Expenditures

The second major difference between Keynesian theory and the quantity theory is that Keynes did not assume that departures from full employment were temporary aberrations that could safely be ignored in economic analysis. It is possible in these circumstances that an increase in the level of expenditure caused by an increase in the money supply would lead to a rise in real output and employment rather than being dissipated entirely in higher prices. Keynes suggested analyzing the conditions that determine how increased expenditures will be divided between changes in real output and changes in prices rather than assuming at the outset, as the proponents of the quantity theory did, that the level of output is determined independently of the level of expenditure.

Implications of Keynesian Analysis

In summary, Keynes rejected the quantity theory conclusion that an increase in the money supply necessarily leads to an increase in the price level of the same proportion. He argued that the extent to which an increase in the money supply leads to higher spending depends on the numerous factors determining the

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11 James Tobin, "Liquidity Preference as Behavior Toward Risk," Review of Economic Studies, Vol. 25, No. 67 (February 1958).

income velocity of money—factors such as the degree of liquidity preference and the interest elasticity of various kinds of expenditures. Moreover, Keynes asserted that increased expenditures do not lead inexorably to commensurate increases in the price level. Since resources can be less than fully employed for sustained periods, the level of real output can be influenced by aggregate demand. Thus, according to Keynes, the relation between changes in the money supply and changes in the price level is not as simple and direct as the quantity theory implied but depends on a myriad of real and financial conditions, each of which must be taken into account when analyzing the prospective inflationary impact of increases in the money supply.

There is now general agreement among economists and other observers that Keynes was correct in asserting that changes in aggregate demand do not necessarily result in commensurate changes in the overall price level. Theoretical and empirical considerations have led most economists to conclude that the rate of inflation accompanying a given growth in aggregate expenditures depends on the degree of utilization of productive resources, anticipations concerning inflation, and perhaps other factors.[12]

There is also general agreement among economists that the quantity theory assumption of a constant income velocity of money is an oversimplification. Variability in the income velocity of money does not necessarily imply that changes in the money supply do not have a predictable influence on aggregate spending, however. If the factors affecting velocity can be identified and the magnitude of their effects determined, it would be possible to estimate the size of prospective changes in velocity and to adjust monetary policy accordingly.

Unexpected changes in velocity would thwart attainment of the goals of monetary. policy, however, if the monetary authorities use the growth in the money supply as a measure of the impact of monetary policy on the economy. If unpredictable changes in velocity are both frequent and large, it may be desirable to use something other than growth in the money supply (interest rates, for 'example) to gauge monetary policy.[13] Thus, reliance on the growth rate of the money supply as an indicator of the effect of monetary policy on the economy presupposes that the determinants of velocity can be identified.

THE CURRENT VIEW OF THE DETERMINANTS OF VELOCITY

A number of theoretical models have been developed to explain the determinants of velocity. Many of these models are based on the inventory approach to the demand for money developed by William- Baumol and James Tobin.[14] In general, inventory models of cash

12 See, for example, Leonall C. Andersen and Keith M. Carlson, "A Monetarist Model for Economic Stabilization," Federal Reserve Bank of St. Louis Review, Vol. 52, No. 4, April 1970.

13 See J. A. Cacy, "The Choice of a Monetary Policy Instrument," Federal Reserve Bank of Kansas City Economic Review, May 1978, for a discussion of the factors affecting the choice between interest rates and the money supply as a gauge of monetary policy.

14 William J. Baumol, "The Transaction Demand for Cash: An Inventory Theoretic Approach," Quarterly Journal of Economics, Vol. 66, No. 4 (November 1952); and James Tobin, "The Interest Elasticity of Transactions Demand for Cash," Review of Economics and Statistics, Vol. 38, No. 3 (August 1956).

