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GLOBAL MONETARISM AND THE BEHAVIOR
OF POST-WAR VELOCITY OF MONEY

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

IN
ECONOMICS

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For my parents,
Fidel Astejada Rillo
and
Salud Dolorito Rillo
ABSTRACT

This study empirically tests a monetarist model of nominal income growth in the United States during the period of fixed (1966.1-1973.2) and flexible (1982.1-1991.4) exchange rates. It argues that domestic money is still an important variable in managing domestic aggregate demand. However, in a world where national economies have become increasingly more integrated, domestic monetary aggregates must be incorporated with other economic variables to influence nominal income. The unstable M1 velocity in 1982 and the large and persistent change in dollar exchange rates in the 1980s have immediately raised concerns to implement domestic policy taking into account international considerations. The influence of international factors on domestic income is analyzed in this study in terms of two important channels of transmission: exchange rate and world money supply. While the wide range of variations in dollar exchange rate in recent years has been seen as useful indicator of economic conditions, it is also argued that the dollar value of world money supply shocks are an important influence on nominal income.

The results of fitting a distributed lag or an Almon lag in a monetarist model of nominal income reveal that M2 is a better predictor of nominal income growth in the US after 1982. The M2 velocity in the 1980s is found to be stable in contrast to M1 velocity. In addition to independent effect of domestic money (M2) on income, the dollar exchange rate and the dollar value of world money supply exert significant influence on aggregate demand during the flexible rate period. In fact, these variables have more lasting impact than standard
money demand variable like the opportunity cost of money. Moreover, the income regressions based on exchange rate and world money are able to forecast the growth rate in M1 and M2 velocities reasonably well. The paper concludes that both domestic money as well as foreign money should be considered in analyzing fluctuations in nominal aggregate demand in the United States especially during the flexible exchange rate period.
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CHAPTER 1
INTRODUCTION

Recent monetary developments in the United States have posed new challenges for achieving the traditional goals of price and output stability. There is a widespread perception that the relationship between the money supply and the US economy suddenly fell apart in the 1980s, thus calling into question the use of monetary aggregates as guideposts for monetary policy. Those suspicious of monetarism have the financial deregulation in 1980 and the apparently decline in M1 velocity after 1981 to blame. Experience during this period indicates that the long-standing relationships connecting growth in nominal GNP to the growth in money supply have departed significantly from their historical norms, which made the earlier focus on monetary targets inadequate (B. Friedman 1988a, 1988b). While the existence of long and variable lags between monetary policy actions and economic results seems to be a problem, both the money supply and interest rate targets have also foundered

---

1 The experience of the US monetary system at the outset of the 1980s cannot be complete without mentioning the change in operating procedures being implemented by the Federal Reserve on October 6, 1979. The new policy orientation had placed greater emphasis on monetary aggregates and the new operating procedures necessary to achieve those targets. However, experience with accelerating inflation and deepening economic recession had forced the Fed to abandon this monetarist experiment on October 9, 1982, and eventually the stated growth target for narrow M1 money stock. For a critical discussion of this event, see papers published in American Economic Review (May 1984) under the section "Monetarism: Lesson from the post-1979 Experience."
at one time or another in recent years to achieve GNP and price level goals. The breakdown in these relationships has made policy decisions far difficult.

At the same time, experience with the flexible rate system since 1973 has indicated that widely fluctuating movements in the dollar exchange rate have important implications on domestic aggregate demand. The belief that flexible exchange rates would adjust to differences in inflation rates among countries, while keeping at the same time the real exchange rates stable, did not seem to hold up since 1973. More than twenty years of experience with flexible rates has convinced everyone that the system has not worked well as anticipated. Instead the variability of the nominal exchange rates has increased much more than the variability of the ratio of relative price levels. The large and persistent change in dollar exchange rates in the 1980s has made the US economy more vulnerable to developments abroad, and this has immediately raised concerns to implement domestic policy taking into account international considerations.

1.1 Overview of Monetary Policy Issues in the 1980s

Over the past thirty years, the implementation of monetary policy has long been grounded on the perceived stable relationship between various measures of money and the ultimate objectives of monetary policy. From 1950s to 1970s, despite some years of

\[ \text{2 That macroeconomic phenomena can be analyzed best in terms of the relationship between the demand for and supply of money is the basic doctrine behind "monetarism." Monetarism was born in the 1960s largely as a short-run forecasting tool to predict GNP growth on the basis of monetary aggregates. It also involved a theory of inflation, i.e., the argument that inflation was said to be explicable in terms of the rate of growth of the money supply. The link between money and economic activity has a long history in monetary economics that includes major theoretical contributions by Milton Friedman (1967) and Karl} \]
unexplained behavior, monetary aggregates were able to provide an anchor for price and output stability. As shown in Figure 1.1, the movement of M1 money stock has roughly accounted for the movement of price inflation over those years. For the whole period 1960 to 1980, the levels of the rate of growth of the money supply and inflation rate are about equal in both directions. The most dramatic example was the experience with declining money growth and declining inflation rate over a two-year period beginning in 1975. By that time most economists in the United States were convinced of the stability of the demand for money and the ability of monetary aggregates to guide the economy. In fact, the same reliable information is conveyed about nominal income growth in the US (Figure 1.2). Business-cycle peaks are preceded by peaks in the money growth series over the same period, thus confirming in the process most of the monetarist views.3

But all this had changed dramatically in the 1980s. Since 1980 monetary targeting has ceased to be a reliable guide for monetary policy. The empirical regularities of money demand that seemed to characterize the earlier periods suddenly disappeared, and instead the M1 velocity drifted convincingly from its 1953-79 trend. This shift in money demand has made the conduct of monetary policy based on M1 money stock more problematic.

Brunner (1968).

3 The econometric evidence likewise confirms the same impression. Using the standard empirical tests relating income growth and price inflation rate to information conveyed by respective growth of money aggregates, Benjamin Friedman (1993) was able to show that the F-statistics in the nominal income and price equations were statistically significant during the 1969-79 period. By contrast, the results were obscured when the period was extended from 1979 to 1982, with none of the money aggregates bearing a usefully informative relationship to either nominal income or prices separately.
Figure 1.1

MONEY AND PRICE INFLATION (CPI) EIGHT QUARTERS LATER
Figure 1.2

GROWTH RATES OF LAGGED M1 MONEY SUPPLY AND NOMINAL GDP
The broader monetary aggregate M2, on the other hand, remains relatively stable over the years and appears to be a useful target for policy. Evidence suggests that the volatility of M1 growth on a quarter-to-quarter basis was relatively higher during 1979-83 than it had been during the earlier periods (B. Friedman 1988). Moreover, the GNP-to-lagged-M1 correlation entirely fell apart after 1983, with a negative correlation that was never heard of in the 1960s and 1970s. Even the monetarist contention that "inflation is and will ever be a monetary phenomenon" was seriously challenged by developments in the 1980s. Despite a rapid growth money growth in 1981-85, price inflation actually decelerated in 1985-87. At a most basic level, policy makers cannot rely at all on money measures to predict the economy, prompting some economists to proclaim the "death" of monetarism (Dewald 1988).

In the meanwhile, the increased recognition of international factors on the US economy lurks at the background of this alleged failure to conduct monetary policy based on purely domestic variables. An important aspect of this development is the view that exchange rate changes in recent years have become so significant that a combination of money supply and exchange rate strategies is "necessary for determining optimal discretionary responses," and that considerations of such will help validate short-run inflationary and output developments in the US economy (Willet and Bremer 1985). Popular discussions indicate that widely fluctuating exchange rates have macroeconomic effects on aggregate demand and on prices, and thus serve as an important channel through which various forces including domestic macroeconomic policies affect the economy. In this respect, the United States has
become much more like the smaller countries in the world who have long focused on the importance of international economic developments in their domestic economic well-being.

Evidence from the 1980s seem to support this view of greater economic interaction. Perhaps the dramatic rise of the dollar between 1979 and first quarter of 1985, a 73 percent appreciation of its trade-weighted value relative to ten industrial currencies, seems to set the scenario for the deteriorating US trade position in the 1980s. Over the six year period between 1980 and 1986, the trade deficit had increased to $143 billion or more than three percent of GNP. As the trade deficit rose, many US industries were particularly hard hit as their demonstrated ability to compete in world markets all but collapsed. Moreover, as a result of tremendous surge in foreign holdings in the domestic economy during the 1980s, foreign investors have assumed an importance in US financial markets that was previously unknown in modern times.

Under these circumstances, and considering the substantial exchange rate movements in 1980s, it would be surprising if the earlier focus of monetary policy was not changed or altered. In fact, it has been argued that the apparent instability in the demand for money can be intimately linked to the strong influence of international factors in the US economy (Brittain 1981, McKinnon 1982). While the strong form of this claim does not hold up to

---

4 In sharp contrast, a few decades before the deficit was about to surge in 1980s, the average percent share per annum of current account to total GNP in the United States was very small, from 0.2 percent in 1950s to 0.4 percent in 1960s and 0.1 percent in 1970s. "It is little wonder (then)," as Benjamin Friedman (1988) argues, "that many analysts of the US monetary policy during these decades practically ignored potential effects on real economic activity via exchange rate channels." For a recent summary of the trade deficit issue, see Martin Feldstein, "The Dollar and the Trade Deficit in the 1980s: A Personal View," NBER Working Paper # 4325 (April 1993).
strong empirical testing yet, it seems that the increased importance placed on the exchange
rate in recent years does support this view of international economic linkages.

1.2 Objectives of the Study

This dissertation is motivated by the recent controversy in monetary economics
arising from the alleged "collapse" of money-income and money-price relationships. The
issue appears to be of greater importance for macroeconomic policy because if monetarism
is "dead", as some critics argued, then how to target monetary policy in terms of monetary
aggregates becomes extremely difficult. This study, however, maintains that domestic money
is still an important instrument in managing domestic aggregate demand. But in a world
where national economies have become increasingly more integrated, domestic monetary
aggregates must be incorporated with other economic variables (primarily exchange rate) to
influence nominal income. In short, it's domestic monetary control with an international
perspective.

The influence of international factors on domestic income is analyzed in this study in
terms of two important channels of transmission: exchange rate and world money supply.
While the wide range of variations in dollar exchange rate in recent years has been seen as
useful indicators of underlying economic conditions, it is also argued that the dollar value of
world money supply shocks are an important influence on nominal income. In as much as
"domestic policy can be improved through more regular and systematized exchange of
information with foreign authorities concerning economic developments and policy intentions"
(Kohn 1990), then considerations of world monetary variables presumably provide additional

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information to domestic monetary policy. The maintained hypothesis is that under the flexible system, the growth of national income is not only influenced by the domestic money supply growth but also by changes in exchange rates and the dollar value of world money supply. In particular, this study focuses on the following objectives:

1. To provide evidence that the large and persistent movements in dollar exchange rates in recent years have had significant effects on US nominal income, and that under flexible system and global monetarism, the US economy is very much influenced by foreign monetary developments;

2. To provide new dimension on the usefulness of exchange rate as indicator for policy and as an important channel through which domestic aggregate demand is influenced;

3. To provide evidence on the empirical regularity of money demand in the light of recent controversies and to show the independent effect of domestic money, in addition to exchange rate and world money variables, in the economy.

1.3 Organization of the Study

This dissertation is organized as follows. Chapter 2 reviews the literature of the relationships between money and income vis-a-vis the major issues of instability in money demand and complications arising from exchange rate changes in the 1980s. Since 1982 the instability of M1 velocity has shifted monetary targeting to M2 demand given its ability to predict well the growth of nominal income. The persistent movements in the dollar exchange rate in the 1980s are also analyzed and their implications on domestic aggregate demand.
examined. The theoretical framework is presented in Chapter 3 where the interaction between money and exchange rate regimes is discussed. It is shown theoretically that the insulation property of the flexible rate system does not actually work as anticipated. Instead the argument that world monetary conditions are being transmitted to domestic economy is a realistic possibility under the flexible system. This is the basis of empirical investigation in Chapter 4. Single equation regressions are estimated to establish the predictive ability of domestic money, world money, and exchange rate on nominal income in the United States. Finally, the paper concludes in Chapter 5 with policy implications derived from the model.
CHAPTER 2

VELOCITY AND EXCHANGE RATE CHANGES:
IMPLICATIONS FOR THE US ECONOMY IN THE 1980s

Two of the more important developments in monetary economics over the past decade
are the increased recognition of the importance of international influences on the US economy
and the development of substantial instabilities in the estimated demand for money functions
in the United States. This chapter examines these issues vis-a-vis the behavior of income
velocity of money in the 1980s and the wide movements in the value of the dollar and their
implications on domestic aggregate demand.

2.1 M1 Velocity in the 1980s

Perhaps at the center of monetarist controversy in the 1980s is the unusual instability
of M1 velocity and the breakdown of familiar economic relationships based on M1. The main
argument is that unstable velocity\(^5\) reduces the predictability of money demand and thereby

\(^5\) At its most basic level, the income velocity of money, conventionally measured by the
ratio of nominal GNP to nominal money stock, is perhaps one of the most closely studied
relationships in economics. Early reference to the concept of income velocity was made in
Irving Fisher's famous "equation of exchange" as an accounting identity equating nominal
output to nominal money stock multiplied by the average number of times each unit of
nominal money is used. Later Fisher argued that velocity is a stable function of some factors,
and using this assumption, Fisher's identity was transformed into a useful equation. Thus,
with constant velocity, an exogenously controlled money stock can be used to stabilize
nominal income growth, as implied in Fisher's equation. For the classical treatment of the
subject see Irving Fisher, The Purchasing Power of Money: Its Determination and Relation
to Credit, Interest, and Prices (MacMillan 1911). An example of historical overview of the
concept in recent years is found in Daniel Thornton (1983), "Why Does Velocity Matter?"
FRB St. Louis Review.

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renders monetary targeting more difficult. At the same time the instability in velocity raises important questions on the relevance of monetarism and the ability of long-standing economic relationships between money, nominal income, and prices to hold.

2.1.1 Understanding the Demand for Money

The idea that there exists a stable demand for money function has well-defined theoretical foundations. Milton Friedman's (1956) hypothesis that "the quantity theory is in the first instance a theory of money demand" underlies the primacy of money demand issues in monetary theory, and that as an economic relationship it has taken the appearance of a well-established empirical truth. As Friedman further argues: "The quantity theory accepts the empirical hypothesis that the demand for money is highly stable - more stable than functions such as the consumption function that are offered as alternative key relations."

Traditional money demand formulation involves the use of a scale variable like income and interest rate as sine qua non of stable money demand. This implies that as an empirical regularity, the demand for money must be able to exhibit a set of necessary conditions for money to exert an influence on the economy. Presumably, highly stable implies that the parameters of the money demand do not change over time and consistent estimates are maintained across samples. Moreover, the demand for money function can be predicted on the basis of few variables that appear as arguments in the function, and that as a way of establishing causality, these variables must be able to link money to economic activity.
The same key relationships implied by this stability property of money demand are reflected in a simple IS-LM model by Poole (1970). In this context, the existence of stable money demand function provides policy makers with knowledge about the quantity of money that is useful in the design of the transmission mechanism involving money, interest rates, and nominal aggregate demand. Thus a monetary policy based on money supply target is more effective than the one based on interest rate target if the variance of the money demand function is relatively smaller than the variance of the IS curve.

The last three decades from 1950s to mid-1970s were precisely the period when the application of monetarist ideas to policy came into new height, largely as a result of greater confidence placed on the empirical regularity of money demand that "was well on its way to replacing the Keynesian multiplier or the traditional Phillips curve as the central (economic) relationship" (Laidler 1990). As a practical result, monetary targeting based on narrow money stock M1 (consisting essentially of currency and demand deposits) became the focus of new operating procedures of the Federal Open Market Committee in October 1979. But even before that in the 1960s the Fed had already started to set targets for M1 money supply. For reasons both theoretical and practical, "the demand for transactions purposes seemed well worked out" and "it was straightforward that currency and demand deposits were the two main ways of effecting transactions in the United States" (B. Friedman 1993). Earlier in 1978 the Federal Reserve had proposed a new system of reserve requirements based more narrowly on "transactions balances", and this was the same system the Congress passed as part of the Monetary Decontrol Act of 1980. Again M1 was at the center of all these monetary developments.
But at the very time that this was happening, around 1974, various specifications of money demand, including short-run and long-run models, began to break apart. The widely differing estimates of income and interest elasticities show a specification problem that is more complicated than estimated prediction errors indicated. This has led many people to question the empirical regularity of money demand and to wonder where the "missing money" was. Suddenly the extent to which money growth targeting guided monetary policy became unclear, and in 1982, with many difficulties encountered, the FOMC abandoned their "monetarist experiment."

2.1.2 From "Missing Money" to "Falling Velocity"

To translate the demand for money function into one describing velocity is to assume an equality of the demand for and supply of money. While the instabilities in money demand were only considered an aberration in mid-1970s, the exact effect did not come into full view until the problem of falling velocity was recognized in 1982. By that time the nation's GNP growth was so weak relative to the pace of monetary expansion that the velocity of money - the ratio of GNP to M1 - dropped significantly below its historical trends. The problem of "missing money" was easily supplanted by a more serious problem of "falling velocity", and

---

6 The first manifestation of the problem of "missing money" within a policy making framework occurred following the 1973-74 recession. During that time business recovered sharply "despite M1 growth normally would have been consistent with a much slower advance of nominal income." (See, for example, B. Friedman 1993). The problem was first exposed by Goldfeld (1976) in an influential paper of the same title "The Case of the Missing Money." See also the survey article of Judd and Scadding (1982) for a comprehensive discussion of papers published after 1973 of this particular episode of unstable money demand in the United States.
since then, the world of monetary policy making in the United States was never the same again. In fact, had the velocity growth not shifted in 1982, nominal GNP growth would have been substantially higher, and the recession presumably would not have been as lengthy or as severe (Tatom 1983). The Council of Economic Advisers, in its 1982 report, implicitly echoes the same concern:

The presumption, on the basis of past experience, is that most velocity changes are temporary. Thus, increasing the rate of monetary growth in response to temporary declines in velocity runs the risk of providing excessive liquidity and increasing inflation, while a failure to recognize a continuing shift in liquidity preference or velocity runs the risk of providing inadequate liquidity and reducing real GNP. (p. 22)

Figure 2.1 shows that the behavior of M1 velocity after 1982 was "historically atypical." Between 1959 and 1981, the velocity of M1 was relatively stable, with only a small break around 1973, just prior to the 1974-76 "missing money" period. On annual basis, it grew at an average of 3.2 percent rate with a standard deviation of 1.20 percent. In contrast, the M1 velocity fell at 2.9 percent per year during the 1982-86 period with a standard deviation of 5.67 percent (Rasche 1989). Indeed this velocity shift after 1982 appears rather substantial considering the almost stable velocity trends for the past thirty years.

Understanding velocity trends suggests that declines in velocity in the United States are not unprecedented.7 There have been occasions when considerable breakdowns in velocity have been noted. While the significance of earlier breaks cannot be appropriately

7 As William Poole (1988) indicates, analysis of velocity trends has a long history. For example, back as far as 1963, Irving Fisher wrote that improvements in communications and transportation would have a positive effect on velocity, while Friedman and Schwartz attributed the postwar rise in velocity to increased confidence concerning economic stability.
Figure 2.1

M1 VELOCITY: 1960.1-1991.4
dismissed, the recent breakdown is special for its intensity and persistence. Tatom (1983) provides evidence on the timing of velocity decline and economic recession between 1948 and 1982. In terms of sheer size, the growth of velocity during the 1981-82 recession was the largest at 4.3 percent. At the same time it registered the largest increase in the unemployment rate compared to other recessions with almost similar decline in growth rate of velocity.⁸

But still the 1982 velocity behavior, as Milton Friedman (1987) argues, is not fully understood. For if unstable velocity underlies the failure of monetarism, "then how the devil was it ever a success back during the period (1946-70) when the variability of velocity was much greater than it is in (1982)?" In his view the decline in velocity was caused primarily by the increased volatility of money growth following the change in Federal Reserve's operating procedures in October 1979. The shift in operating targets from federal funds rate to nonborrowed reserves has increased the degree of uncertainty in the economy and thereby caused the public's demand for money to shift upwards. The problem, according to Friedman, is not the absence of a good model to explain the movements in velocity in recent years, but the fact that a major source of fluctuations in velocity has been the fine tuning attempts by the Fed to influence the situation. Based on this, the velocity decline does not, in any way, undermine monetarism; instead, it strengthens the monetarist proposition of a constant growth rule of the money supply. In the words of Friedman (1987):

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⁸ Actually, except for the 1973-75 recession, the growth rate of velocity was negative in the last eight recessions. Tatom considers the velocity movements in the 1973-75 recession more anomalous (than the recent break) when the money demand significantly shifted downwards during the period. For other details of velocity change in historical perspective, see John A. Tatom's article in Review (August/September 1983).
The point I want to make here is simple. We cannot look at (the) chart and then go around talking about the terrible movements in velocity of recent periods have disconfirmed everything that those of us who have been studying money for some 30 years have concluded from the past. Therefore the real issue is not monetarism versus fiscal policy. The real issue is fine tuning versus establishing a stable framework of both monetary and fiscal policy to which the economy can adjust. And let's by all means draw the conclusion that the instability of velocity means that we cannot depend on short-term movements in money. The problem is the implication that there is something else we can depend on. (p. 15)

While Friedman's volatility hypothesis may be correct (Mascaro and Meltzer 1983, Hall and Noble 1987, Marlow 1991), the evidence in the post-1979 data suggests the contrary. Four years after Milton Friedman reaffirmed the reliability of M1 as an indicator of aggregate demand despite the acceleration in time lag, Benjamin Friedman (1988) has countered with new evidence showing the full extent of the collapse of M1's relationship to both income and prices. The correlation of money, income, and prices in 1979-82, a period in which the high volatility in money growth is observed, did not only drop in value (as in the case of M1 and inflation) but also showed the absence of any statistical significance at all (as in the case of M1-GNP relationship). Indeed to accept the weakness of velocity in 1982 as a mere historical aberration has been anything but reassuring.

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2.1.3 The Changing Financial Environment and Reasons for M1 Velocity Decline

As earlier mentioned, the monetary environment in the 1980s has created some conditions that were to have an impact on the formulation of monetary policy during the period. In fact, a number of economists point to the deregulation of financial sector in the United States as an important factor for the unusual decline in velocity. It has been argued that financial innovations\(^\text{10}\) that affect the availability of financial assets and the opportunity costs of holding money balances have altered the relations between the monetary aggregates and broader economic conditions.

