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Supplement 3

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March 6, 1986

To: Members of the Executive Board

From: The Secretary

Subject: World Economic Outlook - Staff Studies - The Velocity of Money and the Practice of Monetary Targeting: Empirical Experience and Theoretical Foundations

The attached supplement on the velocity of money and the practice of monetary targeting - empirical experience and theoretical foundations provides background material for the Executive Board discussion on Friday, March 21, 1986 of the World Economic Outlook.

Mr. Mathieson (ext. 7662) is available to answer technical or factual questions relating to this study prior to the Board discussion.

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INTERNATIONAL MONETARY FUND

World Economic Outlook: Staff Studies

The Velocity of Money and the Practice of Monetary Targeting: Empirical Experience and Theoretical Foundations

Prepared by the Research Department 1/
(In consultation with other Departments)

Approved by Wm. C. Hood

March 3, 1986

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1/ The principal authors of the paper are Peter Isard and Liliana Rojas-Suarez

I. Introduction

Over much of the past decade, monetary policies in most of the major industrial countries have been oriented toward controlling the growth rates of monetary aggregates as a medium-term strategy for bringing down inflation. Although inflation rates rose considerably during the late 1970s, their substantial declines since 1980 stand as evidence of an increased commitment to achieving price stability. Indeed, by 1985 the average rate of consumer price inflation in the seven major industrial countries had been reduced to one-third of the peak rate reached in 1980, and to three-fifths of the average rate for the decade through 1976.

In their attempts to achieve greater price stability, however, central banks have exercised considerable discretion to deviate from or adjust their monetary targets, instead of following the "monetarist prescription" of precommitting themselves and adhering rigidly to money supply rules. 1/ Most central banks have exercised discretion to adjust, de-emphasize, or abandon their targets in response to financial innovations and deregulation, which have introduced new instruments to serve as money or money substitutes, with significant unanticipated effects on the relationships between the targeted monetary aggregates and variables such as nominal GNP. Discretion has also sometimes been exercised during periods in which unanticipated exchange-rate developments have created concerns about the external influences on output and inflation. Recently, concerns have been expressed about the exercise of discretion in countries where some monetary targets have been abandoned or de-emphasized.

This paper examines the behavior of velocity and the practice of monetary targeting in seven major industrial countries. Its purpose in doing so is to provide a background for reassessing the practice of monetary targeting in light of both the experiences of the past decade and the theoretical foundations that have been developed for understanding both the behavior of velocity and the different channels through which monetary policy may influence output and other "real" variables. Those experiences and theoretical foundations have led to evolving views in the debate over the appropriate conduct of monetary policy. This paper

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1/ A "rule" is defined as a prespecified formula that defines the desired outcome for the money supply or some other selected variable. The exercise of "discretion" is defined as the alternative to following a "rule". A distinction is also drawn between "passive" rules and "activist" rules. An activist rule is one in which central bank behavior responds actively, but according to a prespecified formula, to the state of the economy; such a rule, for example, might prescribe a countercyclical path for the money supply. The types of money supply targets that have been adopted over the past decade correspond to passive rules that do not specify formulas for countercyclical money-supply behavior, even though in many cases the money supply targets have been specified as ranges.

refrains from supporting any particular position in that debate, but rather concentrates on clarifying the empirical perspectives and theoretical assumptions that lead to the different conclusions.

The review of empirical experience is provided in Part II, which begins with a statistical focus on quarterly data for the 1974-85 period. Two types of perspectives are provided. The first set of statistical material compares the variability of the velocities of different monetary aggregates within countries, of similar monetary aggregates across countries, and of particular monetary aggregates during different time periods. The second set of material examines the associations across countries between the variability of monetary growth and the variabilities of both real GNP growth and inflation rates over the twelve-year sample period, and also over each of several four-year subperiods.

The focus on statistics alone can be misleading, however, without an understanding of the nature of the macroeconomic interrelationships between prices, output, and money. In particular, the statistical focus does not isolate the extent to which the variability of velocity has been an "exogenous" development that has led central banks to exercise their discretion to deviate from their announced targets, or the extent to which the exercise of central bank discretion may itself have "caused" velocity to become more variable.