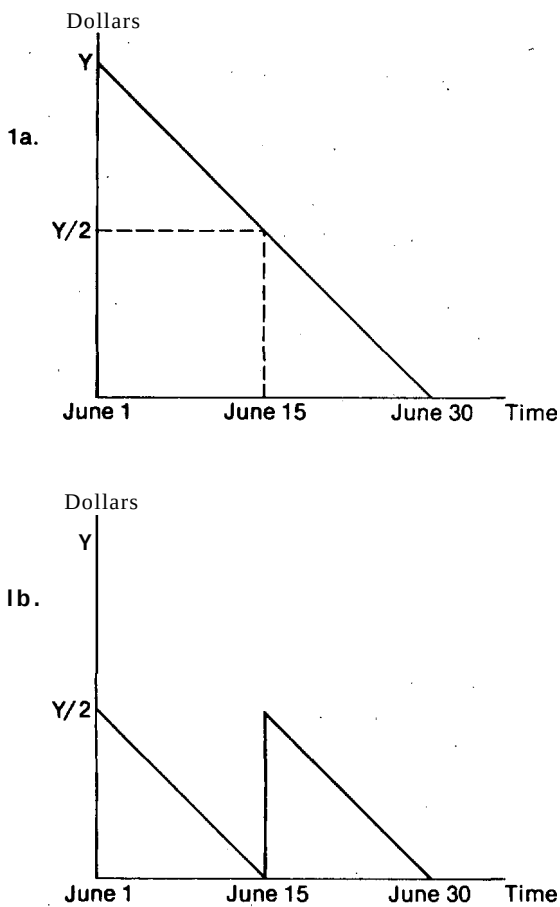
A number of alternative models of the demand for money have been developed. The demand for money functions advocated by most monetarists are more general than the inventory models. Monetarist models view money as one of many forms in which wealth can be held. The demand for money is thus postulated to depend on total wealth and the yields on money and other assets. At a very abstract level, there is no conflict between monetarist models (or portfolio balance models as they are sometimes called) and inventory

management view money balances as reservoirs or "inventories" of purchasing power that can be drawn upon as needed to finance expenditures. Earning assets are considered alternatives to money balances as temporary repositories of funds held to bridge the gap between receipt of income and its subsequent expenditure.

The Inventory Model of Cash Management

It is useful to analyze a simple inventory model to understand the implications of such a model for the determinants of the demand for money.[15] Assume that an individual receives a lump sum income payment of $Y at the beginning of every month and spends this income at a constant rate throughout the month, with all expenditures being financed by checks drawn on the individual's demand deposit. If the entire income payment is deposited directly in the checking account at the beginning of the month, the demand deposit balances will exhibit the profile demonstrated in Chart 1a, declining steadily from $Y at the beginning of the month to $0 at the end of the month.[16] The average daily

Chart 1
MONTHLY PROFILE OF MONEY BALANCES



models of the demand for money. The distinguishing characteristic of inventory models is the presumption that the level of expenditures is an important determinant of the fraction of wealth held in money balances. For an introduction to monetarists' views on velocity and the demand for money, see Milton Friedman (editor), Studies in the Quantity Theory of Money (Chicago: University of Chicago Press, 1956).

15 The exposition of the inventory model that follows is essentially the same as that presented in Baumol.

16 The profiles in Chart 1 are simplified slightly to demonstrate the essential characteristics of the inventory models. Since demand deposit balances are computed only at the end of each banking day, the measured balance in the demand deposit would decrease by equal amounts each banking day, yielding a "stairstep pattern" for the balance rather than the smooth decline pictured in the charts. This simplification does not alter the analysis, however.

balance in these circumstances is $Y/2, and the income velocity of funds held in the checking account is 2 per month [that is, (Income)/(Average Balance) = ($Y per month) /($Y/2 = 2 per month].

The individual can reduce the average amount held in his demand deposit by investing part of his paycheck temporarily in interest-earning assets. Assume, for example, that one-half of the monthly income payment is deposited directly in a demand deposit and the other one-half is invested in a short-term interest-earning asset. The beginning balance in this case is $Y/2, and the balance declines at a steady rate until reaching $0 in the middle of the month. At this point, the individual must redeem the interest-earning asset purchased at the beginning of the month and deposit the proceeds in his demand deposit if he is to maintain the same expenditure pattern as in the previous example.[17] Deposit of the funds from redemption of the interest-earning asset results in an increase of the checking account balance to $Y/2, which decreases at a steady rate for the duration of the month and reaches $0 at the end of the month. The pattern of the checking account balance corresponding to this sequence of events is demonstrated in Chart 1b. The average daily balance in the checking account is reduced to $Y/4 by the temporary investment of one-half of each month's income in interest-earning assets, and the income velocity of demand deposit balances is increased to 4 per month [that is, ($Y per month)/($Y/4) = 4 per month].