A combination of market developments and regulatory reforms characterized the rapid changes in financial system under the Monetary Decontrol Act of 1980. Most important of these is the introduction of new or modified financial assets, including assets that can be used for making transactions. In the 1980s, the Fed has broadened the definition of M1 to include other checkable deposits (OCDs) - primarily composed of negotiable orders of withdrawals (NOW accounts), automatic transfer service (ATS accounts), and credit union share drafts.

\(^{10}\) It must be emphasized, however, that financial innovations did not occur only in the 1980s. The changes in the financial system that were implemented over the earlier decade and a half are also well known. During the 1970s, for example, most of the important innovations (such as new and interest-bearing assets like money market mutual funds and overnight repurchase agreements) tended to reduce the demand for M1, in sharp contrast to innovations of the 1980s that may have increased M1 money demand. The high and variable interest rate of the 1970s had caused a significant shift to these new assets, thus reducing the demand for M1. For a discussion of this issue on financial deregulation, see James L. Pierce, "Did Financial Innovation Hurt the Great Monetarist Experiment?" American Economic Review, May 1984, pp. 392-96. See also Andrew B. Abel and Ben S. Bernanke, Macroeconomics, 2nd edition, 1992.
At the same time, the rapid growth of NOW and ATS accounts coincided with large inflows of other liquid assets such as savings deposits, money market deposit accounts (MMDAs), and money market mutual funds shares. It has been suggested that such inflows have distorted M1 demand compared to its historical determinants. Lindsey (1982) estimates that in 1981, for example, a year after the nationwide introduction of NOWs, the actual velocity of M1 grew slowly relative to the trend abstracting from the effects of OCDs. The M1 velocity would have been higher by a 2.75 percentage points if OCDs had never been introduced.\textsuperscript{11}

Related to this are the effects of market interest rate on the cost of holding money. Traditional theories of money demand identify interest rates as one principal determinant of velocity, such that a decline in the interest rate will cause the demand for money to rise relative to GNP and consequently velocity to fall. Popular discussions indicate that the financial innovations of the 1980s have altered the sensitivity of M1 balances to interest rates. In particular, financial innovations produced new and close substitutes for deposit and currency components of M1 and heightened the sensitivity of these components to changes in interest rates.

It is reasonable to believe that velocity trends have responded to these changes in interest rates. The problem with a high interest elasticity of M1 is that, given a small decline in the interest rate to influence M1, income will not be expected to change significantly

\textsuperscript{11} Lindsey also provides estimates of growth rates of velocity of other monetary aggregates. See David Lindsey, "Recent Monetary Developments and Controversies," Brookings Papers on Economic Activity 1982.
because a small reduction in interest rates has little impact on spending, thus causing M1 velocity to drop unexpectedly. Rasche (1989) is able to show this relation by examining regression equations for the changes in the log of M1 velocity and changes in nominal interest rate, each against a constant and a dummy variable, for the period beginning in December 1981. His results indicate that a substantial drift in M1 velocity in the early 1980s moved in the same direction as that of the observed drift in nominal interest rates, both for long- and short-term rates. It's also possible, according to Bazdarich (1987), that the disinflation process in the United States in the 1980s has contributed to structural shift in the demand for money function. Since 1981 a sharp drop in velocity relative to trend has occurred given a very abrupt drop in inflation rate. In contrast, the slow but steady increase in velocity of the 1960s and 1970s is also consistent with a steady acceleration in inflation over the same period. When inflation (and presumably inflationary expectations) is declining, the demand for money should rise if deposit rates are rigid, and the velocity of money should fall. It has been argued that disinflation and the associated decline in market interest rates substantially reduced the opportunity costs of holding money relative to GNP. Such being the case, the falling velocity of the 1980s can be explained by this disinflation-type phenomenon (Judd 1983, Tatom 1983a, 1983b).12

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12 Empirically, Rasche (1989) also investigates the hypothesis that the observed change in velocity behavior is a result of a break in inflationary expectations. He argues that if the postwar period through 1980 is characterized by a steady upward drift in inflation, then it is reasonable to conjecture that it has been associated with the observed positive drift in nominal interest rates. Moreover, he argues that if inflation expectations stabilized at a lower rate in the early 1980s, it is reasonable to conclude that there has been no drift in interest rates over this period.
While much of the literature has treated the 1980s velocity puzzle as a consequence of financial innovations, the empirical evidence does not seem to bear on these issues. More than a decade has passed since the "great velocity decline" but a consensus has yet to emerge to fully explain it.

2.1.4 Implications of Unstable M1 Velocity

The quantity theory of money states nominal income is equal to money stock multiplied by its velocity. If velocity is stable, changes in money stock may have predictable effect on real output or prices (or both) in the short run, but will result primarily in price level changes in the long run. Thus, from a perspective of monetary policy, the reason for desiring a reasonably stable velocity is clear: growth in money supply can be used to stabilize nominal income growth.

Milton Friedman presented evidence of close relation between the growth rate in M1 and in nominal GNP for the period 1979-83. Most striking is the one-to-one relation between ups and downs in M1 growth and in GNP growth one quarter later, with a correlation of .45 for the period as a whole. Stronger evidence is made when the analysis is extended backwards for longer periods. The relation between the growth rate in M1 and in nominal income suggests a correlation of .72 from 1871 to 1981, or .75 for the 24 years from 1960 to 1983. After recognizing the robustness of his results, Friedman writes: "Two things are notable about the relation between money and income in these years: first, the lag is both shorter on the average and less variable in earlier years, second, the relation is unusually close. I believe that both are a consequence of the exceptionally large fluctuations in M1 growth.
The effect was to enhance the importance of the monetary changes relative to the numerous other factors affecting nominal income and thereby to speed up more consistently the reaction" (p. 399).

However, in the 1980s, the same predictable relationships that were previously taken to support a central role for money did not hold up. After 1983, the volatility of M1 money growth rate did not only remain high, but a positive correlation between lagged M1 and nominal GNP completely fell apart. Indeed a negative correlation of .10 between lagged M1 and GNP was very unusual.

Empirical evidence of a deteriorating money-income relationship are even more compelling. Studies incorporating a St. Louis-type,13 reduced-form equation, suggest a systematic overprediction of GNP growth when fitted for data in the 1980s. In fact, the forecast of errors was greatest after 1982 when a number of financial innovations were introduced and the Fed had de-emphasized M1 as a policy guide (Simpson 1984). Moreover, using the same St. Louis equation estimated for another period 1960.1-1979.3, Benjamin Friedman was able to show that the inclusion of data in the 1980s significantly reduced the equation's coefficient of determination, from .32 (for samples estimated in 1960.1-1979.3) to .11 (for the period 1960.1-1986.4), and to .02 (for samples without the 1960s, 1970.3-1986.4).

13 The well-known St. Louis reduced-form equation as introduced by Andersen and Jordan (1968) relates growth in nominal GNP to contemporaneous and lagged growth in M1 and a fiscal variable. This approach allows for lags between changes in money and income, and thus forecasts from such an equation should be affected less than velocity by large variations in money growth (Simpson 1984). It is assumed that when the coefficients of the St. Louis reduced-form equation are constant over time, the predictive ability of M1 to predict growth in nominal GNP is thereby enhanced.
One explanation is that the nationwide availability of NOW accounts has altered the interest sensitivity of M1 and consequently the cost of holding money. Moreover, the introduction of money substitutes such as repurchase agreements and certified deposits has caused a surge in demand for M1 since 1985. Taken together, these developments imply a downward shift in the M1 velocity growth rate and as a result the assumption of stability implied in the St. Louis equation is no longer plausible, thereby weakening at the same time the stability of M1-GNP link (Baghestani 1990).¹⁴

Similar evidence of a breakdown in relation between M1 and nominal GNP can be found in predictions derived from money-demand models. While a Goldfeld-type money demand equation performed quite well prior to mid-1970s, its behavior became erratic in the 1980s as shown by sizable underpredictions that occurred in 1982 and 1983. For example, between 1974 and 1986, the size of the standard error of estimate was increased to .84 percent. In contrast, a smaller error (.42 percent) was registered in 1952-79, but extending the period further to 1986 only raised the standard error to .61 percent. Indeed attempts to come up with better representations of money-income relationship in the 1980s "have met at

¹⁴ Specifically, Baghestani notes that the observed downward shifts in intercept term (one for 1981.2-1983.1, and the other for 1985.3-1987.3) presumably led the Fed to deemphasize M1-targeting in October 1982 and abandon M1 since 1987. Estimates from St. Louis reduced-form equation for the period 1962.1-1987.4 indicate that the immediate and first period effects of growth rate of M1 on nominal GNP growth rate are no longer significantly different from zero. Thus Baghestani concludes that the St. Louis equation should be respecified to reflect the effect of financial innovation on the stability of M1-GNP link. For other evidence, see Simpson (1984), Porter et. al. (1979), and Garcia and Pak (1979).
best with very limited success." In the meanwhile, the same story is approximately the same for money-price relationship.

2.2 M2 Velocity in the 1980s

In 1987, doubts about the stability of future M1 velocity growth have shifted emphasis of the Federal Reserve away from M1 and towards the broader aggregate M2 as a monetary target. The reason being that the behavior of M2 offers more useful information about nominal aggregate demand and thus allows monetary policy actions to have more predictable impact on domestic economy.

2.2.1 M2 Velocity and Its Opportunity Cost

The use of M2 as an intermediate target by the Fed is motivated, in part, by the perceived stability of M2 velocity. As shown in Figure 2.1, M2 velocity appears to be unaffected by changes in the economic environment in the 1980s. Although the measure at times has fluctuated significantly above its long-run average for several years, it is essentially trendless both before and after the early 1980s. This tendency of M2 velocity to fluctuate around a constant level since 1955 confirms the predictability of this measure (Figure 2.2).

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Figure 2.2

M2 VELOCITY: 1960.1-1991.4
Perhaps one reason why M2 velocity is trendless, despite the observed trends in interest rates that could have disrupted the demand for M2, is the close positive correlation between M2 velocity and its opportunity cost, measured as the spread between the yield on a short-term Treasury security and the weighted average return on M2. Over a longer period through the late 1980s, the observed movements in M2 velocity from its long-run average appear to be accompanied by comparable movements in M2 opportunity cost (Figure 2.3). The fact that M2 opportunity cost has the tendency to always return to its long-run average level may also provide "an economic rationale for M2 velocity to do the same" (Hallman and Anderson 1993).

The implication of this on a stable growth for M2 demand is clear. In the case where rates on the components of M2 can not adjust as fast as changes in market rates, the increase in opportunity cost of M2 would result into slower money growth relative to income growth, and consequently, velocity would increase. However, once the rates of M2 ultimately adjust point-for-point with changes in market rates, M2 opportunity cost would begin to narrow, and as M2 growth rises relative to income growth, M2 velocity is also expected to move toward its trend level. In such a case, the opportunity cost is stationary around a trendless differential, and the velocity of M2 will also be trendless. Since the opportunity cost of money would not change, both the M2 demand and velocity would be independent of changes in interest rates. Thus in the long run interest rate trends would not affect M2 velocity.

However, in the short run where changes in the opportunity cost of M2 are largely driven by changes in market rates, M2 demand will still be affected by any change in interest rates. The reason being that as the rates of various components of M2 adjust instantaneously
Figure 2.3

M2 OPPORTUNITY COST: 1960.1-1991.4
but only partially to changes in market rates, both M2 velocity and its opportunity cost would
move in the same direction. Research on money demand provides evidence that M2 in the
1980s partially responded to the relationship of deposit rates to changing market rates.
However, unlike the demand for M1, the deregulation and financial innovations in the 1980s
has not altered the behavior of M2.$^{16}$

2.2.2 The Stability of M2 Demand

A stable demand for M2 implies the existence of small unpredictable changes in M2
velocity relative to changes in nominal income. Equivalently, if demand for M2 can be
predicted using a small number of variables, then M2 offers useful information that can be
exploited to influence the growth of nominal expenditures. This condition is reasonably well
satisfied for many years. Since the founding of the Federal Reserve in 1913, M2 and nominal
income have grown at approximately the same rate, suggesting the existence of a relatively
simple and enduring relationship between the two (Carlson and Byrne 1992). Table 2.1
suggests that over the last three decades, movements in nominal GDP in the US are positively
related to lagged growth in M2 money stock. For example, for the period 1980-88, the

$^{16}$ To further explain this point, the rates paid on various components of M2 [such as
small time deposits, money market deposit accounts (MMDAs) and money market mutual
funds (MMMFs)] change promptly with changes in market rates. In contrast, the rates paid
on NOWs and savings deposits change only slowly as market rates change. Thus, when
market rates fall, the attractiveness of holding NOWs and savings deposits is increased as
the spread between market rates and the rates they offer narrows. Consequently individuals
substitute out of small time deposits, MMDAs and MMMFs into NOWs. However, since all
these deposits are within M2, the increase in demand for NOWs is simply offset by reduced
demand for other deposits, leaving the total demand for M2 unchanged. See, for example,
Hetzel (1989) for a discussion of this issue.
average annualized growth rate of M2 lagged two years (9.0 percent) corresponds well to average annualized growth rate of 7.8 percent for nominal GDP. Between 1989 and 1991, the average annualized growth rates of income (5.0 percent) and lagged M2 (5.2 percent) became fairly closer (Hetzel 1992). The strong M2-GNP link is consistent with the greater emphasis by the Fed to target M2 than other monetary aggregates, "at times suggesting that relationships based on M2 may (now) be settling into a new, more usefully exploitable stability after a period of disequilibrium due to changing market structures" (B. Friedman 1993). In addition, it has been argued that M2 outperforms potential new candidate measures of money.

The empirical evidence for a stable M2 money demand are equally reassuring. Moore, Porter and Small (1990) specify a short-run M2 demand in the United States using an error correction framework. This specification involves a long-run equilibrium money demand function and a dynamic error correction adjustment. In this approach, the long-run relationship between M2, income, and opportunity cost is first estimated in levels, and the estimated residuals from this equation are then used in an error-correction model to specify the system's short-run dynamics. If the coefficient on the error correction term is negative, then the short-run convergence of M2 to its equilibrium value is expected. This implies that M2 velocity is stationary with a tendency to always return to its long-run trendless value.

---

17 Interestingly, both M2 and nominal GDP growth rates remained close despite the deregulation and financial innovations in the 1980s. During the deregulation years (1966-80), the average growth rate for nominal GDP is 9.2 percent while 8.7 percent for M2. Since then their growth rates have slowed down - averaging 6.1 percent and 6.7 percent, respectively. See Dewald (1994).
### TABLE 2.1.
GROWTH RATES OF NOMINAL GDP AND M2 LAGGED TWO YEARS

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP Growth (Annual)</th>
<th>M2 Growth (Annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>11.8</td>
<td>12.1</td>
</tr>
<tr>
<td>1974</td>
<td>8.1</td>
<td>12.5</td>
</tr>
<tr>
<td>1975</td>
<td>8.7</td>
<td>9.9</td>
</tr>
<tr>
<td>1976</td>
<td>11.5</td>
<td>6.1</td>
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<tr>
<td>1977</td>
<td>11.6</td>
<td>9.3</td>
</tr>
<tr>
<td>1978</td>
<td>13.1</td>
<td>13.0</td>
</tr>
<tr>
<td>1979</td>
<td>11.5</td>
<td>12.7</td>
</tr>
<tr>
<td>1980</td>
<td>8.8</td>
<td>8.5</td>
</tr>
<tr>
<td>1981</td>
<td>11.9</td>
<td>8.3</td>
</tr>
<tr>
<td>1982</td>
<td>3.9</td>
<td>8.0</td>
</tr>
<tr>
<td>1983</td>
<td>8.1</td>
<td>9.4</td>
</tr>
<tr>
<td>1984</td>
<td>10.9</td>
<td>9.3</td>
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<tr>
<td>1985</td>
<td>6.9</td>
<td>12.5</td>
</tr>
<tr>
<td>1986</td>
<td>5.7</td>
<td>8.2</td>
</tr>
<tr>
<td>1987</td>
<td>6.4</td>
<td>8.9</td>
</tr>
<tr>
<td>1988</td>
<td>7.9</td>
<td>8.2</td>
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<tr>
<td>1989</td>
<td>7.0</td>
<td>6.6</td>
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<tr>
<td>1990</td>
<td>5.1</td>
<td>5.2</td>
</tr>
<tr>
<td>1991</td>
<td>2.9</td>
<td>3.9</td>
</tr>
</tbody>
</table>

SOURCE: Hetzel (1992)
Between 1961-86, it was found that a short-run money demand based on this specification is relatively stable. Despite the financial deregulation and disinflation that occurred in the 1980s, both the in-sample and out-of-sample forecasts of the model are able to predict M2 growth precisely. But perhaps a more significant result of the model is the evidence of large short-run interest elasticities of M2 demand. Moore et. al. have shown not only the differential adjustment in rates of different components of M2, but have also argued that the sluggish adjustments of M2 deposit rates relative to market rates have substantial short-run effects on M2 demand, and consequently on its velocity. Since changes in the market rates more or less reflect similar changes in M2 opportunity cost, one might expect the demand for M2 to be relatively stable in a sense of M2 velocity being stable.

Further evidence concerning the stability of M2 is presented by Mehra (1991) using the same approach of error-correction and cointegration. Over the postwar period, the results of stationarity tests indicate that the M2 velocity series tends to gravitate around a fixed value. While the divergence between real M2 and real income can occur for some years, the divergence between the two series does not grow over time and, more importantly, they seem to form a cointegrating relationship in the long run. Once again this confirms the strong link between M2 and nominal income and is consistent with other studies that used different forms

18 Actually the innovation of the MPS model lies in the way in which the opportunity cost is measured. Unlike in earlier studies of demand for money, in which the cost of holding money is simply defined as the interest income foregone, the opportunity cost in MPS model is given by the spread between the three-month Treasury bill rate and the average weighted return on M2. This definition seems appropriate during the 1980s where explicit interest payments on some types of deposits were allowed for the first time. Since then most empirical studies on money demand have adopted this definition of opportunity cost as originally described in the MPS model.
of error correction procedures to establish the stability of this ratio of M2 to income (Ramey 1993, Feldstein and Stock 1993).

More recently also Hetzel (1992) has examined the parameter stability and prediction errors from estimated M2 money demand equations from 1919 to 1991. Similar to the model estimated by Friedman and Schwartz (1982), real M2 is regressed on real output and opportunity cost variables measuring the rate of return on financial market assets and on physical assets. The overall results support the existence of historically stable demand for real M2 in both levels and first differences, with estimated prediction errors of 2.2 percent and 1.0 percent, respectively. In particular until 1988, changes in real income and opportunity cost provide systematic changes to real demand for M2 although prediction errors started to increase in late 1990.

Implicit in the stability analysis of M2 is the usefulness of this aggregate in influencing US monetary policy actions in most recent years. Within the Federal Reserve System M2 has assumed an important role in policy analysis that was once accorded to M1 in previous decades. This increased confidence in M2 can be gleaned from the Fed's P* model of inflation, which shows a reliable long-run link between M2 and the price level. The model is motivated, in part, by the stability of M2 velocity which according to Hallman, Porter, and Small (1991) provides a basis for choosing M2 as the most reliable anchor for the price level. Thus, essentially the future price level can be determined by the future courses of only M2, potential real GNP, and long-run velocity. The model's empirical results appear to be encouraging. For one, the model outperforms a simple version of the more traditional
approach that relates changes in inflation to the "output gap." Moreover, the model's coefficients are stable over a 33-year period.

2.2.3 The Recent Behavior of M2 and Nominal Income

The predictability of M2 and its velocity for most of the 1980s makes M2 a useful definition of money for monetary policy. But recent behavior of M2 suggests that the relationships between M2 and variables such as interest rates and income began to go off track. Since late 1990, the growth of M2 appears to have slowed down, resulting also in the growth of nominal GDP that is slower than anticipated. Moreover, M2 velocity rises above its long-run average (1955-89) despite the observed drop in M2 opportunity cost during the same period. Collins and Edwards (1994) estimated that between 1991.1 and 1993.4, M2 demand was overpredicted by an average of 2.5 percentage points per quarter or roughly about $380 billion by the end of 1993.

One popular explanation that is advanced to account for this unexplained weakness in M2 in the last two years is the restructuring of thrift industry in 1988. Economists (Carlson and Parrot 1991, Duca 1993) who believe in this explanation argue that the thrift restructuring altered the pricing behavior of most deposits that were previously controlled by the thrift institutions. Prior to the thrift industry restructuring, deposit rates in savings and loans are relatively higher than market rates. But when thrift deposits are liquidated and old contracts abrogated, suddenly the above-market rates offered by the thrifts are no longer available. As a result, the opportunity cost of holding M2 balances increase and depositors
transfer funds out of M2 into other investments like bonds and equity mutual funds that yield higher returns to consumers (Anderson 1994).

This overprediction of M2 demand (underprediction of M2 velocity) immediately raises questions about the stability of broad monetary aggregate and its relationship to nominal income. For one, there are those who view the recent behavior of M2 as an indication that M2 may not be an appropriate monetary target at all (Higgins 1992) and that other reliable aggregates should be considered (Poole 1991). There are also others who suggest that, on empirical grounds, the recent weakness in M2 is a sign of parameter instability inherent in M2 money demand (Baum and Furno 1990).

Yet, as M2 advocates argue, the weakening of growth rates of M2 and nominal income in the last two years is only temporary. Despite the rise in output growth that is attributed to M1 growth in recent recovery from 1990-91 recession, M2 remains a good predictor of income. As Thornton (1994) elaborates: "... the recent rise in output growth is a normal cyclical pattern unrelated to monetary policy, and that the recovery was unusually slow because monetary policy, as reflected by the slow growth of M2, was unduly restrictive." On the other hand, according to Hetzel (1992), the unpredictable changes in real M2 money demand in recent years do not really undermine the changes in nominal expenditures. This is because the magnitude of unpredictable changes in the demand for real

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19 Some of these proposed aggregates include MZM (M2 less small time deposits plus assets of institution-only money market mutual funds), M2E (M2 plus assets of institution-only money funds), M2BF (M2 plus bond mutual funds), and the most recent M2+ (M2 plus household holdings of bond and equity mutual funds). For a critique of these measures, see Collins and Edwards (1994).
M2 is relatively small in comparison to the magnitude of changes in other determinants of nominal income - i.e., changes in nominal M2 and predictable changes in M2 velocity.