Some additional empirical perspectives are provided in the second section of Part II by reviewing the macroeconomic conditions that individual central banks have experienced in pursuing their monetary targets over the past decade. While the period since 1980 has witnessed a decline in inflation in all major countries, this period has also encompassed extensive changes in exchange rates, nominal and real interest rates, output, and unemployment. Thus, some authorities have been inclined to orient their policies more closely to movements in variables other than the inflation rate.

The renewed focus on short-term movements in exchange rates, interest rates, output, and unemployment raises the issue of the extent to which the monetary authorities can pursue short-term objectives without jeopardizing the credibility of their long-term commitment to an anti-inflation policy. Currently, two policy questions in particular appear to be extremely relevant for the conduct of monetary policy: (1) what is the extent to which monetary policy can be used to affect the behavior of real variables in the short run?; and (2) is it likely that attempts to achieve such short-run objectives will result in higher levels of inflation over the long run?

Part III of the paper reviews the theoretical models that have been developed to address these issues. Specifically, alternative "views of the world" are presented and their implications for monetary policy are discussed. Since different views of the world are held by different economists and policy makers, it may not be surprising that the debate

over the appropriate conduct of monetary policy has not been resolved. To a considerable extent, however, the debate has been confused by an inadequate recognition of the strengths and limitations of alternative analytic frameworks, and by misperceptions of the types of theoretical models and assumptions that support different conclusions. Accordingly, the aim of Part III is to raise the awareness of the main issues in the debate by providing a streamlined presentation and comparison of the different theoretical approaches.

Three different theoretical approaches have been developed for analyzing the behavior of velocity and addressing the issue of whether central banks should exercise discretion, aim at fixed targets or follow activist countercyclical rules. One approach has concentrated attention on simple or extended models of the demand for money. These models, however, are subject to the general criticism that the level of output, the interest rate and, in some cases, the price level are taken as exogenous, even though the influence of central bank behavior on those variables may be quite important for understanding the variability of velocity and for drawing inferences about the appropriate conduct of monetary policy. A second approach has analyzed velocity within a complete macroeconomic model, but under the assumption that expectations about future price levels or inflation rates are formed adaptively (i.e., that the expected future levels of prices or rates of inflation are weighted averages of current and past values of such variables).

The third approach, which has played a central role in reformulating the theory of monetary policy in recent years (and which accordingly receives predominant attention in this study), has gained appeal for its assumption that expectations about inflation and other endogenous variables are rational and forward-looking in the sense of incorporating relevant information about the structure of the economy and the expected future values of exogenous variables, including the stance of monetary policy. These models do not assume that economic agents have complete information, but do assume that central banks do not have superior information than other economic agents. The analysis of several different types of complete macroeconomic models has shown that conclusions based on the assumption of adaptive expectations can be modified in a situation where market participants are assumed to be "rational." Specifically, in contrast to conclusions drawn from the adaptive expectations hypothesis, the rational expectations assumption provides a theoretical case against central bank discretion, and also provides a theoretical case against a countercyclical monetary policy for models in which prices adjust rapidly. Thus, the view that is taken of the expectations-formation process can be seen as central to the debate about how monetary policy should be conducted.

Another issue that is central to the debate is the extent to which any theoretical or empirically estimated "model" can provide an adequate summary of market behavior. To the extent that economic behavior shifts over time or cannot be precisely estimated empirically, the case against

central bank discretion is weaker than the rational expectations models suggest. Indeed, the predominant challenge to the theoretical case for central bank rules has been the argument that the difficulty of anticipating major shifts in economic relationships or disruptions to macroeconomic conditions implies that a rule would be practically impossible, socially undesirable, and politically infeasible to implement in a credible way.

Part IV of the paper collects together the main arguments in the policy debate, including a discussion of the pros and cons of alternative types of variables that might be adopted as intermediate targets in designing monetary policy rules. Part V provides a summary of the paper.