The reduction in the average demand deposit balance and the consequent increase in interest income is not costless, however. The individual incurs a cost in transferring funds from interest-earning assets into his demand deposit. Assuming that there is a fixed brokerage fee, $b, associated with such transfers, the decision to invest 50 per cent of the monthly income receipt would increase interest income net of transactions costs if the incremental interest income exceeds $b. If an individual finds it worthwhile to invest one-half of his income in short-term assets at the beginning of each month and makes one subsequent transfer of funds in the middle of the month, he might consider the possibility of investing two-thirds of his income initially and making two intramonthly transfers (after one-third of the month and two-thirds of the month had elapsed) into his checking account. In fact, an individual will find it profitable to increase the proportion of funds invested in interest-earning assets up to the point where the cost of making an additional transfer of funds into his checking account from other assets just offsets the incremental income from reducing the amount held in money balances.

Implications of the Inventory Model

Inventory models of cash management imply that the amount of cash held in transactions balances is inversely related to the yield on alternative assets. Thus, the interest sensitivity of the transactions demand for money provides a reason for expecting the income velocity of money to vary directly with the level of interest rates, a result that reinforces the liquidity preference effect of higher interest rates on velocity that was posited by Keynes. The incentive to economize on cash balances by holding funds in interest-earning assets must be weighed against the cost incurred in

[17] For simplicity, it is assumed that interest earned on the funds invested temporarily in short-term assets is reinvested rather than being spent immediately. It is also assumed that transfers of funds from interest-earning assets are always of the same dollar amount as the original deposit in the demand deposit. For a proof of this proposition, see James Tobin, "The Interest Elasticity of Transactions Demand for Cash."

transferring funds to determine the optimal allocation between money and other assets.

In addition to the implication of an interest-sensitive demand for transactions balances, the inventory approach to the demand for money implies that the velocity of money tends to increase as income rises. This tendency results from economies of scale in managing transactions balances, which is implied by the inventory models. Economies of scale exist if economic units desire to increase their cash balances less than proportionately to increases in the level of expenditures. The formal solution to the simple inventory model indicates that the optimal amount of money balances held for transactions purposes increases proportionately less than anticipated expenditure because it becomes practical to hold a larger percentage of working balances in interest-earning assets as the scale of expenditure increases.[18]

Extensions of the Inventory Model

The assumption of the simple inventory models that the timing of withdrawals from checking accounts is known with certainty is somewhat unrealistic. For many individuals and businesses, the magnitude and timing of many expenditures are somewhat unpredictable. Moreover, the time that elapses between the day a check is written and the day the corresponding funds are withdrawn from the demand deposit is subject to a number of random elements. It may be prudent, in these circumstances, to keep a cushion of liquidity in cash balances to ensure against insufficiency of immediately available funds. The desire to maintain a cushion of liquidity in the form of cash balances to meet unforeseen contingencies is what Keynes called the precautionary motive for holding money. Many of the same principles that govern management of transactions balances also apply to management of precautionary balances.[19] Alternative sources of liquidity are available for precautionary purposes. The cost of holding precautionary cash balances is the interest income foregone on alternative liquid assets, and the larger is the scale of anticipated expenditures, the greater is the reward for holding a portion of precautionary balances in interest-earning assets rather than money. In addition, the likelihood of having a large percentage of cash disbursements occur unexpectedly within a given time period is inversely related to the number of expenditures since stochastic elements tend to average out as the frequency of expenditures increases.[20] Thus, the theoretical framework for analyzing the precautionary motive for holding money implies that the amount held in precautionary balances is inversely related to the yield on alternative assets and increases less than proportionately to the level of expenditures.