It's also possible that the behavior of M2 is affected by the financial changes that occurred recently in the United States (e.g., restructuring of savings and loan industry). Carlson and Parrot (1991) argue that because of thrift restructuring the pricing behavior of individual deposit components within M2 is changed and consequently the true opportunity cost of holding M2 balances. Earlier models of M2 demand (such as the MPS model of Federal Reserve System) measure M2 opportunity cost as the difference between the short-term Treasury rate and the weighted average return on M2. The problem is this measure does not capture the change in deposit pricing behavior due to restructuring.

Thus, Carlson and Parrot develop an alternative model to MPS by using a different measure of M2 opportunity cost defined as the weighted average of differences between each M2 component and market interest rate of comparable maturity. A thrift deposits variable is also included to account for deposit pricing effects. The results of fitting these variables in an error-correction money demand equation are consistent with the view that the recent weakness of M2 is related to thrift restructuring. Both the changes in a new measure of M2 opportunity cost and in thrift deposits are able to explain the adjustment of money demand to its long-run equilibrium level.

Feinman and Porter (1992) work on the same approach of redefining the opportunity cost similar to that of Carlson and Parrot. Their model shows that money demand is significantly determined by the yields on long-term Treasury instruments and consumer debt, and that the weakness in M2 demand can be explained by a steep yield curve. Another
approach expands the dependent variable to include the public's holdings of bond mutual funds. For example, Duca (1993) found that both the assets of bond mutual funds and RTC activity helped explain the missing M2.

We conclude by posing the same question: how useful is M2 as a monetary target? The evidence we have gathered so far suggest that the demand for M2 is relatively stable and is still a good predictor of income despite its weak performance during the most recent business cycle.

2.3 The Dollar and the US Economy

Another important aspect of policy making in the 1980s is the increased recognition of the role of international factors under the flexible exchange rate system. It has been argued that as the economies in the world become highly integrated, the domestic policy setting must be able to reflect the complications arising from international factors. There is little disagreement that the US economy now is relatively more open than before and that movements in exchange rates in recent years have had strong influence on the domestic aggregate demand.

2.3.1 The US Experience Under the Floating System

When the Bretton Woods adjustable-peg system was abandoned in March 1973, a renewed optimism for achieving domestic macroeconomic control dawned upon the world economy. Much of the criticism against the fixed system is that it undermines the ability of domestic economy to insulate itself from disturbances originating abroad, and these
constraints on independence have probably hindered individual nations' decisions about
domestic macroeconomic stability. Thus, when the new system of flexible rates was put in
place, a number of economists were convinced that "they are a means of permitting each
country to seek monetary stability according to its own lights, without either imposing its
mistakes on its neighbors or having their mistakes imposed on it" (Friedman 1953).20

The reason for a shift in consensus among policy makers is clear. In the 1960s the
world economy was almost at the brink of disintegration. Despite the sustained increases in
growth experienced by the US and Europe, the problem of large differentials in inflation rates
among countries had become insurmountable. With the US dollar as the key currency in the
world, the US had the advantage of setting the trend in world inflation rates at the expense
of other countries' autonomy to pursue their own macroeconomic policy. For example,
disturbances arising from fiscal and monetary policy actions are not immediately bottled up
under the pegged rates; instead, they indirectly affect the balance of payments and the level
of international reserves, and ultimately the control of domestic money stock.

Flexible exchange rates were then viewed as a necessary step in restoring order to the
world of international trade and finance by allowing countries to enjoy independence in
setting their domestic macroeconomic policies. Conceivably, the exchange rate policy and

20 Another classic academic case for flexible rates was made by Harry G. Johnson in "The
(June 1969), pp. 12-24. To quote Johnson's perceptive assessment of the system during the
late 1960s: "The fundamental argument for flexible exchange rates is that they would allow
countries autonomy with respect to their use of monetary, fiscal and other policy instruments
... The argument for flexible exchange rates can be put more strongly still: flexible exchange
rates are essential to the preservation of national autonomy and independence consistent with
efficient organization and development of the world economy."
(p.13).
monetary independence become reconcilable. By adopting a floating rate, the transmission of shocks from abroad will be cut and monetary authority in each country will be able to gain full control of nominal money stock that it sacrifices under a fixed rate system. So strong was the confidence placed on the flexible rate system that by the end of 1975 almost everyone believed that the system had worked reasonably well.

But experience has shown that the insulating properties of floating rates were exaggerated (Dornbusch 1983, Obstfeld 1985). Ten years after the insulation position of the floating rate was hailed as a success, the global economic and political environment had become more sensitive to persistent shifts in both nominal and real exchange rates. Whitman (1984) has argued that the shift from fixed to flexible rates "has simply rerouted the pathways by which disturbances are transmitted internationally." The indirect transmission that occurred under the fixed rate is simply dominated by more direct impact on relative prices, costs, and competitiveness of the current account under the floating system. At a most basic level, the degree of interdependence is even greater, if not the same.21

Perhaps a major reason to explain this is the failure of purchasing power parity to hold under the flexible system. Whether in its absolute or relative form, PPP does not conform well with the experience of the US under the floating rate and, in fact, is a "poor description

21 Obstfeld (1985) presents evidence confirming that a significant degree of interdependence has remained under the floating system. According to him, while the correlation coefficients of annual unemployment rates among US, Japan, and Germany were high under the fixed period (1960-72), a shift toward the flexible rates after 1973 did not seem to diminish the value of coefficients. Even after adjustments were made to eliminate the effects of the two major oil price shocks, the degree of correlation was still positive though slightly lower, for the US-Germany and Germany-Japan. For other details, see Maurice Obstfeld, "Floating Exchange Rates: Experience and Prospects," Brookings Papers on Economic Activity 2, 1985, pp. 369-460.
of the facts" (Dornbusch 1988). Throughout the floating rate era, the exchange rate of the dollar has deviated significantly from its PPP value and it appears that the large deviations in relative prices of traded goods in the US and in other countries undermine the strict validity of PPP. Certainly there was no expectation for the real exchange rate of the dollar to remain steady after the shift to the floating rate, but the unusually persistent fluctuations are more than what transitory departures from PPP can explain.

Theoretical explanations suggest two possibilities. For one, changing trade patterns as well as real shocks such as shifts in technology, preferences and commercial policies cause systematic changes in the relative price of traded and nontraded goods. A favorable increase in world demand for domestic goods, for example, is likely to result in higher relative price level in home country or a real appreciation of the exchange rate. At the same time, temporary deviations in PPP can arise as a consequence of sticky wages and prices. In the presence of long-term labor contracts and oligopolistic pricing in traded goods market, prices are no longer arbitrated and determined by law of one price. Instead they are being set by individual firms as a fixed and common markup over wages. With labor as the only factor, the relative price of domestic and foreign variants of the product in the world market is given by the relative unit labor costs measured in common currency. As a result the slow movements in wages (because they are assumed sticky) will be reflected point by point by changes in real exchange rate. Evidence of this failure of PPP to hold under the flexible

---

system has been documented by Frenkel (1981) for the 1970s, in which he argued that PPP has performed considerably worse for the US dollar than for other major currencies during 1973-79 period. But the evidence is particularly striking when the analysis is extended over a longer period of time. Figure 2.4 shows bilateral real exchange rates, measured as the US wholesale price index divided by the dollar value of the foreign wholesale price index, between the US and Germany and between the US and Japan from 1970 to 1991. The choice of this index is consistent with the fact that wholesale price indexes are dominated by tradable manufactures that are rather similar across countries. Hence bilateral comparisons of tradable goods prices can be made on the basis of these measures.

One immediate implication of Figure 2.4 is that the law of one price is not an accurate description of the behavior of exchange rates above. If exchange rates adjust so as to offset inflation differentials in traded goods sectors between countries, then the movements in the bilateral exchange rates should be relatively smooth. But the large swings in these measures over the twenty-year period indicate persistent deviations of US prices relative to prices in Japan and Germany, thus refuting PPP.

Further evidence of this failure of PPP is given by the correlations of the quarterly rates of wholesale price indexes (expressed in dollars) for the US, Japan, and Germany. The weak version of PPP predicts these coefficients to be approximately equal to one. But as Table 2.2 shows, the very low and even negative correlations (especially those involving the United States) only strengthen the view that prices of traded goods did not follow the law of one price.

Figure 2.4

TABLE 2.2.
CORRELATIONS OF INFLATION RATES EXPRESSED IN U.S. DOLLARS
1970.1-1991.4 (WPI, Quarterly Data)

<table>
<thead>
<tr>
<th></th>
<th>United States</th>
<th>Japan</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>-.084</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>-.111</td>
<td>.665</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Data Source: OECD Main Economic Indicators (various years)
Ever since Frenkel's analysis of PPP relationships in the 1970s, the behavior of real exchange rates in most countries has exhibited large variability over the years. While nominal exchange rates are expected to move with more flexibility after 1973, the unusually large movements of real exchange rates (in the range of 30 to 40 percent) do not appear to be a "realistic possibility." Mussa (1986) studies the movements in bilateral real exchange rates for major developed countries from 1957 to 1984, and concludes on the basis of his data, that real exchange rates during the flexible system are eight to 80 times higher than under a fixed system. Meltzer (1990) also finds the same pattern of variability in multilateral exchange rates using IMF data for selected countries. Both the changes in nominal and real exchange rates in his study appear to be highly correlated but are not closely correlated with changes in the ratio of price index numbers (as measured by wholesale prices and relative unit labor costs). He further shows that changes in nominal and real exchange rates under an adjustable peg system like the EMS tend to be less variable than those under a flexible system.

2.3.2 The Behavior of the Dollar and Effects of Domestic Policy

An examination of the dollar exchange rate for the United States since 1970s also reveals the same impressions. Figure 2.5 shows the trade-weighted nominal and real exchange rate of the dollar against the currencies of 10 industrial countries for the period 1970-91. Two important implications of the behavior of the US dollar rate immediately become clear. For one, movements in real exchange rate are dominated by movements in nominal exchange rate. Both values move together and by similar amounts over the twenty year period. For another, the real value of the dollar experienced an enormous swing. Since
Figure 2.5

TRADE-WEIGHTED DOLLAR EXCHANGE RATE: 1982.1-1991.4
the shift to flexible system in 1973 the dollar had depreciated sharply in real terms until 1980, and over a five-year period (1980.1-1985.1) rose by nearly 60 percent. Thereafter, intense real depreciation of the same percentage occurred until early 1987, and since then the dollar's exchange rates (both nominal and real) had returned to a similar range back where they left in 1979 (Meltzer 1993).

Strict purchasing power parity implies that changes in nominal exchange rate should be uncorrelated to changes in real exchange rates. This is because the adjustment in relative prices is reflected as differentials in nominal and real values of exchange rates. Yet, as shown in the evidence above, movements in nominal and real exchange rates of the dollar remain highly correlated over the years. One possible explanation is given by the effects of real disturbances in the economy. As a result of policy shocks that caused a divergence in relative price of domestic output, part of the adjustment in real exchange rate to this real shock is accomplished through a movement in nominal exchange rate. Interestingly this characteristic of the movements in dollar exchange rate is not only peculiar to the United States but is also shared by other major currencies operating under the flexible rate system.

The point of the foregoing analysis is that the large swings in the real value of the dollar in the 1980s may have been related to the effects of domestic macroeconomic policy actions, and not simply due to temporary deviations as implied in random walk model of real exchange rate. For if real exchange rate is a random walk, monetary and fiscal actions

\[\text{---}\]

\[23\] Random walk models posit that the real exchange rate is equal to its permanent component plus a transitory white noise term.
would not have persistent effects on real exchange rate. Instead the real exchange rate is expected to move to its equilibrium value after some transitory random variations.

An important discussion of the behavior of dollar exchange rate indicates that the real dollar appreciation in the early 1980s is an equilibrium reaction to structural shift in US budget position that began in 1982. Meltzer (1993) explains that as a result of an expansionary fiscal policy by the US during the four years of dollar appreciation (1981-84), the real value of the dollar rose by 44 percentage points due to substantial changes in defense spending and increased after-tax return to real capital in that period. On the other hand, the real depreciation of the dollar after 1985 is linked to a shift to more restricted fiscal policy position and a gradual build up of external liabilities resulting from large fiscal deficits.

In general, a fiscal deficit must equal the excess of domestic private spending over investment less net exports. It follows that to balance flows in income and product, any shift in structural deficit requires some adjustment in net domestic saving and current account. Since net domestic saving depends on real interest rate and net exports are a function of real exchange rate, an essential part of this adjustment to a fiscal deficit is a movement in both real interest rate and real exchange rate. Thus, an upward shift in fiscal policy as occurred in the United States beginning in 1981, necessitates a combination of increase in net saving or a decrease in net exports. To achieve this result a higher real interest rate and a real appreciation of exchange rate are required.

As earlier indicated, an increase in deficit must be financed either by an increase in the excess of domestic saving or an increase in net foreign borrowing (a decrease in net foreign investment). Since 1982 the US budget deficit has been mostly financed by net foreign
borrowing; in contrast, the fraction financed by net domestic saving has declined substantially since then. The effects of these fiscal shifts become clearly important when the actual changes in real interest rates and real exchange rates are analyzed. From 1980 to 1985, when the dollar appreciated by nearly 60 percent, the real interest rate increased from -3.4 percent in the first quarter of 1980 to 5.0 percent of the same quarter in 1985. Throughout the 1980s when real interest rates in the US are at their historical high levels of more than 4 percent, the budget deficit had jumped from $15.8 billion in the first quarter of 1980 (1.3 percent of GNP) to $94.7 billion in the last quarter of 1988 (2.4 percent of GNP).24 Related to the budget deficit is the existence of high trade deficit and capital mobility in the US during the 1980s. Popular discussions indicate a crucial role for the real exchange rate in the deterioration of the US trade balance in the 1980s. Feldstein (1992) has argued that the appreciation of the dollar has been the dominant influence in the declining trade balance during the first half of the decade. However, during the second half of the decade when the dollar had fallen enormously, everyone expected the trade account to exhibit a significant improvement. However the US trade problem did not seem to disappear. Suddenly popular sentiment shifted to excessive spending as a direct cause of the deficit, and the discussion has gone down again to fiscal policy issues.

Another important issue is the dramatic growth of capital mobility in recent years and the fact that international capital flows have transformed the US as a major debtor nation. More striking too is the extent by which foreign holders have increased their net acquisition of US financial assets (such as US Treasury bills), from a low 7.4 percentage share of capital

24 An earlier study of this issue is presented by Branson (1986).
inflows in 1983 to a significantly high 56.4 percent in 1985 (Tabellini 1990). One interpretation of this high capital mobility is the increased sensitivity of domestic financial markets to external developments. For many decades, for example, it has been known that in a Mundell-Fleming world of flexible exchange rates and perfect capital mobility, the effectiveness of fiscal policy in affecting domestic real output is reduced. Under fixed rates and perfect capital mobility, however, an expansionary fiscal policy is likely to increase the foreign exchange reserves and output in a domestic economy.

The main conclusion drawn from this section is that the actual shifts in fiscal position of the United States in the 1980s have contributed to the substantial swings in the real dollar exchange rate. However, this does not imply that other factors like monetary effects have not been at work in explaining the behavior of the dollar over the years. There is at least a reasonable basis to argue that the initial rise of the dollar in the first half of 1980s was influenced by the tightening of monetary policy in 1979-82 (Willet and Wilhborg 1990). But as is now well known, fiscal developments seem to yield useful more insights into the behavior of the dollar in recent years.

2.3.3 Exchange Rate Changes and Aggregate Demand

In general, concerns over variability of real exchange rate are motivated by the same goal of reducing fluctuations in output and prices brought about by misalignment problem. Demand shifts arising from real exchange rate variability may alter the allocation of resources and the economy's output mix. A rise in the value of the dollar, for example, is expected to depress the US output or inflation of internationally traded goods as the dollar value of income abroad is reduced. It is also likely that the world price expressed in dollars
would fall resulting in a redistribution of demand for traded goods from the United States to foreign producers. Such is the case of the dollar appreciation in the early 1980s as one recalls the damage done to US producers from which they have only partially recovered (Ohno 1992).

Empirical evidence of this link between real exchange rate and domestic output has been mainly concentrated on studies of manufacturing employment. Since the manufacturing sector produces goods that are traded internationally, the effects of exchange rate movements can be easily analyzed by observing changes in share of manufacturing employment to total nonagricultural employment. Branson and Love (1986) estimate the elasticity of manufacturing employment, by sector, to real appreciation of the dollar from 1963 to 1985. Their results indicate that fluctuations in the real exchange rate have had substantial effects on employment and output of US manufacturing industries, with an elasticity of employment with respect to real dollar appreciation of -0.14. Although the highest significant elasticity is found in mining sector (elasticity of -0.387), durable manufacturing is second with an elasticity of -0.206.

An earlier evidence presented by Obstfeld (Figure 2.6) confirms this demand-based linkage. As shown in the figure, the real dollar appreciation over the 1979-83 period was also accompanied by a sharp decline in US manufacturing employment. This ratio of manufacturing employment to total nonagricultural employment did not only decline from 1960 to 1984 in all three countries (US, Japan, and Germany), but is most pronounced in the case of the United States. While such evidence appears to have a strong implication on the relevance of exchange rate changes, Obstfeld still believes "that the relation between the real
exchange rate and the sectoral allocation of resources is not a simple one, but depends on the nature of the disturbance moving the real exchange rate" (p. 381).

In addition to their effects on output, widely fluctuating exchange rates have their links to domestic prices. The most common analysis of this linkage between the dollar and US prices involves an estimation of a single-equation model, in which the domestic price level is regressed against labor costs, demand pressure (unemployment rate), and import prices as explanatory variables. In this approach, increases in domestic inflation are indirectly affected by changes in import prices. When the value of the dollar falls, dollar prices of foreign goods increase relative to domestically produced goods. Since imports are part of the basket of goods that domestic residents purchase, measures of inflation based on that basket will also rise (Hafer 1989).

Studies that incorporate this approach are generally supportive of this link, even suggesting a long-run increase of 0.8 percent to 1.5 percent in consumer prices given a 10 percent depreciation of the dollar (Hooper and Lowery 1979). While the import channel may provide one explanation for analyzing the impact of exchange rate on prices, other economists argue that labor costs and demand pressure (as measured by unemployment rate) are also affected, after some lags, by changes in exchange rate. Therefore the total effect of exchange rate on prices will be greater than indicated by the direct effect on import prices alone.

Attempts to include these additional channels are captured by structural models that relate the effects of exchange rate changes on demand pressure and labor costs, and later on prices. Sachs (1985) uses different versions of this model and obtains larger estimates of dollar depreciation on US prices (for example, a 10 percent fall in the dollar is associated with

51
Figure 2.6

SHARE OF MANUFACTURING EMPLOYMENT IN TOTAL NONAGRICULTURAL EMPLOYMENT 1960-1984

SOURCE: Obstfeld (1985)
prices increases ranging from 0.42 percent to 2.56 percent across different years) while Dornbusch and Fisher (1984) come up with almost similar results. Most recently Whitt, Koch and Rosenweig (1986) have used two sets of specification tests (time series independence test and Granger causality test) and found a strong unidirectional relationship from the dollar to prices that extends over many lags, in which a 4.85 percent increase in CPI is preceded by 10 percent decline in the dollar. The results remain robust when tested for other components of CPI although the lag structures appear to affect the degree of price responses to exchange rate changes.

Yet, other empirical studies (Woo 1984, Glassman 1985) indicate a lack of relationship between exchange rate and prices. One argument is that the inflation rates associated with dollar depreciation are not related to exchange rate changes, but are actually caused by energy shocks. Once the effects of energy shocks are accounted for, exchange rate movements have no significant effect on US inflation. Moreover, since exchange rate movements are highly correlated with energy price shocks, the effects of exchange rates on domestic inflation are simply overstated.

2.3.4 Global Monetarism and the Behavior of US Income and Prices

Since the breakdown of Bretton Woods system in 1973, concern over the impact of world liquidity on domestic economy has increased tremendously. The degree of interdependence as implied by the floating system was much greater than previously thought, and suddenly the behavior of US prices and income was influenced by international considerations. Unlike in the earlier decades where the transmission of foreign sectoral

53
conditions to US economy was considered irrelevant, the 1970s and beyond had brought into new heights the increased importance of international factors on US economy.

One popular view is that the experience with widely fluctuating exchange rate over the past twenty years has aggravated the macroeconomic stability problem and has rendered differences in inflation preferences between the US and the world irreconcilable. As a result US macroeconomic policies become highly related with policies abroad. One possible scenario of such interaction is that the dollar value of world money supply may impact the domestic economy as a result of large and persistent swings in the dollar exchange rates. This does not only complicate the conduct of domestic policy but the management of domestic aggregate demand as well. As Dornbusch (1983) argues:

Now, after ten years of experience with flexible rates, there is much less confidence that flexible rates and domestic policy autonomy are reconcilable. On the contrary, the exercise of policy autonomy becomes nearly impossible under flexible rates, because many economies are too small and open to accept the exchange rate variations induced by a policy. Alternatively, the effects of policies with large economies are exported and interfere with foreign internal stability. What flexible exchange rates are still credited with is an ability to isolate a country from the world inflation trend, while it is recognized that they cannot isolate a country from either the effects of policies that initiate a change in trend or from any other disturbances. (p. 4)
Under global monetarism, international influences in domestic economy are reflected through changes in exchange rate or world money supply. Movements in exchange rates are most likely to influence the domestic price level of internationally traded goods as well as the world prices expressed in common currency. At the same time, the long-run path of world prices can be determined by that of the world money stock expressed in a common currency. Thus, a fall in the value of the dollar is expected to raise the dollar value of world money, which influences domestic price level.

The idea that fluctuations in domestic prices are partly dominated by shifts in world money supply is examined by McKinnon (1982) in numerous writings. According to him, in addition to indirect currency substitution, the national monies of major industrial countries are so highly substitutable that they actually create a world money supply. He estimates world money supply growth as weighted average of growth rates of individual money supplies of ten industrial countries (Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, and United Kingdom) and the United States without adjusting for exchange rate fluctuations. The fixed weights used are the relative share of each country's nominal GNP to world production in 1970. World price inflation is estimated by the same method.