II. A Review of Data and Experience

1. The observed variability of velocity

The velocity of money is defined in terms of three important macroeconomic variables: the price level, the level of real output, and the money supply. 1/ As such, velocity may vary over time whenever the price level and/or the supply of output are influenced by factors that do not have contemporaneous and offsetting influences on the money supply, or whenever autonomous changes in the money supply are not reflected in contemporaneous and proportionate changes in the nominal value of output. An understanding of the observed variability of velocity requires an understanding of the exogenous sources of changes in prices, output, and money, and of the time lags with which a change in any one of those variables may influence the others through the responses of private economic agents and policy authorities. Such an understanding is pursued in this study by reviewing both the macroeconomic conditions that central banks have confronted during the past decade and the different classes of analytic models that have been developed. This section presents statistical material that provides perspective for those reviews. An important distinction should be drawn between the factors that have systematic and predictable influences on velocity and factors that influence velocity in random or unpredictable ways. Variability of velocity that is predictable does not, in principle, cause any difficulty for a monetary-targeting approach.

Chart 1 shows the velocities of a number of monetary aggregates for seven major industrial countries. Throughout this paper the definitions of the monetary aggregates are those used by the national authorities in

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1/ The measures of velocity that are used in the World Economic Outlook are constructed by dividing the nominal level of gross national product by the corresponding money supply. Some other measures of velocity are based on measures of income other than gross national product.

CHART 1

MAJOR INDUSTRIAL COUNTRIES

VELOCITIES OF MONETARY AGGREGATES, 1970-85

(Indices, first quarter 1973=100)