THE POSTWAR RISE IN VELOCITY

The ratio of gross national product (GNP) to the narrowly defined money stock (M1), which is the ratio most commonly used to measure the income velocity of money, has risen steadily in the postwar period (Chart 2). The analysis of the transactions, precautionary, and speculative motives for holding money outlined earlier

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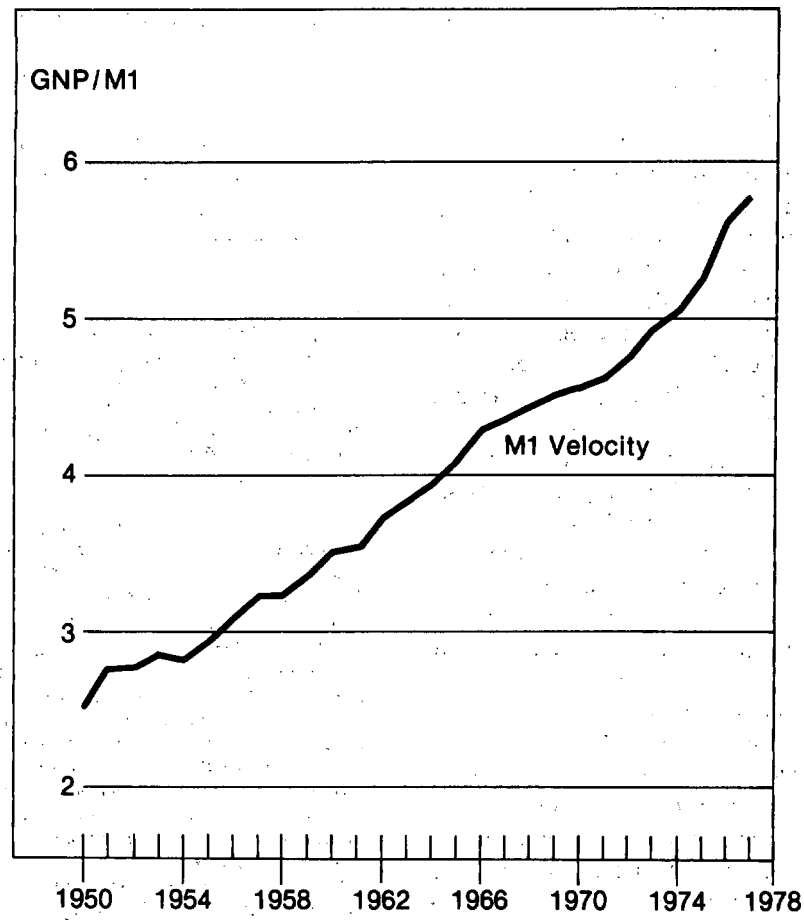
18 For a more complete exposition of the formal derivation of the income and interest rate elasticities implied by the inventory model, see the Appendix on p. 30.

19 See S. C. Tsiang, "The Precautionary Demand for Money: An Inventory Theoretical Analysis," **Journal of Political Economy** (January-February 1969), for an analysis of factors affecting the .amount held in precautionary money balances.

20 For a detailed analysis of the effect of uncertainty on the demand for money, see Don Patinkin, **Money,** Interest, and **Prices** (New York: Harper and Row, 1965), Chapters 5 and 6.

Chart 2
THE POSTWAR TREND OF M1 VELOCITY



is generally consistent with the upward trend in velocity for the past 30 years. The various theoretical considerations previously discussed imply, for instance, that the demand for money decreases as the level of interest rates rises. The upward trend in interest rates in the postwar period helps to explain the secular increase in the income velocity of money.

The implication of the simple inventory model—that the amount of money held to finance expenditures increases less than proportionately to the level of expenditures—provides an additional explanation for the upward trend in income velocity. Real income and expenditure have grown steadily in the postwar period, and the relatively slower growth of the money stock indicates the plausibility of the hypothesis of economies of scale in cash management.

The growing availability of money substitutes has probably also contributed to the rise in velocity in the postwar period. The inventory models imply that the cost of converting interest-earning assets into money is a significant determinant of the fraction of income held as cash balances. It is unlikely,

however, that the multitude of factors affecting the ease of transferring funds is adequately captured by the assumption of a constant brokerage fee. A variety of new types of financial assets have been developed over the past 30 years, and the effect of many of these financial innovations has been to make it easier for firms and individuals to maintain a larger fraction of their liquid balances in earning assets. The growing importance of nonbapk financial intermediaries has been particularly important in expanding the types of money substitutes available to the household sector. Many of these liquid assets are such close substitutes for demand deposits and currency that a number of analysts have suggested the concept of money be broadened to include time and savings deposits.[21] Virtually all analysts agree that the various financial innovations in the past three decades have lowered the effective cost of converting earning assets into money and have thereby contributed to the upward trend in the income velocity of the narrowly defined money supply.