Global monetarist writings in the United States were influenced by a group of international economists led by Robert Mundell, Harry Johnson, Arthur Laffer, Ronald McKinnon, and Marc Miles. Among their major arguments is the view that the US is just like any other small open economy that is incapable of implementing fully independent macroeconomic policies. Thus, in their opinion, a system of fixed rates is more compatible to the attainment of domestic monetary control. In contrast, the traditional (domestic) monetarist group advocates setting domestic monetary rules combined with flexible exchange rates. For a discussion of global monetarist issues, see "Global Monetarism and the Monetary Approach to the Balance of Payments" and other papers by Marina Vn. Whitman in Reflections of Interdependence (University of Pittsburgh Press, Pittsburgh, Pa), 1979.
manner. By comparing the resulting estimates of world money supply growth and price inflation, he concludes that "the two international outbreaks of international price inflation in the 1970s become explicable." Moreover, because of a high degree of substitutability between currencies of industrial countries, "one can't make sense out of year-to-year changes in the purely national monetary aggregates in explaining cycles in purely national rates of price inflation."

McKinnon further shows that world money has recently become a more important determinant of the US price level. He estimated the effect of percentage growth rates in domestic money and world money on US inflation rate for the periods 1958-69 and 1972-82 (annual data). His results are presented as follows:

1958-69:
\[
\Delta \ln P^u = -.094 + .32 \Delta \ln M^u + .21 \Delta \ln M^w_{-1} + .13 \Delta \ln M^w_{-2} \quad R^2 = .43
\]
\[
\quad (-1.35) \quad (-1.73) \quad (1.29) \quad (0.64)
\]
\[
\Delta \ln P^v = -3.15 + .45 \Delta \ln M^w + .21 \Delta \ln M^w_{-1} + .05 \Delta \ln M^w_{-2} \quad R^2 = .14
\]
\[
\quad (-0.92) \quad (1.04) \quad (0.66) \quad (0.15)
\]

1972-82:
\[
\Delta \ln P^u = 3.65 - 1.39 \Delta \ln M^w + 1.79 \Delta \ln M^w_{-1} + 1.60 \Delta \ln M^w_{-2} \quad R^2 = .37
\]
\[
\quad (.34) \quad (-1.00) \quad (1.25) \quad (1.50)
\]
\[
\Delta \ln P^v = -4.98 - 1.12 \Delta \ln M^w + 1.14 \Delta \ln M^w_{-1} + 1.45 \Delta \ln M^w_{-2} \quad R^2 = .82
\]
\[
\quad (-1.18) \quad (-2.63) \quad (2.83) \quad (4.68)
\]

In 1958-69, none of the variance in US prices was explained by world money. During this period of fixed dollar exchange rate, American monetary policy focused only on domestic monetary indicators as if the United States were an insular economy. The predictable effect of US money on American prices seemed to support a fairly close correlation in the 1950s and
1960s between changes in inflation rate and changes in the US money supply lagged one and two years. Consequently, this made it easy for the US monetary authorities to target the domestic money supply while ignoring foreign exchanges. However, from 1972-82, the effective insulation against foreign monetary disturbances that the US had enjoyed in the earlier decades suddenly disappeared. The growth rate in world money supply was able to explain 82 percent of variance in US inflation rate compared to only 37 percent in case of domestic money growth.

A subsequent paper by Ross (1983) challenges this assertion. Using simple correlations Ross demonstrates that over the period 1960-80, US money growth (M1) had higher correlations with US inflation measured by the wholesale price index (WPI) than did world money growth measured by the weighted average of nominal money growth rates of G-10 countries. McKinnon and Tan (1983) respond to this criticism by presenting evidence on domestic inflation for 1979-81, the period, according to McKinnon and Tan, to which McKinnon's earlier assertion was meant to apply. They find that percentage changes in world money lagged a year or two outperformed a similar specification of the US money in explaining US inflation, again measured by WPI.

Wallace (1984) argues however that McKinnon and Tan's results are sensitive to the price index used to measure inflation. His results show that, among others, US money outperforms world money in explaining US inflation when inflation is measured by the US consumer price index or the US GNP deflator. Perhaps part of the reason is that majority of goods measured in CPI are nontraded goods, for example housing and services. In sharp
contrast, traded goods are heavily weighted in WPI, which may explain the high correlation between world money and US inflation as measured by WPI.

Using a different approach of measuring world money, Spinelli (1983) adjusted the world money supply variable to changes in current exchange rates (in dollars). The same countries are included but this time world money is expressed in dollars. He estimated the effect of domestic and world money growth rates on inflation rate in each country during the floating period from 1973 to 1980. His results show that domestic money is a better predictor of domestic inflation in all the 10 countries (except France) included in his estimation. However, the inclusion of world money variable in the regression increased significantly the overall fit of the price regression in almost all countries. Therefore, Spinelli concludes that "when explaining inflation rate under flexible rates, first look at the growth rate of domestic money stock and then supplement the model with some proxy for world nominal shocks; under no circumstances should one use world money only" (p. 770).

The most recent evidence presented by Grilli and Yang (1991) likewise confirms the importance of world money in domestic economic activity. World money is measured as the summation of national money stocks, expressed in dollar terms, of the United Kingdom, France, Germany, Italy and the United States. According to them, prices of internationally traded goods rose significantly in nominal dollar terms between 1900 and 1983, substantially in line with the monetary conditions that prevailed in the world economy. World money supply per unit of output is found to be an important variable explaining both levels and changes in nominal prices of internationally traded goods. Results from regression analysis shows that the long-run relationship between world money and international prices is strong.
and statistically significant in all cases, as well as quite stable over time. Thus it is clear that regardless of the fitted equations, the sample periods, the estimation techniques, or the countries involved, world nominal shocks always seem to affect the rate of inflation.

However, as a result of large controversy concerning world money as a measure of international influences, McKinnon (1984) has recently shifted his emphasis to the exchange rate. Such a reformulation of the original McKinnon world money supply hypothesis is motivated by the fact that there are "lags in the collection of both foreign and American money supplies", and more importantly on empirical grounds, "fluctuations in the dollar exchange rate appear to be an important indicator of subsequent changes in nominal GNP and in the dollar price of tradable goods."

The results of using exchange rate as independent variable in the income growth equation for the US from 1972-82 are as follows:

\[
\Delta \ln Y^w = 3.92 + 1.68 \Delta \ln \text{Mus} - .77 \Delta \ln \text{Mus-1} \quad R^2=.28
\]
\[
\quad ( .86 ) \quad ( 2.62 ) \quad (-1.19)
\]

\[
\Delta \ln Y^w = 6.68 + 1.91 \Delta \ln \text{Mus} - 1.45 \Delta \ln \text{Mus-1} - .02 \Delta \ln \text{E}
\]
\[
\quad ( 3.11 ) \quad ( 6.27 ) \quad (-4.73) \quad (.30)
\]

\[
-.29 \Delta \ln \text{E-1} \quad \text{(-4.99)} \quad R^2=.87
\]

As shown above, the inclusion of exchange rate in the income suggests a significant increase in the proportion of total GNP variance explained within a year or so. This is evidenced by the fact that during the same period and given any time path in the US money supply, a 10 per cent appreciation of the dollar was able to predict a reduction in nominal GNP growth by 2.6 percentage points the following year. Such exchange rate effect, according to McKinnon, is
a reflection of shifts in effective demand for US money arising from indirect currency substitution.

That the dollar exchange rate can also be an important leading indicator of subsequent changes in American inflation or deflation is also borne by the evidence presented by McKinnon. In fact, both the world money supply and exchange rate appear to be equally important in determining the American price level. Himarios (1989) estimates McKinnon's model using quarterly data and finds significant effects of exchange rate on US GNP and PPI consistent with McKinnon's results which are based on annual data. Using a vector autoregressive model, Viren (1990) is able to support McKinnon's world money supply hypothesis but only finds a marginal effect of exchange rate on prices and nominal income. In contrast, Batten and Hafer (1986) reject the same evidence for the United States. There are also others who are skeptical of McKinnon's currency substitution hypothesis and argue instead that the extent of international influences on US economy is likely to be captured by traditional channels such as capital and trade flows (Radcliffe, Warga and Billet 1984).

As expected the empirical issue as to which is a better channel of transmission between world money and exchange rate still remains an open question. What is certain, however, is the fact the influence of international factors on the domestic economy is very much greater under the flexible exchange rate system than in the fixed regime. To the extent that existing economic conditions in the world have macroeconomic effects on aggregate demand and on prices, then an examination of these different channels of transmission deserves closer considerations.
CHAPTER 3
THEORETICAL FRAMEWORK

This chapter examines the interaction between money and exchange rates. The particular channels by which monetary policy affects the economy depend on whether on the monetary regime is based on fixed exchange rates or on flexible exchange rates (Hamada 1985). In the literature dealing with inflation in small economies, for example, considerable attention has been paid to the role that foreign monetary disturbances play in the generation of domestic inflation and the mechanism through which these disturbances are transmitted to the domestic economy under alternative exchange rate systems. The standard Mundell-Fleming analysis suggests that the effectiveness of monetary as well as fiscal policies in influencing domestic nominal income is constrained by the openness of the domestic economy (especially capital mobility) and the particular choice of exchange rate regime. Moreover, it can be argued that under the present system of flexible rates, considerable movements in exchange rates exert effects on domestic income in the short run, as the experience of the US economy in the 1980s has shown.

3.1 The Global Monetarist Model
The central proposition of the global monetary approach is that, under a regime of fixed exchange rates, the long-run path of world prices is determined by the path of the world money stock. Inflationary pressures in one country are transmitted across national boundaries through (a) the effect of changes in prices of traded goods; and (b) changes in national
monetary stocks brought about by the disequilibria in balance of payments. It implies, therefore, that all national rates of inflation must converge to a common rate assuming perfect goods arbitrage.

To show the international transmission of inflation under fixed exchange rates, consider a two-country model developed by Dornbusch (1973).

Let the desired nominal money balances in home country be

\[ L = kp\bar{y} \]

and a similar "Cambridge" demand for money function also for the foreign country

\[ L' = k'p'\bar{y}' \]

Taking the logarithms of (1) and (2) we have

\[ \ln L = \ln k + \ln p + \ln \bar{y} \]

\[ \ln L' = \ln k' + \ln p' + \ln \bar{y}' \]

where \( L \) is the money balances, \( k \) is the "Cambridge k", \( p \) is the price level and \( \bar{y} \) represents the exogenously determined full employment level of real output. Foreign variables are denoted by an asterisk.

In a world where all goods are traded goods, arbitrage ensures that goods prices in the home country and abroad are the same. Thus by virtue of purchasing power parity, the
The world price $p^*$ is exogenous to the domestic economy, being determined only by world money supply.

$$\ln p - \ln p^* - \ln e$$

where $e$ is the exchange rate, the domestic currency price of foreign exchange rate (in logarithm).

Assume that money is the only financial asset. When monetary stock equilibrium obtains, we assume that all income is spent. The excess demand for money ($\Delta m^d$) is equal to excess of income over total expenditures

$$\Delta m^d = p\bar{y} - pc$$

$$\Delta m^d = p'\bar{y}' - p'c'$$

Accordingly, the excess demand for money (the hoarding function) can be written as

$$\lambda (kp\bar{y} - m) = p\bar{y} - pc + h$$

$$\lambda'(k'p'\bar{y}' - m') = p'\bar{y}' - p'c' + h'$$

where $h$ and $h^*$ are the equilibrium rates of hoarding in each country and $\lambda$ and $\lambda^*$ are the rates of adjustment.

Equations (5) and (5a) represent the model's hoarding behavior as derived by Dornbusch (1973). The expenditure function provides the link between the monetary and
real aspects of the model. In the presence of a stock excess demand for money, expenditure falls short of income as the community hoards in order to attain the desired money balances, and the converse occurs in the presence of excess supply of money and this produces a balance of payments disequilibrium.

Equilibrium in the world goods market requires that world spending equals world income, or equivalently, the domestic rate of hoarding equals the foreign rate of dishoarding. Thus using the expenditure and hoarding functions in each country we can write

\begin{align}
(6) & \quad p\bar{y} + e\bar{p} = c - pe^*c^* \\
(6a) & \quad \lambda (kp\bar{y} - m) = -\lambda e(k^*p^*\bar{y} - m^*)
\end{align}

by adding (5) and (5a). Equations (6) and (6a) are the conditions for world goods market equilibrium expressed in terms of domestic currency.

The expression for the equilibrium inflation rate can now be derived by taking the differential of domestic price level \( p \) and exchange rate \( e \) in (6a), holding all other variables constant,

\begin{equation}
(7) \quad \dot{p} = \frac{\lambda^*m^*e}{\lambda m + e\lambda^*m^*} \dot{e}
\end{equation}

where \( p \) and \( e \) represent the relative change in domestic price level and exchange rate, respectively. Thus, a devaluation of domestic currency increases the domestic price level by the share of foreign money to world money stock expressed in domestic currency.
Similarly the impact effect of domestic money (m) and foreign money (m*) on domestic price can be derived as follows

\[
(7a) \quad \bar{p} = \frac{\lambda m}{\lambda m + e \lambda m^*} \bar{m} \\
(7b) \quad \bar{p} = \frac{\lambda m^* e}{\lambda m + e \lambda m^*} \bar{m}^* 
\]

If exchange rates are fixed and if they are expected to remain so, and assuming that domestic inflation rate is the same as world inflation rate by purchasing power parity \([\Delta \ln p = \Delta \ln p^* + \Delta \ln e]\), then the inflation rate in the home country is determined not only by the growth rate of the domestic money supply, but also by that of the foreign country.

Dornbusch also argues that the distribution of world money stocks determines in the short run the balance of payments. Consider an adjustment process that is induced through monetary flows. An inflow of money at home corresponds to an equal outflow abroad. Thus the equilibrium rate of hoarding in home country \((\bar{h})\) is the excess of income over spending, which is also the country's balance of payments surplus. Accordingly, from (6), the balance of payments surplus, \(b\), is a function of the distribution of money holdings between countries,

\[
(8) \quad b = \Delta m - \bar{p} \bar{Y} - \bar{p} \bar{c} - \bar{h} 
\]

In Figure 3.1, we show the equilibrium rate of addition to money holdings between countries. For the home country the hoarding schedule is drawn as a positive function of the price level. A higher price level raises money income and hence the demand for money.
Similarly, for the foreign country we show the rate of dishoarding or the excess of spending over income. At a lower price level there is a lower demand for money and this creates a stock excess supply of money which causes spending to increase relative to income.

Suppose initially that the world goods market is in equilibrium. This requires that the demand for money equals the supply of money in both countries. This equilibrium is shown at point A. Consider now the effects of an increase in the foreign money supply. Immediately foreign monetary expansion causes the domestic price level to rise and the new equilibrium now corresponds to a trade surplus in the home country. The surplus in turn implies an inflow of money at home and an equal outflow abroad. Accordingly, money holdings at home rise, as does the level of spending while we have the opposite effects in foreign country. At a given exchange rate the increase in the nominal quantity of money shifts the hoarding schedule up and to the right while the foreign dishoarding function shifts down and to the left. The money flows will continue until the long-run equilibrium is again obtained and the surplus is eliminated on the vertical axis. In the long run the new distribution of monies allows income to be equal to spending in each country.

This description of adjustment process highlights two features of the global monetary approach to the balance of payments that are worth noting. On the one hand, the balance of payments problems are essentially monetary in nature. The second is that the balance of payments surplus is equal to the flow excess demand for money. Clearly, under a fixed exchange rate case, domestic money growth is automatically linked to foreign money growth via the balance of payments. In the short run the world distribution of money stocks automatically determines the balance of payments, and aggregate demand depends not only
Figure 3.1

DOMESTIC AND FOREIGN EQUILIBRIUM RATES OF HOARDING

\[ \Delta m = h = eh^* \]
on the domestic money but also on the world money supply. Over the longer term the
distribution of money stocks is exogenous through the balance of payments.

3.2 The Flexible Exchange Rates and Insulation

Consider now a simplified model of equilibrium exchange rate determination. We
start off with the relationship between price levels and the exchange rate in (3), repeated here
for convenience,

\[(3) \quad \ln p - \ln p' = \ln e \]

Next we introduce the following definition of real balances,

\[(9) \quad \frac{m d}{p} = l(y, r) - m/p \]

\[(9a) \quad \frac{m d}{p} = l'(y', r') - m'/p' \]

where \(m, p, r, y\) denote the nominal quantity of money, the price level, nominal interest
rate and real income (in logarithms).

Taking the logs of (9) and (9a)

\[(10) \quad \ln l - \ln m - \ln p \]

\[(10a) \quad \ln l' - \ln m' - \ln p' \]

and substituting from these definitions into (3) to obtain the following equation for the
exchange rate

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Equation (11) shows that the equilibrium exchange rate depends on nominal money supplies and money demand in each country. Differentiating (11) and denoting a proportional change by \( \Delta \), we have

\[
\Delta \ln e = (\Delta \ln m - \Delta \ln l) - (\Delta \ln m' - \Delta \ln l')
\]

which is an outcome of the purchasing power parity.

That a system of flexible exchange rate offers more monetary independence is perhaps the most powerful motivation for a change in international monetary regime after the Bretton Woods collapsed in 1973. It is often maintained that flexible exchange rates are capable of insulating the domestic economy from foreign inflation. Thus, under flexible exchange rates, the balance of payments effects on money supply are blocked. Moreover, changes in the exchange rate could offset the effect of foreign inflation on domestic inflation operating through the law of one price.

Consider for example a monetary expansion in the home country under a flexible exchange rate regime. Assume initially that the nominal money stocks at home and abroad are constant, then at time \( t_0 \), monetary authorities in a home country increase the rate of monetary growth to 10 per cent per year. Eventually this also implies that the rate of inflation must rise to 10 per cent per year. The path of adjustment of money is shown in Figure 3.2a. If foreign prices are assumed to be constant, purchasing power parity now requires a 10
Figure 3.2
EFFECTS OF DOMESTIC MONETARY EXPANSION UNDER FLEXIBLE RATE SYSTEM

(a)

Domestic Money

Foreign Money
percent depreciation of the domestic currency against foreign currency to offset the 10 percent inflation.

In Figure 3.2b, we show that monetary acceleration in a home country causes the dollar value of money abroad to also increase primarily through exchange rate changes, and not to any changes in nominal money stock. Changes in the dollar value of foreign money exactly reflect the same changes in domestic money. Thus under flexible exchange rates and PPP, it is assumed that different countries can pursue independent monetary policies.

However, if we look at the world's experience with the flexible exchange rates, the case for international monetary linkages is well supported. A high degree of interdependence is still observed among many countries of the world. This is shown in Figures 3.3-3.5 describing the movements in US monetary aggregate (M1) and the world money expressed in dollar terms from 1970 to 1991. During the period of dollar appreciation from 1980 to 1985, the dollar value of world money was declining, while the dollar depreciation in 1985 to 1987 caused the dollar value of world money to explode. This is particularly true in the case of German deutschmark and Japanese yen.

Whether the movements of the dollar can be explained by monetary policy alone is not clear. It appears that the major depreciation and appreciation of the dollar during the 1970-91 period were also caused by fiscal policy and not simply by monetary considerations. The real exchange rate movements of 30 or 40 percent were certainly not considered a realistic possibility and did not appear to be connected to most of the assumptions underlying the theory of insulation under flexible rates. Quite obviously, the persistence of rate movements in the short run confirm the possibility that the change in foreign price still exerts real effects.
Figure 3.3

M1 MONEY SUPPLY IN JAPAN (IN LOGARITHMS)
Figure 3.4

M1 MONEY SUPPLY IN GERMANY (IN LOGARITHMS)
Figure 3.5

M1 MONEY SUPPLY IN CANADA (IN LOGARITHMS)
in the home country even under the flexible system. Perhaps one major explanation for deviations from purchasing power parity is the fact that the law of one price is defined only for traded goods, and in the case where the non-traded goods are included, the entire argument of perfect arbitrage by PPP breaks down.

3.3 The Role of Non-traded Goods Sector

The introduction of nontraded goods in open economy models is important because the domestic price level can deviate from world-determined prices in the presence of a significant nontraded goods sector. As such the effects of a given macroeconomic policy will be affected by how the nontraded goods sector responds to these policies, and consequently different countries will experience different inflation rates, depending on the adjustment in the prices of nontraded goods in each country. Thus, a meaningful analysis of the international transmission of inflation should include not only the initial importation of inflation from the world market into the domestic tradables sector but also the interaction between tradables and nontradables sector as well.

Following Dornbusch (1973), we denote traded and nontraded goods as $x_t$ and $x_n$. We also assume that the supplies of these two commodities depend on the relative price of

---

26 This is because when all goods are traded goods the law of one price holds. The Purchasing Power Parity (PPP), sometimes presented as the law of one price, stipulates that the purchasing power of home currency in the domestic economy must be equal to the purchasing power of home currency abroad, or else arbitrage will occur until parity does exist. If all goods were tradable, with zero transaction costs and no trade barriers, any existing exchange rate between two currencies would make the price levels in the two respective countries equal. Whereas if some goods are nontradable, there is no reason to expect the prices of these goods - hence also some "general" price level of which these prices form a component - to be equal everywhere. Thus the PPP fails in this respect.
nontraded goods, \( p \) - that is, the ratio of domestic currency price of nontraded goods, \( p_n \), divided by the price of traded goods, \( p_t \),
\[
(14) \quad \phi = \frac{p_n}{p_t}
\]

Let \( y \) be real income or the real value of output, expressed in terms of traded goods,
\[
(15) \quad y = x_t \cdot \phi x_n = y(\phi)
\]

and let total expenditure be expressed as
\[
(16) \quad c_t + \phi c_n = \nu \tilde{m}
\]

where \( m \) is the real money stock (measured in terms of price of traded goods) and \( \nu \) is the income velocity of money. In (15) and (16), we adopt \( p_t \) as the numeraire.

Given the definition of hoarding in (5), and given that in equilibrium, income equals expenditures, we write
\[
(17) \quad \Delta \tilde{m} = (x_t \cdot \phi x_n) - (c_t + \phi c_n) = h
\]

where \( h \) is the planned rate of hoarding. As in one-commodity model, monetary considerations affect the goods market via the expenditure function and rate of hoarding - all measured in terms of traded goods.
Equation (17) may also be rewritten as the budget constraint:

\[(18) \quad (x_c - c_c) + p(x_n - c_n) = \Delta m\]

From the budget constraint we observe that when the home goods (nontraded) market clears \((x_n = c_n)\), the excess supply of traded goods equals the planned rate of hoarding. It is also clear that in this model, an increase in the relative price of nontraded goods, given the price of traded goods, raises the real exchange rate since it raises hoarding and thereby the demand for money.

\[(19) \quad x_n(p) = c_n(p, z)\]

\[(19a) \quad x_n^*(p^*) = c_n^*(p^*, z^*)\]

\[(19b) \quad h(p^*, \pi) = -h^*(p^*, \pi^*)\]

where \(z\) and \(z^*\) denote the real expenditure in each country, or the excess of real income over real hoarding.