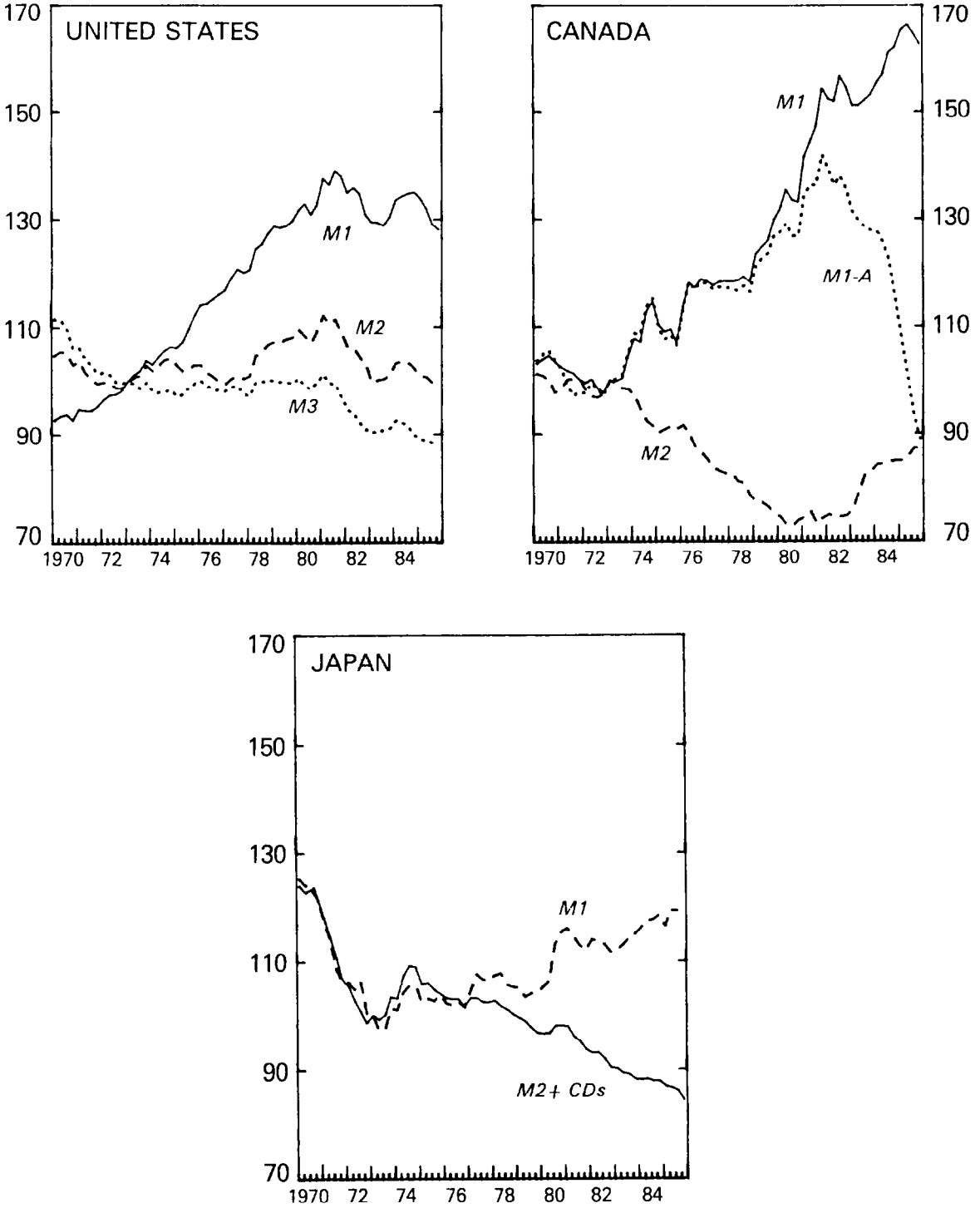
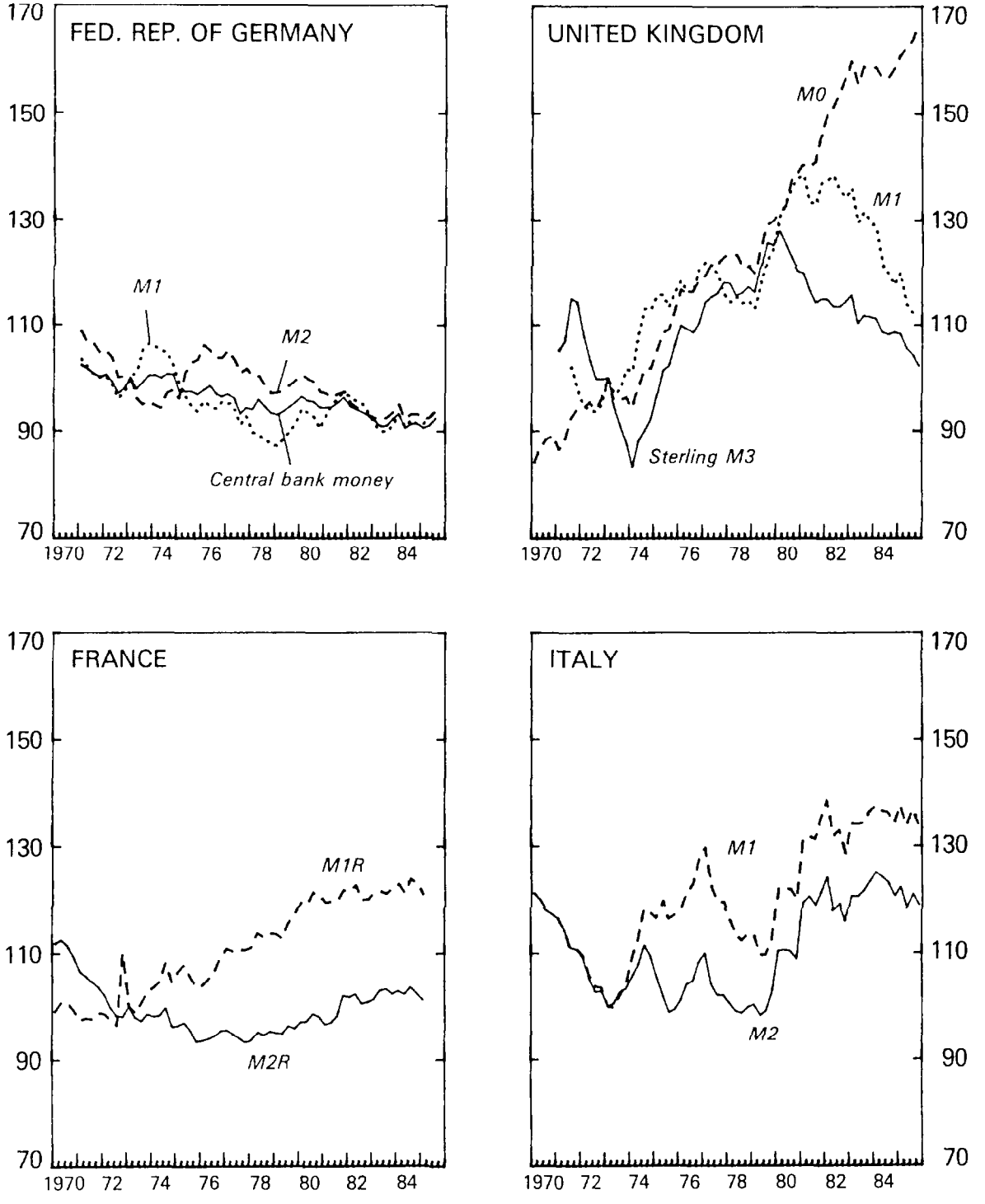