In summary, many factors have contributed to the rise in the income velocity of money in the postwar period. Inventory models of cash management provide a useful framework for analyzing the impact of higher interest rates, economies of scale, and financial innovation on the income velocity of money. The implications of the inventory models are ,consistent with postwar experience in a qualitative sense, but it is only by empirical estimation of the quantitative impact of various influences on the demand for money that definitive conclusions can be drawn regarding the importance of each factor for the behavior of the income velocity of money.

A number of empirical studies have attempted to determine the important parameters of the aggregate demand for money function.[22] The equation to be estimated typically specifies the demand for real money balances as a function of the yield on one or more alternative assets and some measure of real income.[23] It is often assumed that

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21 See Milton Friedman and Anna J. Schwartz, **Monetary Statistics of the United States** (New York: National Bureau of Economic Research, 1970), for a comprehensive discussion of the issues involved in choosing the types of assets to be included in "the" money supply.

22 For ease of exposition, the term "demand for money function" will be used to refer to functions with either the quantity of money balances or the income velocity of money (or its inverse) as the variable to be explained. A velocity function can easily be converted to an explicit demand for money function by simple algebraic manipulation. Thus, a particular specification of a velocity function implies a unique specification of the demand for money function and vice versa.

For a summary of much of the empirical work on the demand for money, see Edgar L. Feige and Douglas K. Pearce, "The Substitutability of Money and Near-Monies: A Survey of the Time-Series Evidence," **Journal of Economic Literature,** Vol. 15, No. 2 (June 1977).

23 Milton Friedman, "The Demand for Money: Some Theoretical and Empirical Results," **Journal of Political Economy** (August 1959), advocates use of a long-run concept of income in specifying a demand for money function. Friedman argues that individuals adjust their desired money balances in line with the sustainable level of income over a prolonged period, a concept which he calls "permanent income." Karl Brunner and Allan H. Meltzer, "Predicting Velocity: Implications for Theory and Policy," **Journal of Finance,** Vol. 18, No. 2 (May 1963), prefer to include wealth rather than either current or permanent income in the demand for money function.

If something other than current income is included as the scale variable in specifying a demand for money function, the derivation of a velocity function requires that the relation between current income and the included scale variable be specified. The necessity to specify the relation between current income and either permanent income or wealth, neither of which can be measured directly, introduces the possibility of compounding errors in specifying the demand for money function and errors in measuring the independent variables used to explain the demand for money. In addition, it is difficult to see the relevance of concepts such as permanent income and wealth for the demand for money by the business sector. To avoid these conceptual problems, the discussion in this article focuses on the traditional specification of the demand for money function, with measured income as the scale variable.

individuals and businesses do not adjust their actual cash balances to desired levels instantaneously. This assumption is incorporated by including past values of income and interest rates in the equation explicitly or by inferring the speed of adjustment to desired values from the coefficient on the lagged value of the money stock.

The results from empirical estimation of the demand for money function differ substantially according to the statistical techniques used, the period for which the equation is estimated, and the precise specification of the form of the function. In general, though, the empirical results are generally consistent with the predictions from the inventory models outlined earlier.[24] Most studies find that the demand for money increases less than proportionately to the level of income, that yields on alternative assets have a significant negative impact on the desired level of cash balances, and that the introduction of new types of liquid assets results in slower growth in the quantity of money demanded.

In the judgment of many analysts, empirical estimates indicate that the demand for money function has exhibited substantial stability and that unexpected changes in the income velocity of money are therefore unlikely to invalidate the use of the money supply or its growth rate as the primary indicator of monetary policy. A number of economists consider the evidence on the stability of the demand for money function so persuasive that they advocate reinstitution of a revised version of the quantity theory of money as the primary framework for analyzing macroeconomic relations. The monetarists, as the new advocates of a revised quantity theory are called, assign a primary role to growth in the money stock as a determinant of the growth in total spending. Indeed, most monetarists deny that factors other than the growth in the money supply, such as fiscal policy, exert any systematic influence on income or inflation except, perhaps, in the very short run.[25]

The consensus regarding the relative stability of the demand for money and velocity functions that emerged from the numerous empirical studies mentioned has had a significant impact on the implementation of monetary policy. The Federal Reserve has increasingly emphasized the importance of monetary growth for economic performance in the past several years. The general climate of opinion seemed, until recently, to have come full circle—from the constant velocity assumption of the original quantity theory, through the deemphasis of velocity resulting from the economic experience in the 1930's and Keynes' criticism of the quantity theory, to the apparent empirical verification of a stable demand for money function and the belief that unpredictable changes in velocity are unlikely, to have a significant impact on income and inflation. The assumption of a constant income velocity as a basis for analyzing aggregate economic relations was replaced by the presumption that velocity was predictable, though not necessarily constant.