An important result being examined is that the introduction of nontraded goods complicates the analysis considerably. With nontraded goods, the transmission of inflation through the world market into a domestic economy through commodity trade now becomes a two-stage process: the first stage being the direct linkage between the world market and the tradable sector of the economy, and the second stage comprising the subsequent spillover
effect to the nontradable sector. Thus, it is possible that foreign inflation may still be imported under flexible rates. When the domestic currency depreciates, the domestic price of tradables in terms of nontradables will rise at home. This causes a divergence in the initial production and consumption points at home, as production shifts toward the tradables and consumption shifts toward nontradables in response to a change in relative prices. An obvious inflationary tendency in the nontraded goods market exists as the excess demand in that sector builds up and these changes in relative prices in turn affect the equilibrium rates of hoarding. Abroad exactly the opposite takes place. The reduction in the relative price of tradables in terms of nontradables causes producers to shift resources to home goods while consumers substitute toward traded goods, thus generating a balance of payments surplus for the home country. It appears, therefore, that a theory of linkage between the world prices expressed in common currency and the general level of domestic prices of tradables is trivial, unless the second stage of interaction between the two domestic sectors (the traded and home goods markets) exists.

The foregoing analysis can be formally obtained by differentiating the world goods market equilibrium in equation (19b). For the home country, the change in domestic rate of hoarding is equal to

\[ ch = \Theta \phi + \beta \phi \]  

(20) 

where

\[ \Theta = \frac{\partial h}{\partial \phi} \]
Similarly, the relationship between the relative price of nontraded goods and real hoarding is obtained by differentiating equation (19) to obtain

\begin{align}
\beta &= \frac{\partial \hat{r}}{\partial \hat{m}} \\
\tag{21}
\bar{p} &= -\frac{m_n}{(\eta_n + \epsilon_n) \bar{p} \bar{c}_n} \cdot d\hat{h}
\end{align}

where

\begin{align*}
m_n &= \frac{\partial c_n}{\partial \bar{p}} \bar{p} \\
\eta_n &= -\left[ \frac{\partial c_n}{\partial \bar{p}} + \frac{\partial c_n}{\partial \bar{z}} \frac{\partial \bar{y}}{\partial \bar{p}} \right] \frac{\bar{p}}{c_n} \\
\epsilon_n &= \frac{\partial x_n}{\partial \bar{p}} \frac{\bar{p}}{x_n}
\end{align*}

Equation (20) can be simplified by substituting (21) to get

\begin{align}
\tag{22}
d\hat{h} &= \Phi \beta \bar{p} \bar{c}
\end{align}

where

\begin{align*}
\Phi &= \frac{1}{1 + \delta} \\
\delta &= \frac{m_n}{(\eta_n + \epsilon_n) \bar{p} \bar{c}_n}
\end{align*}
The terms \( m, \eta \) and \( \epsilon \) represent the marginal propensity to spend on nontraded goods, the compensated elasticity of demand for nontraded goods, and the elasticity of supply on nontraded goods.

Accordingly, using equation (22) and its counterpart in a foreign country, equilibrium in the world market for traded goods can be determined as follows:

\[
(23) \quad \phi \beta \hat{p}_t + \phi' \beta' \hat{p}_t' - 0 = \alpha \delta + \alpha \delta' + dh
\]

Since \( pt^* = pt - \epsilon \), a devaluation of domestic currency increases the domestic price of traded goods by an amount that is less than proportionately to the rate of devaluation.

\[
(24) \quad \hat{p}_t = \frac{\phi' \beta^*}{\phi \beta + \phi' \beta'} \delta = \psi \epsilon
\]

As in the one commodity model, equation 24 illustrates the positive relationship between the domestic price of traded goods and change in the exchange rate. In as much as a domestic devaluation increases the domestic price of traded goods, then it can be argued that the world money stock expressed in domestic currency will also cause the domestic currency price of traded goods to increase less than proportionately to the rate of change of world money supply. But perhaps a more interesting result is the impact effect of exchange rate changes on the relative price of nontraded goods in the home country. Substituting (23) in (22), and then the result obtained in (21), yields

\[
(25) \quad \hat{p} = -\delta \phi \beta \psi \epsilon
\]
As shown in equation 25, a devaluation reduces the relative price of nontraded goods in the home country which also implies a reduction in hoarding and thereby the demand for money. In the case of foreign country exactly the opposite occurs. It is also clear that in this model, a reduction in world money supply expressed in domestic currency has the same effect on relative price of nontraded goods.

As shown by the evidence for 1970-91, movements in foreign money expressed in common currency do not necessarily reflect similar movements in the domestic money. In the presence of nontraded goods, perfect arbitrage does not hold up and deviations from the purchasing power parity become a possibility. As such the domestic price is no longer the same as the foreign price, and given this scenario, it's possible that the domestic economy may be influenced by monetary conditions in the world. In a world of perfect capital mobility, even a slight divergence in interest rate parity may cause massive capital flows among countries and influence the direction and magnitude of exchange rate changes provided that the marginal propensity to spend on imported goods is greater than zero. This substitutability between domestic and foreign assets undermines the insulation property of flexible exchange rates. For if the world is non-Fisherian\(^{27}\), any increase in foreign inflation arising from foreign

\(^{27}\) The Fisher relationship can be described as follows:

\[
(1) \quad i = r + \Delta \ln \, p
\]

that is, the nominal interest rate \(i\) is exactly equal to the real rate of interest \(r\) plus the rate of inflation \(\Delta \ln \, p\).

In an open-economy model, the capital account remains in balance if the change in exchange rates \((\Delta \ln \, e)\) exactly offsets the differences in interest rates between countries (example, the United States and the rest of the world).
monetary growth will have an impact domestically as investors seek to adjust their portfolios and expectations in response to changes in real rates of return. In addition, flexible exchange rates can intensify some of the domestic effects of inflation.

The preceding discussion can be formalized as follows. Under perfect capital mobility, interest arbitrage ensures that the domestic interest rate and the world rate are linked so that:

\[(26) \quad i = i^* + \Delta \ln e\]

which also implies that with adjustment in anticipated change in nominal exchange rate, domestic and foreign assets are perfect substitutes.

Given the existence of long-run equilibrium exchange rate, \(\bar{e}\), and rational expectations in asset market, the rate of change for exchange rate can be written as:

\[(27) \quad \Delta \ln e = \Omega (\bar{e} - e)\]

\[(2) \quad \Delta \ln e = \Delta \ln i_{us} - \Delta \ln i_{low}\]

Under conditions of continuous PPP, the change in exchange rates will also reflect international differences in inflation rates:

\[(3) \quad \Delta \ln e = \Delta \ln P_{us} - \Delta \ln P_{low}\]

Substituting (3) into (2), we obtain the following relationship:

\[(4) \quad i_{us} - \Delta \ln P_{us} = i_{low} - \Delta \ln P_{low}\]

\[r_{us} = r_{low}\]

Thus, as long as the Fisher relationship in (1) and PPP hold, the domestic real rate of return equals that in the rest of the world.

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where the coefficient $\Omega$ measures the speed of adjustment of spot exchange rate to its long-run level $\bar{e}$.

Stating in real terms the relationship in (26) yields

$$\Delta \ln q = r - r^*$$

and combining (21) and (22), we can write the equation for real exchange rate $(q)$ as

$$q = \bar{q} - \frac{1}{\Omega} (r - r^*)$$

Thus, as shown here, the real exchange rate will be high and depreciating when real interest rates at home exceed those abroad.

Consider the Fisher relationship again. Suppose there is domestic monetary growth. So long as the price level rises immediately, the interest rate must also rise by percentage point for percentage point with inflation to keep the domestic real rate of return equal with that abroad. Accordingly, under continuous purchasing power parity, the long-run equilibrium exchange rate will rise in the same proportion. In the long-run equilibrium, the real rate of return in home country equals that in the world so capital flows will be stable.

However, the economy may not instantaneously jump to the new long-run equilibrium because maybe prices are "sticky." If prices are sticky in the short run (Dornbusch 1976), this implies an initial increase in real money supply and a consequent fall in real interest rate. The fall in domestic real interest rate then leads to a capital outflow and
a depreciation of the real exchange rate. Dornbusch argues that in the short run, when the price is given, the exchange rate must overshoot to obtain the asset market equilibrium. Consequently the value of foreign money expressed in domestic currency also overshoots perhaps even more than the changes in domestic money. Thus this sticky-price model with nontraded goods is able to show how exchange rate dynamics can be explained by a direct linkage between domestic asset market and foreign rates of interest given monetary shocks.

But perhaps a major insight of the model is given by the analysis of fiscal policy. Dornbusch has also shown that real exchange rate overshooting can occur not only because of monetary stocks in economies with sticky goods prices, but also as a consequence of fiscal policy shocks. In fact, consistent with recent US experience, the stance of fiscal policy during the 1980s has served as an important driving force for the real value of the US dollar. Over the period 1980-85, the real value of the US dollar rose by nearly 60 percent, the same period during which the whole stance of US fiscal policy was very expansionary. Since then the real exchange rate of the US dollar has been on a slide (see Figure 2.5) and the evidence suggests that this is can be explained by large shifts in US fiscal policy (e.g., Tax Reform Act of 1986) in recent years (Feldstein 1986) and by the gradual build up of service payments on external debt (Masson and Knight 1990).

Consider now the effects of fiscal policy in this model. Assume initially that a fiscal expansion, as given by a fiscal variable \( g \) (say, government spending) takes place. We also assume, as in Dornbusch (1987), that there exists a long-run level of government spending \( \bar{g} \) and an initial level of fiscal expansion \( g \) that is gradually phased out over time at the rate \( \lambda \).
Equation (30) shows the adjustment process of transitory fiscal policy which, according to Dornbusch, "corresponds to the US experience of the 1980s." Assume further that the level of government spending, \( g \), is related to domestic demand for output as follows:

\[
\Delta \ln g = -\lambda (g - \bar{g})
\]

Equation (31) shows that prices move in proportion to the excess demand for output, where demand depends on real exchange rate \((e-p)\) and government spending \((g)\).

\[
\Delta \ln p = \Theta \left[ \Phi (e-p) + g \right]
\]

A fiscal expansion creates an excess demand for goods that raises output or prices, and consequently the domestic real interest rate, given a nominal money stock. With higher real rate of return on domestic assets, incipient capital flows cause the real exchange rate to appreciate and the trade deficits to increase as the equilibrium level of expenditures in home country also rises by an amount equivalent to capital flows. Over time, as fiscal policy is gradually phased out, the overvaluation of real exchange rate generates a future expectation of depreciation. This expectation of depreciation of the real exchange rate offsets the difference in the real rates of interest at home and abroad. The depreciation then continues until the initial equilibrium is restored and balance of payments equilibrium (with stable capital flows) is maintained.

Clearly a strong feature of our model is the analysis that large shifts in real exchange rates have strengthened, rather than diminished, the degree of economic interactions under a flexible exchange rate system. While both monetary and fiscal policy changes appear to
exert an overriding influence on the pattern of real exchange rates, the implications in terms of the international transmission of these macroeconomic policies support much of the observed interactions among the major industrialized countries since 1980. In the context of our global monetarist model, for example, sustained movements in the real value of US dollar in the 1980s may imply similar movements in the dollar value of world money that can in fact explain changes in prices and income in domestic economy. In fact, since 1980s the United States is no stranger to this recent economic experience and we maintain that the effects of exchange rate changes on US domestic economy are really important. This is the scope of empirical investigation in the next chapter to which we now turn.
CHAPTER 4

THE EMPIRICAL RELATIONSHIPS OF MONEY, INCOME, AND EXCHANGE RATES UNDER FIXED AND FLEXIBLE RATE SYSTEMS

The collapse in the relationship between M1 and nominal income since 1982 constitutes an important empirical issue in the conduct of US monetary policy. As shown in chapter 2, the reason M2 might be preferred to M1 as a monetary target is because the relationship between M2 and nominal GDP appears to be more stable in recent years. Another important issue in the 1980s is the increased influence of international factors on the domestic economy. The theoretical analysis in chapter 3 suggests how in a system of flexible rates, domestic monetary control may be complicated by wide fluctuations in exchange rates. It has been argued that the change in the dollar value of foreign money exerts significant effects on domestic aggregate demand and on prices. In this chapter, it is shown that the inclusion of the dollar exchange rate in monetary models of nominal aggregate demand improves their statistical fit during the 1980s. When the dollar exchange rate is included as an independent variable in the income regressions, much of the fluctuations in money anticipate fluctuations in nominal GDP and the relationship between money and nominal income is significantly enhanced.

4.1 Description of the Empirical Model

The empirical work is motivated by the controversy arising from the breakdown in money-income relationship after 1982, and the argument that such shifts may be explained by
changes in the exchange rate (McKinnon 1984, Ambler and McKinnon 1985). While the
influence of international factors in the conduct of US monetary policy is often mentioned,
most of the attention has concentrated on the effect of world monetary conditions on
domestic prices. Many studies have concluded that changes in the dollar exchange rate affect
US prices (Himarios 1986, Viren 1990) while ignoring the possibility that the exchange rate
changes may also affect other components of domestic economic activity, such as income.
In this paper we attempt to refocus the issue. An important hypothesis to be tested is the
view that during the 1980s, changes in domestic aggregate demand are sensitive to changes
in the value of the exchange rate of the dollar as well as monetary aggregates.

4.1.1 Test of the Quantity Theory of Money

Central to modelling the relationship between a monetary aggregate and income is the
quantity theory equation written as

\[ \Delta \ln m + \Delta \ln v + \Delta \ln y \]

where \(m, v,\) and \(y\) are the quantity of money, velocity, and nominal income, respectively, and
a \(\Delta \ln\) before each variable represents a percentage change. Clearly, in this equation, a stable
relationship between the growth rate of money and a subsequent growth rate in nominal
income is predicated on a stable growth rate of income velocity.

However, as shown in chapter 2, the same stable relationship between M1 and
nominal GDP that guided US monetary policy from 1955 to 1980 started to breakdown
thereafter. In the 1960s and 1970s the growth of M1 seems to be highly correlated to growth
of nominal income (see Figure 1.2). The velocity decline in 1982 did not only put into question the stability of M1 demand, but also questioned the use of M1 as the measure exhibiting the greatest relation to income during the postwar period. Figure 4.1 shows this deteriorating money-income relationship in the 1980s, in which the lagged growth rate of M1 failed to reflect similar movements in the growth rate of nominal GDP.

In contrast, the relationship based on M2 appears to be more stable. As is evident in Figure 4.2, the change in lagged growth rate of M2 seemed to induce an equal change in the rate of growth of nominal GDP thus rendering the ratio of income to M2 stable. Existing studies within the Federal Reserve System (Hallman, Porter and Small 1989, Feinman and Porter 1992) - as well as outside (Ramey 1993, Feldstein and Stock 1993) suggest that the greater importance attached to M2 than to other aggregates is not misplaced. Moreover, on empirical grounds, the performance of M2 during the most recent business cycle appears to be reassuring.

4.1.2 Specification of the Model

This view on the empirical regularity of M2 demand in influencing the economy is a starting point of our empirical investigation. However, under the present system of flexible exchange rates, the ability of monetary aggregates to predict nominal income is now being influenced by other factors. The US dollar exchange rate has become a significant factor in influencing fluctuations in US GDP. McKinnon (1984) provided ample evidence on this issue when he argued for using the dollar exchange rate as indicator of monetary policy. More recently, Wallace and McNown (1992) have also shown the existence of long-run
LAGGED GROWTH RATES OF GDP AND M1 MONEY SUPPLY
Figure 4.2

LAGGED GROWTH RATES OF GDP AND M2 MONEY SUPPLY
equilibrium relationship between M2, nominal income, and dollar exchange rate during the period of flexible rates in the US.

It is widely believed that exchange rate considerations during the flexible period appear to exert significant influence in the economy. Surprisingly, however, studies that explicitly tested the effects of the exchange rate on domestic income are very limited, especially during the recent years of widely fluctuating exchange rates. Possibly with the exception of McKinnon (1984), there are no other major studies that addressed this empirical issue of the relationship between money, income, and the exchange rate. However, McKinnon's study (based on annual data) only focused on the period up to 1982 and did not include most of the 1980s where substantial movements in the US dollar had occurred. In this paper, the goal is to show that changes in dollar exchange rate have lasting effect on nominal GDP after 1982.

4.1.2.1 The Polynomial Distributed Lag Technique

The general framework of the empirical model is as follows. Let money growth and nominal income form a long-run equilibrium relationship. Assuming further that exchange rate changes can affect domestic income, then a nominal income model of the following form seems to be appropriate:

\[
\Delta \ln Y_t = \alpha + \sum_{i=1}^{g} \beta_i \Delta \ln (M_{t-i}) + \sum_{i=1}^{g} \gamma_i \Delta \ln (E_{t-i}) \\
+ \sum_{i=1}^{g} \delta_i \Delta \ln (X_{t-i}) + \mu_t
\]
where M is the money stock (M1 and M2), Y nominal income (nominal GDP), E the nominal exchange rate (defined as the trade-weighted foreign exchange value of the US dollar against the currencies of 10 industrial countries), and X represents other variables that affect income (for example, the world money supply and opportunity cost of holding money). The natural logarithm is ln and Δ represents first differences. α, β, γ and δ are parameters greater than zero, and μ is the disturbance term.

Equation (2) is specified as a polynomial distributed lag or an Almon lag model.28 The model choice is based on the economic theory that money affects nominal income with a lag. Economists generally agree that changes in money stock will not have immediate effects on the economy at a single point in time, but the impact is distributed over a number of future points in time. Empirical studies suggest that changes in the growth rate of money are fully reflected in the nominal income growth in about six months to two years. Thus a distributed lag analysis that takes into account important lag information is appropriate in view of the actual implications of our theoretical model.

28 The polynomial distributed lag or Almon (1965) lag is a special case of unrestricted finite distributed lag specified as

\[ y_t = \alpha + \sum_{i=0}^{n} \beta_i x_{t-i} + \epsilon_t \]

in which \( x_t \) is assumed to be nonstochastic and \( \epsilon_t \) is assumed to be normally distributed with mean zero and variance \( \sigma \). The Almon procedure is based on the assumption that the coefficients of each lagged variable of an equation can be approximated by a polynomial of a fairly low degree. By limiting the lagged regressors to lie on a finite order polynomial, the problem of severe multicollinearity associated with extremely long lags is avoided. Important references on Almon lags are Judge et. al. (1987) and Greene (1990). Other studies that extensively used this technique are found in Frost (1975), Batten and Thornton (1983), Pagano and Hartley (1981), and Schmidt and Waud (1973).
In general, the distributed lag model assumes that the necessary lag length may be extremely long, which in turn can lead to imprecise parameter estimates and severe multicollinearity problem (Greene 1990). One advantage of the Almon lag (1965) technique as used in this study is that it provides a flexible method of incorporating a variety of lag structures, which in turn reduces the effect of multicollinearity. By imposing some structure on the lag distribution and using smooth polynomial functions, the Almon lag technique can reduce the number of parameters in the model. Thus the rationale for the use of the Almon method is that it increases the precision of the estimates and, for strictly empirical matters, this method has been widely used in many recent macroeconomic analysis.

4.1.2.2 Determining the Lag Structure

An important aspect of polynomial distributed lag model is the determination of correct lag length and degree of polynomial. Without the appropriate specification, the use of the model would have been erroneous as it leads to inconsistent estimates of the individual lag coefficients and invalid tests. For example, if the assumed polynomial degree is correct, but the lag length is underestimated (i.e., choosing n less than the true lag length), the polynomial distributed lag estimator will be biased. Thus a large amount of caution is needed in specifying the model in view of some problems associated with misspecification of lag length and polynomial degree.

Two commonly used fit measures, the Akaike’s information criterion (AIC) and Schwarz’s criterion (SC), are utilized to determine the appropriate lag length for each
independent variable.\textsuperscript{29} For both criteria, a lag length of \( n \) that is less than or equal some maximum \( N \) is chosen so as to minimize AIC(\( n \)) or SC(\( n \)). Both criteria are based on the maximum value of the log of the likelihood function and are similar in spirit to adjusted \( R^2 \) in that they reward good fit but penalize the loss of degrees of freedom (Greene 1990).

Tables 4.1 to 4.4 give the results of lag specification search for individual independent variables in the model. Two periods representing the fixed rate system (1966.1-1973.2) and

\textsuperscript{29} Akaike's AIC (1973) criterion is

\[
\text{AIC}(n) = \ln \sigma + \frac{2n}{T}
\]

while Schwarz's SC (1978) criterion is

\[
\text{SC}(n) = \ln \sigma + \frac{n \ln T}{T}.
\]

The term \( \sigma \) is the maximum likelihood estimator of the residual variance obtained from a model with a lag length \( n \), that is \( \sigma = \frac{SSE}{n} \) where \( T \) is the sample size. For a discussion of these criteria, see Judge et al. (1985).

Other procedures used for estimating the lag length of a polynomial distributed lag model are also suggested by various authors. For example, Schmidt and Waud (1973) used the minimum standard error of the residuals as their criterion.
flexible rate regime (1982.1-1991.4) are examined for data on money supply (M1 and M2), nominal GDP, nominal dollar exchange rate, opportunity cost, and world money supply. As shown in the tables, the values of AIC and SC assume a minimum at n = 8 for almost all variables so that N = 8 is chosen as lag length. This seems to be appropriate (Burdekin 1989, Gujarati 1988) since in practice, a maximum lag length of eight or ten quarters is often used in a regression involving quarterly data\(^{30}\) for ten years, like those employed in this paper.