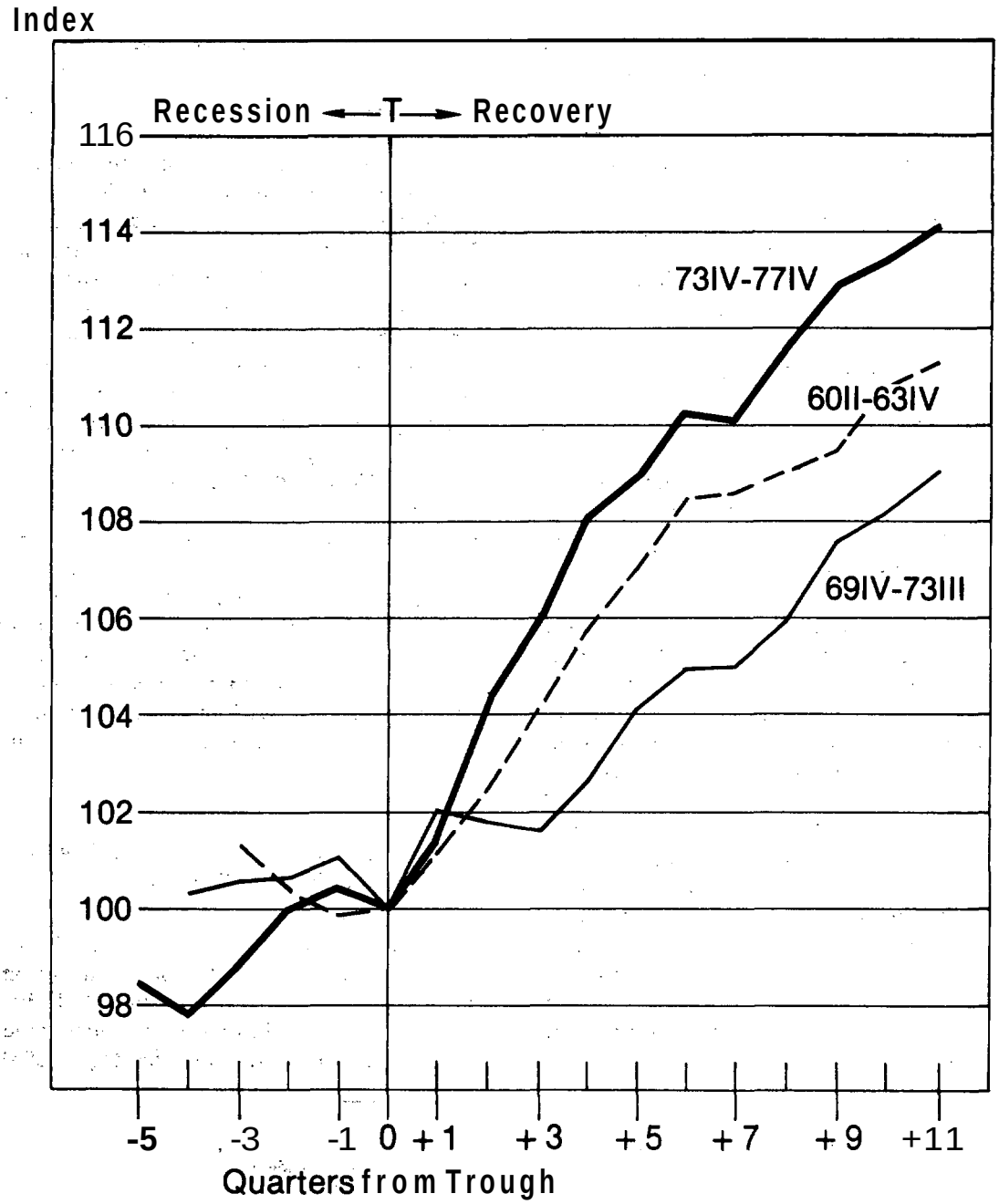
THE BEHAVIOR OF VELOCITY IN THE CURRENT RECOVERY

Recent experience has led some analysts to question whether the behavior of the income velocity of money is predictable. Velocity—especially for M1—has increased quite rapidly in the past three years, and the degree of the

24 Empirical estimates of the income and interest elasticities of the demand for money from numerous studies are reported in Feige and Pearce.