4.1.2.3 Determining the Degree of the Polynomial

Having specified the lag length, the degree of the polynomial is also determined. As in the selection of correct lag length, the choice of the polynomial degree is important to avoid any specification error that leads to biased and inconsistent estimates. Although various procedures have been suggested for selecting the correct polynomial degree, we follow Gujarati’s (1988) simple suggestion of sequentially testing the statistical significance of lag coefficients in each model approximated by a polynomial of a certain order. We first fit the distributed lag model given in (2) by a fourth-degree polynomial and then compare the results with regressions involving polynomial models of lower degrees (say 1, 2 or 3). After running different regressions, with varying polynomial degrees, we find that a third-degree polynomial

\(^{30}\) The macroeconomic data series used are quarterly from 1966.1 to 1973.2 (for fixed rate period) and from 1982.1 to 1991.4 (flexible rate period). The variables are nominal GDP, M1, M2, dollar exchange rate, world money supply, and opportunity cost of M2.
### TABLE 4.1
DISTRIBUTED LAGS: AKAIKE'S INFORMATION CRITERION (AIC) 1982.1-1991.4

<table>
<thead>
<tr>
<th>Lag Length</th>
<th>$\Delta \ln M_1$</th>
<th>$\Delta \ln M_2$</th>
<th>$\Delta \ln EXRATE$</th>
<th>$\Delta \ln WORLD$</th>
<th>$\Delta \ln OPCOST$</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>-10.05</td>
<td>-10.02</td>
<td>-9.549</td>
<td>-9.620</td>
<td>-9.652</td>
</tr>
<tr>
<td>8</td>
<td>-10.36*</td>
<td>-10.19*</td>
<td>-9.850*</td>
<td>-9.861*</td>
<td>-9.870*</td>
</tr>
</tbody>
</table>

**NOTES:**

M1 and M2 are nominal money stocks; EXRATE is the trade-weighted value of the US dollar; WORLD is the world money supply; and OPCOST is the opportunity cost of money.

a Minimum of the column.
<table>
<thead>
<tr>
<th>Lag Length</th>
<th>Δ ln M1</th>
<th>Δ ln M2</th>
<th>Δ ln EXRATE</th>
<th>Δ ln WORLD</th>
<th>Δ ln OPCOST</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>-10.36*</td>
<td>-9.930*</td>
<td>-9.626*</td>
<td>-9.585*</td>
<td>-9.577*</td>
</tr>
</tbody>
</table>

NOTES:

M1 and M2 are nominal money stocks; EXRATE is the trade-weighted value of the US dollar; WORLD is the world money supply; and OPCOST is the opportunity cost of money.

a Minimum of the column.
### Table 4.3

**DISTRIBUTED LAGS: AKAIKE'S INFORMATION CRITERION (AIC) 1966.1-1973.2**

<table>
<thead>
<tr>
<th>Lag Length</th>
<th>Δ In M1</th>
<th>Δ In M2</th>
<th>Δ In EXRATE</th>
<th>Δ In WORLD</th>
<th>Δ In OPCOST</th>
</tr>
</thead>
</table>

**NOTES:**

M1 and M2 are nominal money stocks; EXRATE is the trade-weighted value of the US dollar; WORLD is the world money supply; and OPCOST is the opportunity cost of money.

*a Minimum of the column.*
TABLE 4.4.
DISTRIBUTED LAGS: SCHWARZ'S CRITERION (SC) 1966.1-1973.2

<table>
<thead>
<tr>
<th>Lag Length</th>
<th>Δ ln M1</th>
<th>Δ ln M2</th>
<th>Δ ln EXRATE</th>
<th>Δ ln WORLD</th>
<th>Δ ln OPCOST</th>
</tr>
</thead>
</table>

NOTES:

M1 and M2 are nominal money stocks; EXRATE is the trade-weighted value of the US dollar; WORLD is the world money supply; and OPCOST is the opportunity cost of money.

a Minimum of the column.
model provides a reasonably good approximation and consistent estimates of the coefficients. When other specifications are used, the adjusted R2 statistic is not as high and the estimated lag coefficients are not consistently significant. Thus it is decided that an Almon model of a third degree is the most appropriate. This result is also in line with the usual econometric practice of using a third- or fourth-degree polynomial as an accurate approximation of the lag structure (Pin Jong and Rubinfeld 1981, Gujarati 1988).

4.1.3 OLS Estimation and Autocorrelation

The empirical model that is being estimated is a third-degree polynomial-lag function with no end-point restrictions. This general approach is used since there is no a priori rationale for imposing end-point restrictions (see, for example, Schmidt and Waud 1973). It is assumed, for simplicity, that the dependent variable (Δ ln nominal GDP) is linearly related to the independent variables. Also, as in McKinnon (1984), the lagged terms are included to capture the long-standing view that lagged money supplies and exchange rates have significant effect on nominal income.

We start the estimation period in 1982 after the deregulation of the US financial sector. This period 1982-91 also corresponds to the dramatic decline in M1 velocity in 1982 and the subsequent shift to M2 in 1987 as monetary target by the Federal Reserve System. Hence the use of M2 as our measure of money stock in the model is consistent with the empirical evidence during this period, and the fact that the post-1982 period is interesting to study since during this time most monetarist ideas especially on money-income relationships and the purchasing power parity relationship were seriously challenged. For comparative
purposes, similar income regressions are run for the fixed rate period (1966.1-1973.2),
relating M1 and M2 to nominal GDP.

Since most macroeconomic time series data are nonstationary (Nelson and Plosser
1987), the regression is estimated using first differences to avoid the spurious regression
phenomenon described in Granger and Newbold (1974). It is also estimated by ordinary
least squares (OLS) with correction for serial correlation using the Cochrane-Orcutt
procedures as discussed in Shazam econometric program (version 7.0).

As expected in any empirical work utilizing time-series data, a considerable amount
of serial correlation is possible. While the correction for serial correlation is taken into
account, our results are still carefully checked for any evidence of autocorrelation in the
residuals. Initially the computed Durbin-Watson d statistic is used to examine whether
autocorrelation still remains in the regression that has already been adjusted for
autocorrelation. In general the results of the Durbin-Watson d test reveal that there is no
longer autocorrelation in our model. However, as noted by White (1985), the Durbin-

31 Tests for stationarity require that the series in levels must be time invariant, otherwise
the data must be differenced to eliminate the time trend that may produce spurious results.
The Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests are used to examine the
stationarity of the data set. Based on a significance level of 10 percent, all data series are
found to be nonstationary and all of them only require first differencing to be stationary.

32 The Durbin-Watson d statistic is the most commonly used test for first-order serial
correlation in all models without lagged dependent variable as regressor. This is again in line
with the polynomial distributed lag model being used in this study. The DW statistic is
simply the ratio of the sum of squared differences in successive residuals to the residual sum
of squares. As a rule of thumb, the presence of positive or serial correlation is detected if the
computed d statistic lies outside the lower and upper bound d values derived by Durbin and
Watson.
Watson method may not be appropriate in a transformed regression when initial correction autocorrelation has already been made.

As an alternative to the d test, we use a nonparametric test, the so-called runs test or Geary (1970) test, as suggested by Gujarati (1988). The idea is that there is an observed sequence of the residuals that can be positive or negative residuals depending on their randomness, and a run is defined as an uninterrupted sequence of one attribute, such as positive or negative. Thus, in a runs test, the hypothesis of randomness of the residuals is examined. For example, if there are too few runs compared with the number of runs expected in a random sequence of N observations, it would mean that the residuals don't change their sign very rapidly, thus indicating a positive correlation exists.

The results of the runs test for different regressions are shown in Tables 4.5 and 4.6. Since the number of runs in each regression falls within the critical region, the null hypothesis of randomness of the residuals can not be rejected with 95 percent confidence. This clearly indicates that there is no serial correlation in the residuals from each regression. For example, in a regression of M2 and exchange rate in Table 4.5, the number of runs (12) is within the critical region (11.5, 22.35) thus confirming the absence of autocorrelation problem.

4.2 The Empirical Results

McKinnon (1984) has argued that the shift to flexible rates after 1973 led to a strong volatility in exchange rates. In contrast to the dollar standard of the earlier years (1958-71), flexible rates resulted into greater speculative shifts in capital flows especially during the 1980s which caused the exchange rate of the dollar to undergo large changes in values. Our
TABLE 4.5
RUNS TEST: LEAST SQUARE ESTIMATES OF NOMINAL GDP
Flexible Rate: 1982.1-1991.4

<table>
<thead>
<tr>
<th>Regression</th>
<th>Runs</th>
<th>Critical Values *</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>13</td>
<td>(17+, 15-)</td>
</tr>
<tr>
<td>M2</td>
<td>19</td>
<td>(15+, 17-)</td>
</tr>
<tr>
<td>M1 + EXRATE</td>
<td>14</td>
<td>(15+, 17-)</td>
</tr>
<tr>
<td>M2 + EXRATE</td>
<td>12</td>
<td>(16+, 16-)</td>
</tr>
<tr>
<td>M2 + WORLD</td>
<td>17</td>
<td>(15+, 17-)</td>
</tr>
<tr>
<td>M2 + OPCOST</td>
<td>16</td>
<td>(15+, 17-)</td>
</tr>
<tr>
<td>M2 + OPCOST + EXRATE</td>
<td>17</td>
<td>(15+, 17-)</td>
</tr>
<tr>
<td>M2 + OPCOST + WORLD</td>
<td>16</td>
<td>(16+, 16-)</td>
</tr>
</tbody>
</table>

NOTES:

a. Figures outside the parentheses represent the number of runs, n. If the estimated n lies outside the critical region, the null hypothesis of randomness of the residuals is rejected. Hence the presence of serial correlation.

b. * Critical values of runs obtained from the following interval with 95% confidence:
   \[ E(n) \pm 1.96\sigma_n \] where \( E(n) \) is the mean, \( \sigma_n \) is the standard deviation, and \( n \) is the number of runs. Accept the null hypothesis (H₀: residuals are random/independent) if the estimated n lies inside the confidence interval. For further discussion of this test, see Gujarati (1988).
### TABLE 4.6.

**RUNS TEST: LEAST SQUARE ESTIMATES OF NOMINAL GDP**
Fixed Rate: 1966.1-1973.2

<table>
<thead>
<tr>
<th>Regression</th>
<th>Runs</th>
<th>Critical Values *</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>15 (15+, 14-)</td>
<td>(10.04, 20.08)</td>
</tr>
<tr>
<td>M2</td>
<td>15 (17+, 12-)</td>
<td>(10.30, 20.65)</td>
</tr>
<tr>
<td>M1 + EXRATE</td>
<td>17 (16+, 13-)</td>
<td>(10.22, 20.46)</td>
</tr>
<tr>
<td>M2 + EXRATE</td>
<td>17 (13+, 16-)</td>
<td>(10.22, 20.46)</td>
</tr>
</tbody>
</table>

**NOTES:**

a. Figures outside the parentheses represent the number of runs, n. If the estimated n lies outside the critical region, the null hypothesis of randomness of the residuals is rejected. Hence the presence of serial correlation.

b. * Critical values of runs obtained from the following interval with 95% confidence: 
   \[ E(n) \pm 1.96\sigma \]
   where \( E(n) \) is the mean, \( \sigma \) is the standard deviation, and n is the number of runs. Accept the null hypothesis (H₀: residuals are random/independent) if the estimated n lies inside the confidence interval. For further discussion of this test, see Gujarati (1988).
empirical work consists of evidence that the strength of US money-income relationship in the 1980s is related to these movements in the US dollar. To verify this result, the standard nominal income regression using money as the only explanatory variable is compared with other specifications of the model that include the exchange rate and world money supply variables.

4.2.1 Does the Dollar Exchange Rate Affect Income?

The starting point of our analysis is a test of money-income links based on purely domestic monetary aggregates. Equation (2) was initially estimated using the lagged growth rates in money stock and their influence on growth rate of nominal GDP during the fixed period (1966.1-1973.2) and the years following the sharp fall in M1 velocity (1982.1-1991.4). The idea here is to establish the relative effectiveness of each monetary aggregate in predicting income across different exchange rate periods.

The results of estimating nominal GDP growth using both M1 and M2 growth rates during the fixed rate period are as follows (Table 4.7):

\[ \Delta \ln GDP = -0.0065 + 0.983 \Delta \ln \Sigma M1 \]
\[ (-0.85) \ (1.93) \]

Period: 1966.1-1973.2 Adj \( R^2 = .38 \) se=0.0070 dw=1.93 rho= .012

\[ \Delta \ln GDP = -0.0100 + 0.941 \Delta \ln \Sigma M2 \]
\[ (-2.15) \ (3.83) \]

Period: 1966.1-1973.2 Adj \( R^2 = .17 \) se=0.0082 dw=2.00 rho= -.002

The narrow money stock M1 seems to work better than M2 in predicting nominal GDP in the fixed rate period as shown by the adjusted \( R^2 \). Although the sum of the lagged
coefficients over eight quarters (the terms $\Delta \ln \Sigma M_1$ and $\Delta \ln \Sigma M_2$) is statistically significant for both monetary measures, the standard error of estimating nominal GDP using $M_1$ is smaller and the variance explained is greater. Interestingly, however, when the same equation is estimated for the flexible period, $M_1$ continues to be a better predictor of domestic aggregate demand. As shown in Table 4.8, $M_1$ growth rate explains 52 percent of the variance in nominal GDP growth in contrast to only 36 percent in the case of $M_2$ growth. Whether these results indicate a weak relationship between $M_2$ and income during the flexible rate cannot be taken as conclusive. In fact, some caution is in order in interpreting these results. While the overall fit of simple money supply equation using $M_1$ is a little bit higher than that of $M_2$, the sum of lag coefficients of $M_2$ remain statistically significant and close to one. The important influence of $M_2$ on income also remains stable across the two time periods.

$$\Delta \ln GDP = -.0007 + .381 \Delta \ln \Sigma M_1$$
$$(-.400) \ (4.02)$$

Period: 1982.1-1991.4 Adj $R^2=.52$ se=.0049 dw=1.94 rho=.0007

$$\Delta \ln GDP = -.0041 + .645 \Delta \ln \Sigma M_2$$
$$(-.886) \ (2.29)$$

Period: 1982.1-1991.4 Adj $R^2=.36$ se=.0056 dw=1.92 rho=.018

Casual investigation of the evidence points to the relative strength of $M_1$ in predicting nominal income in the 1980s. However, it can be argued that part of the changes in nominal income could have been possibly explained by changes in exchange rates during the period. For example the sharp appreciation and subsequent depreciation of the dollar exchange rate
TABLE 4.7.

DISTRIBUTED LAG MODEL:
US M1, M2 AND INCOME UNDER FIXED RATE SYSTEM: 1966.1-1973.2
Equation: $\Delta \ln GDP = \alpha + \gamma \Delta \ln M$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$\beta$ Coefficient</th>
<th>Adj $R^2$</th>
<th>SE</th>
<th>DW</th>
<th>$\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.0065 (-.851)</td>
<td>.38</td>
<td>.0070</td>
<td>1.93</td>
<td>.012</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,1}$</td>
<td>.111 (1.13)</td>
<td>.530</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,2}$</td>
<td>.091 (.769)</td>
<td>.424</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,3}$</td>
<td>.406 (3.08)***</td>
<td>1.88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,4}$</td>
<td>.178 (1.40)</td>
<td>.876</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,5}$</td>
<td>.147 (1.17)</td>
<td>.739</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,6}$</td>
<td>.148 (1.41)</td>
<td>.740</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,7}$</td>
<td>-.103 (-1.05)</td>
<td>-.514</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{1,8}$</td>
<td>.002 (1.32)</td>
<td>.221</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln M_1$</td>
<td>.983 (1.93)*</td>
<td>4.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-.0100 (-2.15)**</td>
<td>.17</td>
<td>.0082</td>
<td>2.00</td>
<td>-.002</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,1}$</td>
<td>.849 (2.01)**</td>
<td>.865</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,2}$</td>
<td>-1.06 (-1.33)</td>
<td>-1.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,3}$</td>
<td>1.18 (1.48)</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,4}$</td>
<td>-.705 (-.961)</td>
<td>-.659</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,5}$</td>
<td>.773 (1.00)</td>
<td>.701</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,6}$</td>
<td>-.683 (-.937)</td>
<td>-.610</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,7}$</td>
<td>.588 (1.37)</td>
<td>.509</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M_{2,8}$</td>
<td>.002 (1.64)</td>
<td>.281</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln M_2$</td>
<td>.941 (3.83)***</td>
<td>1.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. $R^2$ is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho ($\rho$) is the coefficient of first-order serial correlation.
3. Significant * 5% level, ** 2.5%, *** 1%.

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TABLE 4.8.
DISTRIBUTED LAG MODEL:
US M1, M2 AND INCOME UNDER FLEXIBLE RATE SYSTEM: 1982.1-1991.4
Equation: $\Delta \ln \text{GDP} = \alpha + \gamma \Delta \ln M$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$\beta$ Coefficient</th>
<th>Adj $R^2$</th>
<th>SE</th>
<th>DW</th>
<th>$\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.0007 (-.400)</td>
<td>-.322</td>
<td>.52</td>
<td>.0049</td>
<td>1.94</td>
<td>.007</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-1}$</td>
<td>-.186 (-1.42)</td>
<td>-.322</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-2}$</td>
<td>.359 (2.20)**</td>
<td>.623</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-3}$</td>
<td>-.131 (-.807)</td>
<td>-.231</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-4}$</td>
<td>.141 (1.02)</td>
<td>.275</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-5}$</td>
<td>-.090 (-1.08)</td>
<td>-.205</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-6}$</td>
<td>.125 (1.97)*</td>
<td>.282</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-7}$</td>
<td>.159 (2.56)**</td>
<td>.359</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-8}$</td>
<td>.004 (2.70)**</td>
<td>.646</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
<tr>
<td>$\Delta \Sigma \ln M1$</td>
<td>.381 (4.02)**</td>
<td>1.42</td>
<td>.36</td>
<td>.0056</td>
<td>1.92</td>
<td>.018</td>
</tr>
</tbody>
</table>

NOTES:
1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. $R^2$ is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho ($\rho$) is the coefficient of first-order serial correlation.
3. Significant at *5% level, ** 2.5%, *** 1%.
in the 1980s brought about by fiscal policy shocks, are found to have had important short-run effect on the economy (Meltzer 1993). Earlier McKinnon (1984) has shown that during the "weak" dollar standard of 1973-82, a purely domestic money supply equation (with suitable lags) is able to explain only 50 percent of variation (adjusted R2) in nominal income. However, the addition of the exchange rate had greatly enhanced the statistical fit of the model to 86 percent. Without the exchange rate variable the effect of money supply on income is obscured.

If the effect of exchange rate on nominal income is systematic and is indicative of growing interaction with the rest of the world, one would expect the exchange rate to have predictive power for nominal income over and above the information contained in the growth rate of money supply. Thus, it would be informative to test this hypothesis. The results of this test are presented below (Tables 4.9 and 4.10):

$$\Delta \ln GDP = .0050 - .0008 \Delta \ln M1 - .497 \Delta \ln EEXRATE$$

$$(-.309) \quad (-.0006) \quad (-.490)$$

Period: 1966.1-1973.2 Adj $R^2$=.30 se=.0075 dw=1.77 rho=.089

$$\Delta \ln GDP = -.0094 + .992 \Delta \ln M2 - .781 \Delta \ln EEXRATE$$

$$(-2.00) \quad (3.65) \quad (-3.31)$$

Period: 1966.1-1973.2 Adj $R^2$=.75 se=.0044 dw=2.51 rho=-.286

In the fixed period, the inclusion of the exchange rate has increased the explanatory power of $M2$ but not of $M1$. The marginal contribution of $M2$ is further enhanced by the exchange rate variable as indicated by the sum of lag coefficients that is almost equal to unity and highly significant. At the same time the growth rate in dollar exchange rate is also significant in predicting the growth rate of nominal income during the period. In contrast,
TABLE 4.9.
DISTRIBUTED LAG MODEL:
Equation: $\Delta \ln GDP = \alpha + \gamma \Delta \ln M1 + \delta \Delta \ln EXRATE$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$\beta$ Coefficient</th>
<th>Adj R$^2$</th>
<th>SE</th>
<th>DW</th>
<th>$\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.0050 (.309)</td>
<td>.30</td>
<td>.0075</td>
<td>1.77</td>
<td>.089</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-1}$</td>
<td>.044 (.210)</td>
<td>.211</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-2}$</td>
<td>.117 (.429)</td>
<td>.544</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-3}$</td>
<td>.144 (.536)</td>
<td>.668</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-4}$</td>
<td>.009 (.039)</td>
<td>.045</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-5}$</td>
<td>-.026 (-.063)</td>
<td>-.130</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-6}$</td>
<td>-.112 (-.642)</td>
<td>-.560</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-7}$</td>
<td>-.106 (-.625)</td>
<td>-.530</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-8}$</td>
<td>-.071 (-.229)</td>
<td>-.735</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln M1$</td>
<td>-.0008 (-.0006)</td>
<td>-7.10</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-1}$</td>
<td>-.140 (-.373)</td>
<td>-.183</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-2}$</td>
<td>-.048 (-.139)</td>
<td>-.062</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-3}$</td>
<td>-.153 (-.500)</td>
<td>-.194</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-4}$</td>
<td>-.123 (-.151)</td>
<td>-.155</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-5}$</td>
<td>-.412 (-.599)</td>
<td>-.437</td>
<td></td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-6}$</td>
<td>.342 (.606)</td>
<td>.297</td>
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<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-7}$</td>
<td>-.038 (-.048)</td>
<td>-.023</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-8}$</td>
<td>.077 (.233)</td>
<td>7.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln E$</td>
<td>-.497 (-.490)</td>
<td>6.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. $R^2$ is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and $\rho$ ($\rho$) is the coefficient of first-order serial correlation.
3. Significant at *5% level, ** 2.5%, *** 1%.
TABLE 4.10.

DISTRIBUTED LAG MODEL:
Equation: $\Delta \ln GDP = \alpha + \gamma \Delta \ln M2 + \delta \Delta \ln EXRATE$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$\beta$ Coefficient</th>
<th>Adj $R^2$</th>
<th>SE</th>
<th>DW</th>
<th>$\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.0094 (-2.00)**</td>
<td>.75</td>
<td>.0044</td>
<td>2.51</td>
<td>-.286</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-1}$</td>
<td>.975 (2.87)***</td>
<td>.993</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-2}$</td>
<td>-.798 (-1.33)</td>
<td>-.786</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-3}$</td>
<td>-.360 (-.489)</td>
<td>-.340</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-4}$</td>
<td>1.82 (1.86)*</td>
<td>1.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-5}$</td>
<td>-1.35 (-1.21)</td>
<td>-1.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-6}$</td>
<td>.645 (.594)</td>
<td>.576</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-7}$</td>
<td>-.741 (-1.01)</td>
<td>-.642</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln M2$</td>
<td>.806 (3.96)***</td>
<td>8.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln E$</td>
<td>.992 (3.65)***</td>
<td>9.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| $\Delta \ln E_{t-1}$ | .850 (4.92)*** | 1.10                 |           |       |       |
| $\Delta \ln E_{t-2}$ | -.813 (-2.77)** | -1.04             |           |       |       |
| $\Delta \ln E_{t-3}$ | -.181 (-.660) | -.229               |           |       |       |
| $\Delta \ln E_{t-4}$ | 1.00 (2.40)*** | 1.26              |           |       |       |
| $\Delta \ln E_{t-5}$ | -.539 (-1.64) | -.571             |           |       |       |
| $\Delta \ln E_{t-6}$ | -1.92 (-.501) | -1.167           |           |       |       |
| $\Delta \ln E_{t-7}$ | .099 (.310) | .061               |           |       |       |
| $\Delta \ln E_{t-8}$ | -1.00 (-3.95)** | -8.73         |           |       |       |

NOTES:

1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. $R^2$ is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho ($\rho$) is the coefficient of first-order serial correlation.
3. Significant at * 5% level, ** 2.5%, *** 1%.
the ability of M1, when combined with the exchange rate, to predict domestic GDP is very weak. The sum of lag coefficients for M1 is not only insignificant but has also a wrong sign ("negative"). The exchange rate has the right sign but is not statistically significant. One explanation is a possible collinearity problem between M1 and exchange rate. If there is an exact linear relationship between M1 and exchange rate, then there is no way to assess their separate influence on domestic income. Therefore it is possible that the exchange rate in our income equation picks up the independent effects of M1, thus distorting the predictive power of M1 on domestic GDP. Nonetheless, the predictive content of the exchange rate during the fixed period becomes more evident when the overall fit of our output regressions (the adjusted R^2) is examined. This is true in the case of M2 in which the adjusted R^2 increases as one moves from fitting the equation with money supply only (Adj R^2=.17), to the equation where exchange rate is also included as explanatory variable (Adj R^2=.75). Under the flexible system, the proportion of total GDP variance explained by the model with exchange rate is increased significantly, and this is true in every equation regardless of the monetary variables (M1 or M2) used (Tables 4.11-4.12):

33 While the issue of collinearity (existence of a single linear relationship) or multicollinearity (existence of more than one exact linear relationship) crops up frequently in empirical analyses, it does not present serious estimation problems. According to Achen (1982), with multicollinearity problem, "unbiased, consistent estimates will occur, and their standard errors will be correctly estimated. The only effect of multicollinearity is to make it hard to get coefficient estimates with small standard error." Kmenta (1986) also warns that "the meaningful distinction is not between the presence or the absence of multicollinearity, but between its various degrees." In fact, some economists argue that multicollinearity is not a serious problem if the sole purpose of regression analysis is prediction or forecasting (Geary 1963), and if the existing collinearity structure continues in the future samples (Judge et. al., 1985).
\[ \Delta \ln \text{GDP} = -0.0026 + 0.533 \Delta \ln \Sigma M1 + 0.011 \Delta \ln \Sigma \text{EXRATE} \]
\[ \text{(Period: 1982.1-1991.4) Adj } R^2 = 0.82 \text{ se = 0.0029 dw = 1.53 rho = 0.186} \]

\[ \Delta \ln \text{GDP} = -0.0090 + 0.911 \Delta \ln \Sigma M2 - 0.133 \Delta \ln \Sigma \text{EXRATE} \]
\[ \text{(Period: 1982.1-1991.4) Adj } R^2 = 0.73 \text{ se = 0.0036 dw = 1.50 rho = 0.247} \]

An examination of our results suggests that when M2 is used in our income model, the effect of exchange rate on income is not obscured. The dollar exchange rate variable has the correct sign and is highly significant. In contrast, with M1, the predictive power of exchange rate over nominal income is now insignificant and with the wrong sign ("positive"). This despite the fact that the growth in M1 is able to explain at least 82 percent of variance in domestic GDP growth while M2 growth can only explain 73 percent. But this particular result cannot be taken to conclude that M2 is not as good as M1 in predicting growth in domestic income in the period 1982-91. The fact that our income equation yields consistent estimate of coefficients (in terms of size and sign) when M2 is used, may lead us to think that M2 is still better than M1, despite a slightly greater fit of the model based on M1.

Clearly, the foregoing results suggest that once the effects of exchange rate changes are accounted for, the growth rate of domestic money supply provide a usefully stable information for predicting the growth of income. This is particularly true during the 1980s of wide fluctuations in the value of the dollar exchange rate. To further examine the relative contribution of exchange rate in our income model, the beta coefficients or standard regression coefficients are also presented in Tables 4.9-4.12. A variable is said to be standardized if it is expressed in terms of standard deviation from its mean and divided by its
TABLE 4.11.
DISTRIBUTED LAG MODEL:
Equation: $\Delta \ln GDP = \alpha + \gamma \Delta \ln M1 + \delta \Delta \ln EXRATE$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$\beta$ Coefficient</th>
<th>Adj $R^2$</th>
<th>SE</th>
<th>DW</th>
<th>$\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.0026 (-5.67)**</td>
<td>.82</td>
<td>.0029</td>
<td>1.53</td>
<td>.186</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-1}$</td>
<td>-.008 (-.098)</td>
<td>-.014</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-2}$</td>
<td>.358 (3.46)***</td>
<td>.620</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-3}$</td>
<td>-.171 (-1.65)</td>
<td>-.302</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-4}$</td>
<td>.153 (1.83)*</td>
<td>.298</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-5}$</td>
<td>-.041 (-.802)</td>
<td>-.094</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-6}$</td>
<td>.099 (2.44)***</td>
<td>.226</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-7}$</td>
<td>.097 (2.67)***</td>
<td>.220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1_{t-8}$</td>
<td>.045 (4.12)***</td>
<td>6.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M1$</td>
<td>.533 (18.72)**</td>
<td>7.86</td>
<td></td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-1}$</td>
<td>-.013 (-1.20)</td>
<td>-.114</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-2}$</td>
<td>.004 (.325)</td>
<td>.034</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-3}$</td>
<td>.002 (.171)</td>
<td>.016</td>
<td></td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-4}$</td>
<td>.045 (3.38)</td>
<td>.345</td>
<td></td>
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<tr>
<td>$\Delta \ln E_{t-5}$</td>
<td>.017 (1.20)</td>
<td>.131</td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-6}$</td>
<td>.023 (1.77)</td>
<td>.177</td>
<td></td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-7}$</td>
<td>-.012 (-.904)</td>
<td>-.095</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-8}$</td>
<td>-.054 (-3.92)**</td>
<td>-6.43</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln E$</td>
<td>.011 (812)</td>
<td>-5.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. $R^2$ is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho ($\rho$) is the coefficient of first-order serial correlation.
3. Significant at *5% level, ** 2.5%, *** 1%.
TABLE 4.12.
DISTRIBUTED LAG MODEL:
Equation: $\Delta \ln GDP = \alpha + \gamma \Delta \ln M2 + \delta \Delta \ln EXRATE$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$\beta$ Coefficient</th>
<th>Adj $R^2$</th>
<th>SE</th>
<th>DW</th>
<th>$\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.0090 (-6.53)</td>
<td></td>
<td>.73</td>
<td>.0036</td>
<td>1.50</td>
<td>.247</td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-1}$</td>
<td>.212 (1.22)</td>
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<td>.213</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-2}$</td>
<td>.669 (3.72)**</td>
<td></td>
<td>.634</td>
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</tr>
<tr>
<td>$\Delta \ln M2_{t-3}$</td>
<td>-.275 (-1.59)</td>
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<td>-.272</td>
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</tr>
<tr>
<td>$\Delta \ln M2_{t-4}$</td>
<td>.018 (.111)</td>
<td></td>
<td>.023</td>
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</tr>
<tr>
<td>$\Delta \ln M2_{t-5}$</td>
<td>.313 (2.97)**</td>
<td></td>
<td>.399</td>
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</tr>
<tr>
<td>$\Delta \ln M2_{t-6}$</td>
<td>-.034 (-.321)</td>
<td></td>
<td>-.043</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-7}$</td>
<td>-.037 (-3.48)**</td>
<td></td>
<td>-.046</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln M2_{t-8}$</td>
<td>.046 (4.47)**</td>
<td></td>
<td>8.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln M2$</td>
<td>.911 (10.03)**</td>
<td></td>
<td>9.45</td>
<td></td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-1}$</td>
<td>-.326 (-2.06)**</td>
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<td>-.267</td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-2}$</td>
<td>-.008 (-.566)</td>
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<td>-.071</td>
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<tr>
<td>$\Delta \ln E_{t-3}$</td>
<td>-.004 (-.304)</td>
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<td>-.032</td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-4}$</td>
<td>.039 (2.66)**</td>
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<td>.300</td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-5}$</td>
<td>-.004 (-.325)</td>
<td></td>
<td>-.035</td>
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</tr>
<tr>
<td>$\Delta \ln E_{t-6}$</td>
<td>.019 (1.24)</td>
<td></td>
<td>.145</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-7}$</td>
<td>-.072 (-4.43)**</td>
<td></td>
<td>-.555</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-8}$</td>
<td>-.069 (-4.22)**</td>
<td></td>
<td>-8.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \Sigma \ln E$</td>
<td>-.133 (-6.96)**</td>
<td></td>
<td>-8.64</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. $R^2$ is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho ($\rho$) is the coefficient of first-order serial correlation.
3. Significant at *5% level, ** 2.5%, *** 1%.
standard deviation (Gujarati 1988). Therefore, the beta coefficients in our model approximate the change in domestic GDP, on the average, when the dollar exchange rate or money supply changes by one standard deviation.

Analysis of these beta coefficients yields some interesting results. For one, even though both M1 and M2 are statistically significant in predicting income, the marginal contribution of M2 is higher than M1. Note that the sum of lag beta coefficients of M2 in Tables 4.12 is higher than that of M1 in Table 4.11 (9.45 for M2 and 7.86 for M1), indicating a greater marginal effect of M2 in explaining domestic nominal income. Moreover, both M2 and the dollar exchange rate are equally important variables as far as changes in nominal income are concerned. Although the variance in income that is due to money supply changes is a little bit greater than the one that is caused by exchange rate disturbances, the difference is very small. For example, during the 1982–91 period, a change in one standard deviation in M2 would produce a change of about 9.45 standard deviation in nominal GDP, and a change of one standard deviation in dollar exchange rate would produce a 8.64 standard deviation in income. This, in a way, confirms the relative importance placed on exchange rate variable.

4.2.2 World Money as Predictor of US Nominal Income

As indicated above, the earlier focus on the M2 money supply as indicator of monetary policy is no longer enough in view of an increasingly open US economy. This explains the increased confidence placed on the dollar exchange rate as an important variable to reflect the growing interaction of the US economy with the rest of the world. Earlier
McKinnon and others have shown that world money is a better predictor of prices than domestic money under the flexible rate system.

Our empirical investigation is extended to account for any independent effect of world money on income. World money is measured as the weighted average of growth rates of nominal money supplies of Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, and United Kingdom, expressed in terms of dollars. The exchange rate index used to convert world money in dollars is the index of the trade-weighted exchange value of the dollar as measured by the Federal Reserve System. The weights used in generating the world money supply variable equal to that of each country's average share of total world trade (imports plus exports) for the five years 1972-76. These are the same weights used in the Fed's measure of the dollar exchange rate.34

If world monetary conditions constitute an important channel by which domestic monetary policy impacts domestic income, then we would expect fluctuations in world money supply growth to contain information about movements in domestic income growth.

34 The measure of world money supply variable used in this paper differs from McKinnon's methodology in two aspects. First, world money growth is calculated as the weighted average of the growth rates of nominal money supplies of 10 industrial countries excluding the United States. McKinnon calls this the rest of the world money (ROW) while world money is: the sum of the growth rates of money supplies of eleven countries including the US. Moreover, McKinnon does not incorporate exchange rate changes in measuring his world monetary variables. Second, unlike in McKinnon's study, the fixed weights used in calculating the world money correspond to each country's share of total world trade (imports plus exports) for the five years 1972-76, and are given as follows: Belgium (.064), Canada (.091), France (.131), Germany (.208), Italy (.090), Japan (.136), Netherlands (.083), Sweden (.042), Switzerland (.036), and United Kingdom (.119). The reason for this is to achieve consistency since the same weights are used in calculating the weighted average exchange value of the dollar. For details of how the dollar index is measured, see the technical note in the Federal Reserve Bulletin (August 1978), p. 700.
Moreover, if world money is indeed significant, our income regressions must show higher predictive power than what has been already accounted for by domestic money and exchange rate.

Such predictable relationship on income appears to hold up in the case of world money. This is evident from the results below (Table 4.13):

\[
\Delta \ln \text{CDP} = -0.0085 + 0.900\Delta \ln \Sigma M2 + 0.114\Delta \ln \Sigma \text{WORLD}
\]

\((-5.21) \quad (8.12) \quad (5.36)\)

Period: 1982.1-1991.4 Adj $R^2=.59$ se=.0045 dw=1.90 rho=.039

As the above results show, the dollar value of world money is a crucial variable in the determination of domestic income. The sum of lag coefficients is both significant and positive, a result that supports a strong positive impact of world monetary growth in earlier empirical studies (McKinnon 1984). In fact there's a great deal of evidence of this predicted relationship in our results, regardless of whether the short-term (the individual lag coefficients) or the long-term impact (the sum of lag coefficients) of world money on income is examined. The inclusion of world money as another explanatory variable enhances the predictive power of our income equation. The overall fit of the income equation is increased significantly to 59 percent (model with world money and M2). In contrast, in a model with only domestic money (M2), the overall significance of the income regression is only 36 percent. It appears that world money has an independent effect on domestic GDP over and above that of domestic money. Even in the presence of world money, the coefficients for M2 remain high and significant.
### Table 4.13.

#### Distributed Lag Model:

Equation: \( \Delta \ln GDP = \alpha + \gamma \Delta \ln M2 + \delta \Delta \ln \text{WORLD} \)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>( \beta ) Coefficient</th>
<th>Adj ( R^2 )</th>
<th>SE</th>
<th>DW</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.008 (-5.21)</td>
<td>.59</td>
<td>.0045</td>
<td>1.90</td>
<td>.039</td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,1} )</td>
<td>.254 (.929)</td>
<td>.255</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,2} )</td>
<td>.464 (1.54)</td>
<td>.440</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,3} )</td>
<td>-.060 (-.219)</td>
<td>-.059</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,4} )</td>
<td>-.017 (-.078)</td>
<td>-.022</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,5} )</td>
<td>.308 (1.91)*</td>
<td>.392</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,6} )</td>
<td>-.075 (-.428)</td>
<td>-.095</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,7} )</td>
<td>-.015 (-.083)</td>
<td>-.019</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t,8} )</td>
<td>.042 (3.79)**</td>
<td>7.88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \Sigma \ln M2 )</td>
<td>.900 (8.12)**</td>
<td>8.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,1} )</td>
<td>.019 (1.37)</td>
<td>.262</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,2} )</td>
<td>.003 (.171)</td>
<td>.045</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,3} )</td>
<td>.006 (.406)</td>
<td>.092</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,4} )</td>
<td>-.027 (-2.08)**</td>
<td>-.371</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,5} )</td>
<td>-.007 (-.609)</td>
<td>-.096</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,6} )</td>
<td>.005 (.302)</td>
<td>.072</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,7} )</td>
<td>.048 (2.78)**</td>
<td>.647</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln W_{t,8} )</td>
<td>.064 (3.64)**</td>
<td>7.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \Sigma \ln W )</td>
<td>.114 (5.36)**</td>
<td>8.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:

1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. \( R^2 \) is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho (\( \rho \)) is the coefficient of first-order serial correlation.
3. Significant at * 5% level, ** 2.5%, *** 1%.
An examination of the beta coefficients for M2 and world money further shows that the marginal contributions of these variables in explaining domestic income are almost the same. When domestic income is estimated with M2 and world money, a one standard deviation increase in M2 will raise income by 8.77 standard deviation, while an increase of one standard deviation in world money causes nominal GDP to increase by 8.31 standard deviation. In contrast, when M2 is the only explanatory variable, the variation in income that is due to the influence of domestic money is very small, at .920 standard deviation. It seems that domestic money is likely to have a greater predictive power in estimating domestic income when world money is included in the estimation.

4.2.3 Velocity and Opportunity Cost of Money

Until 1982 economists were confident that specification based on M1 are relatively stable and can be predicted by a few variables like income and interest rate. The fact that a stable money demand exists also implies a stable relationship between money and nominal income. In such a case the M1 aggregate can be used as a reliable guide for formulating monetary policy. Yet, as is already well known, assumptions of a stable M1 velocity had been clearly refuted in the 1980s.

In contrast, the velocity of M2 is relatively stable and one major reason is because its opportunity cost is also stable. The opportunity cost of M2, defined as a spread between the market rates and yields on demand deposit components of M2, is stationary around a trendless differential and hence would be independent of any trend in interest rates. This explains why the M2 velocity will not be affected by interest rate trends in the long run.
However, in the short run, when deposit rates adjust instantaneously but only partially to a change in market interest rates, the interest elasticity would be proportional but less than the opportunity cost elasticity. Equilibrium money demand would hence be affected, and the velocity would be positively related to the opportunity cost of holding M2 (Carlson 1989).

That M2 velocity is closely related to the opportunity cost of M2 may provide new insights as to the relative importance of opportunity cost measure in the demand for money. If the opportunity cost can affect the velocity of money, then changes in opportunity cost can also be used to predict changes in nominal income. Thus it is expected that the inclusion of opportunity cost variable in our empirical model will give the income equation a better fit.

To test this hypothesis, the opportunity cost of M2 is included in our income equation, in addition to M2, world money, and exchange rate. The M2 opportunity cost is measured as the difference between the weighted average of yields on the three month Treasury bill and three-year Treasury note and the weighted average of rates paid on M2 instruments.35 Initially domestic income growth is regressed against the growth rates of M2 and its opportunity cost. The evidence in Table 4.14 suggests that the marginal contribution of M2 opportunity cost in predicting domestic GDP over the 1982-91 period is quite weak. This is indicated below by insignificant and small size of the coefficients. The effect of including the M2 opportunity cost in the pure money supply equation only reduced the overall fit of the model, a decline in the proportion of GDP variance explained from 36 percent to 30 percent. It appears that the opportunity cost variable picks up the predictive power of M2

35 The M2 opportunity cost used in this paper is the measure adopted by the staff of the Board of Governors of the Federal Reserve Bank System. John Carlson of the Federal Reserve Bank of Cleveland generously provided the data for this study.
and distorts the ability of monetary variable (M2) and in the model to explain changes in US income.36

\[ \Delta \ln GDP = -0.0016 + 0.564 \Delta \ln \Sigma M2 - 0.003 \Delta \ln \Sigma OPCOST \]
\[ (-0.287) \quad (1.64) \quad (-0.155) \]

Period: 1982.1-1991.4 Adj R²=.30 se=.0059 dw=2.11 rho=-.092

But again a more interesting result is the consistently significant effect of the exchange rate in the income equation, when exchange rate is added to M2, world money, and M2 opportunity cost as explanatory variables. The introduction of exchange rate does not only enhance the predictive content of the model (at least 82 percent of variance in domestic GDP - the adjusted R² - can be explained), but it also allows for greater independent effect of M2 on income (Table 4.15). It is also interesting to note that the dollar value of world money is still marginally significant even in the presence of opportunity cost of M2 (Table 4.16):

\[ \Delta \ln GDP = -0.0058 + 0.725 \Delta \ln \Sigma M2 - 0.007 \Delta \ln \Sigma OPCOST \]
\[ - 0.110 \Delta \ln \Sigma EXRATE \]
\[ (-1.56) \quad (3.26) \quad (-0.433) \]

\[ (-4.40) \]

Period: 1982.1-1991.4 Adj R²=.82 se=.0029 dw=2.18 rho=-.095

\[ \Delta \ln GDP = -0.0054 + 0.789 \Delta \ln \Sigma M2 - 0.095 \Delta \ln \Sigma OPCOST \]
\[ + 0.095 \Delta \ln \Sigma WORLD \]
\[ (-1.42) \quad (3.55) \quad (-0.916) \]
\[ (3.11) \]

Period: 1982.1-1991.4 Adj R²=.72 se=.0037 dw=1.89 rho=.033

36 The results of the income regression relating GDP growth rate to growth rates of M2 and exchange rate are a suspect for possible collinearity problem given the insignificant values of the coefficients and low adjusted R². However, an examination of the partial correlation matrix reveals no evidence of collinearity between the two independent variables in the equation.
### Table 4.14.