25 See Andersen and Carlson for an example of the model of the economy considered relevant for macroeconomic analysis by two well-known monetarists.

Chart 3
CYCLICAL BEHAVIOR OF M1 VELOCITY



rise in velocity, particularly in 1975 and 1976, seems to many to be inconsistent with past experience. Although the income velocity of money typically increases substantially during economic upturns, the rapidity and duration of the most recent rise in velocity has been exceptional. (See Chart 3.) The rapid growth in M1 velocity for the past three years is particularly surprising when one considers the accompanying pattern of increases in market interest rates. One of the primary factors contributing to the normal increase in velocity during periods of economic expansion is the rise in market interest rates that typically accompanies rapid economic growth. Businesses and households intensify their efforts to economize on cash balances as the opportunity cost of holding money rises. A substantial portion of the increase in velocity during the current expansion occurred in 1975 and 1976, however, a period in which market rates were generally declining. Thus, the interest sensitivity of the demand for money does not provide a complete explanation of the behavior of velocity in the current recovery.

The quickened pace of financial innovation in the 1970's accounts for a portion of the apparent downward shift in the demand for money function in recent years. A number of regulatory and legal decisions have permitted financial institutions to offer plans that have resulted in a decline in desired M1 balances relative to income. Thrift institutions, for example, have begun to offer interest-bearing accounts that can be used to make payments in much the same way as can checking accounts. Commercial banks have responded by making it easier for their customers to transfer funds out of interest-earning deposits into checking accounts. In addition, businesses and state and local government units have been authorized to hold some of their funds in savings deposits. All of these and other innovations have undoubtedly contributed to the reduction in the desire to hold funds in checking accounts. The total impact of all of these financial innovations can explain only a small fraction of the recent shortfall in the demand for money, however.[26]

Even after taking account of the probable impact of financial innovation, most empirical studies have found that the behavior of M1 velocity in recent years cannot be explained by traditional demand for money functions. A great deal of additional empirical work will be needed to resolve what one author has called "The Case of the Missing Money."[27]

Resolution of the puzzling behavior of velocity in recent years has important implications for monetary theory and policy. If the recent behavior of velocity can be explained within the general framework of traditional economic analysis, predictions based on the presumption of a stable velocity function will

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26 For an estimate of the impact of financial innovation on the demand for money, see Jared Enzler, Lewis Johnson, and John Paulus, "Some Problems of Money Demand," Brookings Papers on Economic Activity, 1976:1.

27 Stephen M. Goldfeld, "The Case of the Missing Money," Brookings Papers on Economic Activity, 1976:3. Goldfeld tried to explain the rapid increase in velocity in recent years using a number of alternative specifications of the demand for money function. While some specifications proved to be slightly better than others, none were capable of satisfactorily explaining the recent behavior of velocity. Goldfeld concluded that "Specifications that seem most reasonable on the basis of earlier data are not the ones that make a substantial dent in explaining the recent data" and that his efforts to solve the puzzle of the shortfall in the demand for money had been unsuccessful (p. 725).

Michael Hamburger, "Behavior of the Money Stock: Is There a Puzzle?" Journal of Monetary Economics, Vol. 3, No. 3 (July 1977), claims to have solved the puzzle of the recent behavior of velocity. The primary differences between the demand for money functions specified by Goldfeld and Hamburger is that Hamburger includes the yields on a wider variety of assets and constrains the income elasticity of the demand for money to be 1. The constraint on the income elasticity, although not uncommon, seems difficult to justify on either theoretical or empirical grounds. It remains to be seen, therefore, whether the solution to the money demand puzzle posited by Hamburger provides a basis for confidence in predictions of the future course of velocity.

continue to be important determinants of the course of money policy. It is possible that the rapid increases in velocity in the last few years can be satisfactorily explained by economic determinants that have not previously been incorporated into theoretical and empirical studies of the relation between the money supply and the level of income. Incorporation of these determinants could yield a velocity function that is sufficiently stable to be valuable for economic and policy analysis. If, on the other hand, the factors causing the atypical behavior of velocity in recent years cannot be identified, economic analysis based on the predictability of the income velocity of money might result in future policy errors that impair economic performance. Thus, questions regarding determinants of the velocity of money are certain to continue to play a dominant role in discussions concerning the future course of inflation, income, and employment.