**DISTRIBUTED LAG MODEL:**
**M2 AND OPPORTUNITY COST:** 1982.1-1991.4
**Equation:** \( \Delta \ln GDP = \alpha + \gamma \Delta \ln M2 + \delta \Delta \ln OPCOST \)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>( \beta ) Coefficient</th>
<th>Adj ( R^2 )</th>
<th>SE</th>
<th>DW</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.0016 (-.287)</td>
<td>.30</td>
<td>.0059</td>
<td>2.11</td>
<td>-.092</td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-1} )</td>
<td>.243 (.508)</td>
<td>.245</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-2} )</td>
<td>.994 (2.43)***</td>
<td>.944</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-3} )</td>
<td>-.388 (-.824)</td>
<td>-.382</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-4} )</td>
<td>-.350 (-.739)</td>
<td>-.449</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-5} )</td>
<td>-.054 (-.194)</td>
<td>-.069</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-6} )</td>
<td>-.006 (.024)</td>
<td>-.007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-7} )</td>
<td>.121 (.561)</td>
<td>.150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-8} )</td>
<td>.003 (1.12)</td>
<td>.571</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \Sigma \ln M2 )</td>
<td>.564 (1.64)</td>
<td>1.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-1} )</td>
<td>.005 (.710)</td>
<td>.152</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>( \Delta \ln OC_{t-2} )</td>
<td>.012 (1.23)</td>
<td>.349</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-3} )</td>
<td>.017 (1.71)</td>
<td>.489</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-4} )</td>
<td>-.004 (-.325)</td>
<td>-.114</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-5} )</td>
<td>-.020 (-2.09)**</td>
<td>-.564</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-6} )</td>
<td>-.002 (-.259)</td>
<td>-.079</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>( \Delta \ln OC_{t-7} )</td>
<td>-.012 (-1.38)</td>
<td>-.400</td>
<td></td>
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</tr>
<tr>
<td>( \Delta \ln OC_{t-8} )</td>
<td>.001 (.180)</td>
<td>.071</td>
<td></td>
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</tr>
<tr>
<td>( \Delta \Sigma \ln OC )</td>
<td>-.003 (-.155)</td>
<td>-.096</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. \( R^2 \) is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimation, and rho \( (\rho) \) is the coefficient of first-order serial correlation.
3. Significant at: *5% level, ** 2.5%, *** 1%.
TABLE 4.15.
DISTRIBUTED LAG MODEL:
M2, OPPORTUNITY COST, AND EXCHANGE RATE: 1982.1-1991.4
Equation:  \( \Delta \ln GDP = \alpha + \gamma \Delta \ln M2 + \delta \Delta \ln OPCOST + \lambda \Delta \ln EXRATE \)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>( \beta ) Coefficient</th>
<th>Adj R(^2)</th>
<th>SE</th>
<th>DW</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.0058 (-1.56)</td>
<td>.82</td>
<td>.0029</td>
<td>2.18</td>
<td>.022</td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-1} )</td>
<td>.308 (1.52)</td>
<td>.309</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-2} )</td>
<td>.713 (3.22)**</td>
<td>.676</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>( \Delta \ln M2_{t-3} )</td>
<td>-.437 (-1.90)*</td>
<td>-.431</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-4} )</td>
<td>-.262 (-1.27)</td>
<td>-.337</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-5} )</td>
<td>.180 (1.10)</td>
<td>.229</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-6} )</td>
<td>.038 (.197)</td>
<td>.048</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-7} )</td>
<td>.149 (.990)</td>
<td>.185</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln M2_{t-8} )</td>
<td>.035 (2.72)**</td>
<td>6.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \Sigma \ln M2 )</td>
<td>.725 (3.26)**</td>
<td>7.28</td>
<td></td>
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</tr>
<tr>
<td>( \Delta \ln OC_{t-1} )</td>
<td>.003 (.609)</td>
<td>.099</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>( \Delta \ln OC_{t-2} )</td>
<td>.001 (.258)</td>
<td>.055</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-3} )</td>
<td>.002 (.239)</td>
<td>.059</td>
<td></td>
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</tr>
<tr>
<td>( \Delta \ln OC_{t-4} )</td>
<td>.006 (.829)</td>
<td>.182</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-5} )</td>
<td>-.014 (-2.03)**</td>
<td>-.394</td>
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<tr>
<td>( \Delta \ln OC_{t-6} )</td>
<td>-.009 (-1.57)</td>
<td>-.301</td>
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<td></td>
</tr>
<tr>
<td>( \Delta \ln OC_{t-7} )</td>
<td>-.006 (-.908)</td>
<td>-.204</td>
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<tr>
<td>( \Delta \ln OC_{t-8} )</td>
<td>.007 (1.37)</td>
<td>.409</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>( \Delta \Sigma \ln OC )</td>
<td>-.007 (-.433)</td>
<td>-.094</td>
<td></td>
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</table>
TABLE 4.15. (Continued)  
DISTRIBUTED LAG MODEL:  
M2, OPPORTUNITY COST, AND EXCHANGE RATE: 1982.1-1991.4

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>β Coefficient</th>
<th>Adj R²</th>
<th>SE</th>
<th>DW</th>
<th>ρ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δln E_{t-1}</td>
<td>-.048 (-2.20)**</td>
<td>-.394</td>
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<tr>
<td>Δln E_{t-2}</td>
<td>-.016 (-.829)</td>
<td>-.136</td>
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<td>Δln E_{t-3}</td>
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<tr>
<td>Δln E_{t-4}</td>
<td>.033 (2.04)**</td>
<td>.257</td>
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<tr>
<td>Δln E_{t-5}</td>
<td>.008 (.519)</td>
<td>.062</td>
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<tr>
<td>Δln E_{t-6}</td>
<td>.025 (1.51)</td>
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<tr>
<td>Δln E_{t-7}</td>
<td>-.083 (-4.62)**</td>
<td>-.636</td>
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<tr>
<td>Δln E_{t-8}</td>
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<tr>
<td>ΔΣln E</td>
<td>-.110 (-4.40)**</td>
<td>-6.87</td>
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</tbody>
</table>

NOTES:
1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. R² is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho (p) is the coefficient of first-order serial correlation.
3. Significant at: * 5% level, ** 2.5%, *** 1%. 
**TABLE 4.16.**

**DISTRIBUTED LAG MODEL:**
M2, OPPORTUNITY COST, AND WORLD MONEY: 1982.1-1991.4

Equation: \( \Delta \ln GDP = \alpha + \gamma \Delta \ln M2 + \delta \Delta \ln OC + \lambda \Delta \ln WORLD \)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Beta Coefficient</th>
<th>Adj R^2</th>
<th>SE</th>
<th>DW</th>
<th>( \rho )</th>
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<tr>
<td>Constant</td>
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<td>.0037</td>
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<tr>
<td>( \Delta \ln M2_{t-1} )</td>
<td>.620 (2.25)**</td>
<td>.623</td>
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<tr>
<td>( \Delta \ln M2_{t-2} )</td>
<td>.966 (2.59)***</td>
<td>.917</td>
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<td>( \Delta \ln M2_{t-3} )</td>
<td>-.733 (-2.32)**</td>
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<tr>
<td>( \Delta \ln M2_{t-4} )</td>
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<td>( \Delta \ln M2_{t-5} )</td>
<td>.217 (1.20)</td>
<td>.277</td>
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<td>( \Delta \ln M2_{t-6} )</td>
<td>.306 (1.19)</td>
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<tr>
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<tr>
<td>( \Delta \ln M2_{t-8} )</td>
<td>.065 (3.44)***</td>
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<tr>
<td>( \Delta \Sigma \ln M2 )</td>
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<td>12.47</td>
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<tr>
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<td>-.219</td>
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<tr>
<td>( \Delta \ln OC_{t-2} )</td>
<td>.020 (1.79)*</td>
<td>.583</td>
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<td>-.531</td>
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<td>-.389</td>
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<tr>
<td>( \Delta \ln OC_{t-8} )</td>
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<td>.635</td>
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<td>( \Delta \Sigma \ln OC )</td>
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<td>-.295</td>
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### TABLE 4.16. (Continued)
**DISTRIBUTED LAG MODEL:**
**M2, OPPORTUNITY COST, AND WORLD MONEY: 1982.1-1994.1**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>β Coefficient</th>
<th>Adj R²</th>
<th>SE</th>
<th>DW</th>
<th>ρ</th>
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</thead>
<tbody>
<tr>
<td>ΔlnW_{t-1}</td>
<td>.005 (.239)</td>
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<td>ΔlnW_{t-2}</td>
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<td>ΔlnW_{t-3}</td>
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<tr>
<td>ΔlnW_{t-4}</td>
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<td>-.655</td>
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<td>ΔlnW_{t-5}</td>
<td>.002 (.127)</td>
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<tr>
<td>ΔlnW_{t-6}</td>
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<td>-.073</td>
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<tr>
<td>ΔlnW_{t-7}</td>
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<td>.521</td>
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</tr>
<tr>
<td>ΔlnW_{t-8}</td>
<td>.103 (3.51)***</td>
<td>12.24</td>
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</tr>
<tr>
<td>ΔΣlnW</td>
<td>.095 (3.11)***</td>
<td>12.11</td>
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</tr>
</tbody>
</table>

**NOTES:**
1. Figures are estimated and standardized (beta) coefficients and t-ratios in parentheses.
2. R² is the adjusted coefficient of determination; DW is the Durbin Watson statistics, SE the standard error of estimate, and rho (ρ) is the coefficient of first-order serial correlation.
3. Significant at * 5% level, ** 2.5%, *** 1%.
After introducing changes in the exchange rate, changes in the opportunity cost of M2 explain nothing about changes in domestic GDP. Instead changes in the dollar exchange rate convey more usefully relevant information than information provided by changes in the opportunity cost. In the presence of the exchange rate, domestic money seems to predict income better than any other variables in the model.

4.3 Predicting the M1 and M2 Velocities From Income Regressions

The income regressions reported in the preceding section confirm the validity of our empirical question: after accounting for the behavior of money, does the behavior of exchange rate have additional explanatory power for domestic income? The evidence presented so far suggest a strong case in support of our hypothesis. It is clear that the US dollar exchange rate should be included as an additional variable in predicting domestic aggregate demand in the United States.

However, the usefulness of the model's empirical results depends not only on the strength of relationships of money supply and exchange rate to income, but also on the stability and predictability of those relationships. If the combination of M2 and exchange rate can predict domestic income better than any other variables, then such equation should be able to capture the swings in income growth reasonably well. Table 4.17 shows the forecast performance of various regressions that are estimated within the model's estimation periods - 1966.1 to 1973.2 (fixed) and 1982.1 to 1991.4 (flexible). The forecasting ability

37 The forecast evaluation results for six income regressions under the flexible rate system are all reported, while in the case of fixed period the best forecast of GDP growth is derived from two equations. As earlier argued, the world money supply variable is not a
of each income regression is evaluated using the root mean squared error and Theil's inequality coefficient as criteria for best forecast.

One noticeable result from the table is that an equation involving the exchange rate and M2 always yields the most accurate forecast of GDP growth. For example, under the flexible system, a model based on M2 and exchange rate seems to track reasonably well changes in GDP unlike the other income regressions. The stability of its forecast can be gleaned from a high correlation of .74 between the actual and forecasted values and a small root mean squared error and low inequality coefficient.\footnote{38}

Thus the forecasts of M1 and M2 velocities under the flexible rate system (Table 4.18) are basically derived from our initial results. Using the forecasted values of GDP and historical values of money supply, the percentage change in the predicted velocity is equal to the percentage change in forecasted GDP minus the percentage change in actual money stock. The predicted values of GDP are obtained from the best forecasts of income regressions given in Table 4.17.\footnote{39} Figure 4.3 shows the ability of income regression to track the relevant during the years of stable and fixed exchange rates. Hence the reason no income regression involving such variable is estimated in the fixed period. Since the main focus of this empirical study is a test of factors affecting income during the flexible rate regime, the predictive content of the six income regressions is analyzed to determine the best forecast of GDP growth.

\footnote{38} SHAZAM reports both statistics in evaluating the accuracy of forecasts. As a rule of thumb, the smaller the value of the RMSE and Theil's inequality coefficient, the better is the forecasting performance of the model. For further discussion of these concepts, see Madalla's \textit{Introduction to Econometrics} (1988) and Theil's \textit{Applied Economic Forecasting} (1966).

\footnote{39} These equations are $\Delta \ln GDP = \alpha + \gamma \Delta \ln M1 + \delta \Delta \ln OPCOST + \lambda \Delta \ln EXRATE$ and $\Delta \ln GDP = \alpha + \gamma \Delta \ln M2 + \delta \Delta \ln EXRATE$ for monetary aggregates M1 and M2, respectively.
relation between the actual and predicted velocities during the flexible rate period. In the case of M1 velocity, the forecast appears to fit well, with relatively small predicted errors ranging from -26 percentage point to +0.01 percentage point (Table 4.18). Moreover, the overprediction in some quarters is offset by an underprediction of velocities noted in other estimation periods, resulting in the predicted and actual M1 velocities that approximate each other very well (Figure 4.3).

In contrast, the predicted M2 velocity also appears to approximate well its actual value despite some sizable misses towards the beginning of 1990. In Figure 4.4 the divergence between actual and predicted values of M2 velocities becomes more pronounced as the forecasting horizon lengthens. One possible explanation is that since the late 1990, the growth of nominal GDP appears to have slowed down. The slower income growth is then reflected in a lower value of actual velocity than the predicted velocity which is based on the forecasted values of income.

Thus, taken together, the empirical model provides two useful observations. For one, the estimated income regressions used to carry out the empirical investigation in this study are able to predict changes in M1 and M2 velocities during the flexible rate period. Moreover, the predictions of the income model can be applied to make accurate forecasts of velocities. Second, the earlier view that argues for the use of exchange rate as important indicator of aggregate demand, in addition to money stock, is ably supported by the empirical

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40 Since the income regressions under the fixed rate period do not yield consistent estimates and fit, no forecasts of velocities based on these regressions are made. In contrast, forecasting the velocities in the flexible period is undertaken in view of the good results obtained in our initial regression runs.
results. Our implied forecasts of M1 and M2 velocities in Figures 4.3-4.4 confirm this. When the forecasted values of GDP are derived from an income model that includes the exchange rate, the predicted and actual values of velocities tend to be fairly close. This, in a way, validates the empirical significance of income relationships that are examined in this study.
TABLE 4.17
EVALUATION OF GDP GROWTH FORECASTS

<table>
<thead>
<tr>
<th>Regression</th>
<th>Root Mean Squared Error</th>
<th>Theil’s Inequality Coefficient</th>
<th>R² between actual and predicted values</th>
</tr>
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<tbody>
<tr>
<td>M1</td>
<td>.0060</td>
<td>.490</td>
<td>.53</td>
</tr>
<tr>
<td>M1 + EXRATE*</td>
<td>.0059</td>
<td>.478</td>
<td>.56</td>
</tr>
<tr>
<td>M2*</td>
<td>.0078</td>
<td>.596</td>
<td>.31</td>
</tr>
<tr>
<td>M2 + EXRATE</td>
<td>.0086</td>
<td>.695</td>
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<tr>
<td>M1</td>
<td>.0045</td>
<td>.561</td>
<td>.63</td>
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<tr>
<td>M1 + EXRATE</td>
<td>.0036</td>
<td>.472</td>
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<td>M1 + WORLD</td>
<td>.0035</td>
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<tr>
<td>M1 + OPCOST</td>
<td>.0037</td>
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<td>M1 + EXRATE + OPCOST*</td>
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<td>M1 + OPCOST + WORLD</td>
<td>.0033</td>
<td>.435</td>
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<tr>
<td>M2</td>
<td>.0050</td>
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<td>M2 + EXRATE*</td>
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<td>.479</td>
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<td>M2 + EXRATE + OPCOST</td>
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<td>.498</td>
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<tr>
<td>M2 + OPCOST + WORLD</td>
<td>.0038</td>
<td>.503</td>
<td>.71</td>
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* Best GDP forecasts
TABLE 4.18.
PERCENTAGE CHANGE IN ACTUAL AND PREDICTED VALUES OF VELOCITY
Flexible Rate Period: 1982.1-1991.4

<table>
<thead>
<tr>
<th>Period/Quarter</th>
<th>\Delta \ln (M1 Velocity)^a</th>
<th>\Delta \ln (M2 Velocity)^b</th>
</tr>
</thead>
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<td>1982.1</td>
<td>-.0036</td>
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<td>Δ In (M2 Velocity)ᵇ</td>
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<tr>
<td>1990.4</td>
<td>-.0133</td>
<td>-.0073</td>
</tr>
<tr>
<td>1991.1</td>
<td>-.0208</td>
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<tr>
<td>1991.2</td>
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</tr>
<tr>
<td>1991.3</td>
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<td>-.0166</td>
</tr>
<tr>
<td>1991.4</td>
<td>-.0113</td>
<td>-.0019</td>
</tr>
</tbody>
</table>

**NOTES:**

a. GDP forecasts obtained from: \( \Delta \ln GDP = \alpha + \gamma \Delta \ln M_1 + \delta \Delta \ln OPCOST + \lambda \Delta \ln EXRATE. \)

b. GDP forecasts obtained from: \( \Delta \ln GDP = \alpha + \gamma \Delta \ln M_2 + \delta \Delta \ln EXRATE. \)

c. \( \Delta \ln \text{actual velocity} = \Delta \ln \text{actual GDP} - \Delta \ln \text{actual money supply}. \)

d. \( \Delta \ln \text{predicted velocity} = \Delta \ln \text{predicted GDP} - \Delta \ln \text{actual money supply}. \)
The forecasted values of GDP are obtained from the income regression:

$$\Delta \ln \text{GDP} = \alpha + \gamma \Delta \ln M1 + \delta \Delta \ln \text{OPCOST} + \lambda \Delta \ln \text{EXRATE},$$

based on the RMSE and Theil's criteria for best forecast.

Figure 4.3

PERCENTAGE CHANGE IN ACTUAL AND PREDICTED M1 VELOCITY: 1982.1-1991.4
The forecasted values of GDP are obtained from the income regression:
\[ \Delta \ln GDP = \alpha + \gamma \Delta \ln M1 + \delta \Delta \ln EXRATE, \]
based on the RMSE and Theil's criteria for best forecast.

Figure 4.4

PERCENTAGE CHANGE IN ACTUAL AND PREDICTED M2 VELOCITY: 1982.1-1991.4
CHAPTER FIVE
SUMMARY AND CONCLUSION

This study has examined the effect of the dollar exchange rate and world money supply on domestic aggregate demand in the United States during the 1980s. It has been shown that in addition to domestic money (M2), the dollar exchange rate and the dollar value of world money provide useful information on the growth of nominal income that is independent of the effects conveyed by purely domestic monetary aggregates. Popular discussions indicate that the increased confidence placed on foreign monetary variables in influencing the domestic economy is not misplaced. The rapidly changing structure of the US international economic position and the persistent and large swings in the value of the dollar in recent years have provided new dimension for analyzing the role of international factors on the domestic economy. In fact, the more specific focus of this paper's argument is that the dollar value of world nominal balances is an important determinant of nominal aggregate demand.

As shown in chapter 2, the decline in M1 velocity and the dramatic movements in the dollar exchange rate are the two important monetary developments in the 1980s. Since 1982 the velocity of M1 demand has gone through substantial swings, thus calling into question the use of M1 as a policy target. The relationship between M1 and nominal GDP that supports monetary targeting based on M1 in earlier decades suddenly disappeared, and along with it, the ability of domestic monetary aggregates to explain nominal income growth. This

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breakdown in M1 nominal GDP relationship made the conduct of monetary policy more problematic, and policymakers reacted by looking at other aggregates as monetary targets.

The shift to M2 demand as policy guide in 1987 is consistent with this policy consensus that questioned M1 demand as predictor of nominal income. In contrast, the behavior of M2 velocity is relatively stable and appears to account for the observed positive relationship between money and income over the business cycle. During the 1980s fluctuations in M2 coincide with those in nominal GDP, and using the criterion that monetary policy immediately affects domestic aggregate demand, then M2 can be considered a better predictor of monetary policy. Evidence that support this view of the empirical regularity of M2 demand is examined in chapter 2.

Another important issue examined is the behavior of the dollar exchange rate in the 1980s. Earlier during the 1960s most monetarists assumed that the flexible system would allow for differential adjustment in inflation rates in the world, thus allowing each country to have independent control of its own domestic macroeconomic policy. But since the shift to flexible exchange rates in 1973, the insulation property of the system did not seem to work well as advocates of flexible rates have anticipated. The persistent and large swings in the dollar exchange rate in the 1980s does not only affect the resource allocation and output mix, but more importantly, they have brought into focus the increased importance of international factors in the domestic economy.

As already been argued, the large fluctuations in the value of the dollar exchange rate in recent years cannot be taken as a realistic possibility. Obviously the dollar exchange rate is expected to move under the flexible system but not to the extent of a 40 percent
depreciation ever since the shift from fixed to flexible system was made. Under these circumstances it's possible that the international transmission of business cycle can still occur, primarily through changes in exchange rates that affect each country's traded goods sector. The global monetarist model is developed in chapter 3 to account for the influence of exchange rate movements on domestic economy. In particular, as the Dornbusch model shows, the domestic price level can be influenced not only by domestic money supply but also by foreign money supply and exchange rate. This is the basis of empirical investigation in chapter 4. The effect of domestic money (M2), world money and exchange rate on domestic GDP in the US during the 1980s is examined, and in general, the results are consistent with this view of interdependence under the flexible rate system. From 1982.1 to 1991.4, the growth rates (with suitable lags) in the dollar exchange rate and the dollar value of world money supply are able to predict the growth rate in domestic GDP.

Clearly, the dollar exchange rate appears to be the most important variable in the income regression. After accounting for the marginal contributions of M2 growth on growth of domestic GDP, changes in the dollar exchange rate remain highly significant and tend to enhance the overall fit of the model. This supports the argument that the exchange rate has an independent effect on income, over and above the information that domestic money (M2) contains. In fact, the effect of world money supply on domestic GDP becomes significant only if it is adjusted for exchange rate fluctuations. Thus what matters most in determination of domestic aggregate demand is not world money per se but the dollar value of world money.
The preceding analysis suggests two important policy implications. For one, the exchange rate of the dollar can be used as additional predictor of nominal aggregate demand in the United States. In view of the wide gyrations in the value of the dollar in recent years, it is but appropriate to consider the available information in the foreign exchange market as inputs in predicting income. Moreover, since the dollar exchange rate affects the dollar value of world money, it is possible that world monetary conditions may also impact on domestic aggregate demand. While the importance of domestic money as predictor of nominal GDP cannot be overemphasized, changes in world nominal balances may provide additional information as to how appropriate targets for nominal income growth can be set. As the controversial velocity issue in the 1980s has shown, predicting domestic income with purely domestic monetary variables as explanatory variables may not be enough given the increasing influence of international factors under the flexible rate system. It appears that world money supply is also equally important in domestic income determination. This is the basis of global monetarism as argued in this study.

Another implication of this study is the role of exchange rate in the proper conduct of government policies. To the extent that flexible rates have influenced the economy in recent years, the information provided by the foreign exchange market can be used to gauge whether the existing monetary policy or fiscal policy was too tight or too easy. The appreciation of the dollar in the early 1980s, for example, suggests how the Federal Reserve could have used this signal to mitigate the severity of the 1982 recession in the United States. In view of the large fiscal deficits in the period, the Fed should have monetized the deficits by increasing the the money supply to prevent the upward pressure on the dollar. In any case,
the "overvalued" dollar was giving a right signal that an expansionary monetary policy was warranted (McKinnon 1982).

Thus, in conclusion, this study has shown that considerations of the dollar exchange rate and world money supply are important in predicting domestic income in the United States. The results presented in this paper are preliminary evidence in support of global monetarism. Future research that takes into account better estimation technique and improvement in the measurement of the dollar exchange rate and world money supply variables is expected to provide better results.
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