CONCLUSIONS

A central assumption of economic analysis is that there are certain key relations in the economy that are stable enough over time to warrant confidence in predictions based on economic models that incorporate those relations. One of the central relations on which economists and policymakers have traditionally relied in analyzing aggregate economic activity is the connection between the money supply and the level of income. The concept of the velocity of money has been both lauded and scorned at various stages in the development of economic theory. This article has discussed the evolution of macroeconomic theories that have affected the attitudes toward the concept of velocity and the empirical evidence that supports these attitudes. Although there is not now, nor has there ever been, complete agreement regarding the determinants of the income velocity of money, the concept of velocity will almost certainly remain a subject of extensive debate among policymakers, economists, and other analysts. As economic theory and data availability have become more refined, understanding of the behavior of velocity has advanced substantially. Continued effort will be required, however, to ensure that knowledge about the factors affecting velocity is keeping pace with the changing economic and social environment in which policy decisions are made.

APPENDIX

In the inventory models of the transactions demand for money, the interest incentive to economize on cash balances is counterbalanced by the cost of transferring funds from interest-earning assets into money as necessary to finance expenditures. Although it is traditionally assumed that the primary cost of converting earning assets into cash is the fixed brokerage fee associated with transferring funds, it seems likely that the major cost for individuals of transferring funds is the opportunity cost of the time necessary to effect such a transfer. Particularly if funds are held temporarily in time and savings deposits at financial intermediaries rather than in money balances, a major factor contributing to the perceived cost of transferring funds out of interest-earning assets into cash is the reduction in leisure time resulting from careful management of cash balances. For a more complete exposition of this point, see Dean S. Dutton and William P. Gramm, "Transactions Costs, the Wage Rate, and the Demand for Money," **American Economic Review,** Vol. **63,** No. 4 (September 1973). The same study provides a possible explanation for the discrepancy between the income elasticity of the demand for money estimated empirically and the scale elasticity implied by simple inventory models.

It is informative in this regard to reformulate the inventory model to take account of both the substitution effect and the scale effect of a change in income resulting from a change in the real wage. If in addition to a fixed brokerage fee (b) for transferring funds from one type of asset to another, there is an opportunity cost of time equal to a proportion (g) of the individual's real wage, then the total cost (X) of maintaining a cash balance needed to finance transactions is:

$$X = r(C/2) + (Y/C)(b + gw)$$

where

Y = total expenditures per time period;
C = the size of transfers from interest-earning assets into cash;
w = the real wage per period;

and

r = the opportunity cost per period of holding funds in noninterest-bearing form.

Differentiating this expression with respect to C and setting the result equal to zero, we find that the cost function is minimized by holding an average balance C/2 equal to the square root of $[Y(b + gw)/2r]$. The elasticity of the average cash balance with respect to the volume of expenditures is $+1/2$ as in the Baumol formulation.

But since an increase in the real wage increases the opportunity cost of time necessary to effect transfers into or out of money, an increase in income resulting from an increase in the real wage has an effect on the demand for money which is independent of the level of expenditure. The magnitude of this effect can be found by differentiating the expression for average cash balances with respect to w and multiplying the result by $[w(C/2)]$. This yields an expression for the (partial) elasticity of the demand for money with respect to the wage rate which, when simplified, is $1/2[1/(1 + b/gw)]$. This "pure income effect" due to the substitution possibilities between leisure and income in regard to managing active money, balances will be closer to $+1/2$ the larger is the percentage of the total cost of transferring funds attributable to the opportunity cost of the individual's time. If, therefore, income is used to measure both the scale of expenditure effect and the substitution effect, one would expect the measured income elasticity to be in the interval $(+1/2, +1)$. Thus, a measured income elasticity close to $+1$ does not, as is often alleged, refute the hypothesis of economies of scale in cash management.