CHART 1 (Concluded)

MAJOR INDUSTRIAL COUNTRIES

VELOCITIES OF MONETARY AGGREGATES, 1970-85

(Indices, first quarter 1973=100)



each country. 1/ The data are measured quarterly, extending in most cases from 1970 through the third quarter of 1985. The chart shows that each of the seven countries has experienced pronounced shifts in trend and/or sharp variation around trend for one or more of its velocity measures since the early 1970s.

The variability of a data sample around its trend can be measured by the standard proportionate deviation of the sample observations around a simple trend line. 2/ A focus on proportionate deviations is required to allow meaningful comparisons of the variability of narrow money velocity (with a relatively high average value) and broad money velocity (with a relatively low average value). Values of this variability index are shown in Table 1 for each of the velocity series. The focus is on the 1974-85 period, 3/ and the sample period has been divided into thirds in order to examine whether variability has increased or declined over time.

As a general phenomenon, it may be noted that the variability levels for the three subsample periods tend to be lower than the corresponding variability levels over the entire sample, consistent with the fact that trends in the velocity series have shifted. Few of the series exhibited significantly higher variability levels during 1982-85 than in earlier subperiods, with the notable exceptions of M1-A in Canada and M1 and M2 in the United States. Within the 1982-85 subperiod, it is notable that the velocities of broad money (M2 and M3) were less variable than the velocities of M1 in all countries except Italy (where M1 and M2 velocities were equally variable); in addition, the velocities of M1 were more variable than the velocities of central bank money in Germany and M0 in the United Kingdom. Over the entire 1974-85 period, the velocities of M2+CDs in Japan and central bank money in Germany exhibited the lowest variability levels, although it is evident from Chart 1 that the series for Japan was more variable over the period extending back to 1970.

In addition to examining the variability of velocity, it may be interesting to examine whether relative stability in monetary growth over periods of several years or longer has been associated with relatively stable rates of output growth and inflation. Chart 2 shows percentage changes in real GNP, the GNP deflator, and the money supply over the same

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1/ These definitions are provided in footnote 2 of Table 4.

2/ For a precise definition, see the footnote to Table 1. It should be recognized that the choice of measuring deviations around a simple trend line is arbitrary. Alternative choices would include moving averages of arbitrary lengths and procedures for modelling the time series properties of velocity.

3/ The exclusion of the period prior to 1974 reflects a recognition that under fixed exchange rates central bank control of the money supply is limited by movements in foreign exchange reserves.

Table 1. Variability Levels for Velocity

	1974-85	1974-77	1978-81	1982-85
Canada				
M1	0.037	0.024	0.021	0.019
M1-A	0.080	0.027	0.017	0.045
M2	0.029	0.017	0.012	0.015
M3	0.072	0.015	0.020	0.019
United States				
M1	0.040	0.007	0.010	0.019
M2	0.033	0.009	0.013	0.018
M3	0.028	0.008	0.011	0.012
United Kingdom				
M0	0.027	0.017	0.020	0.013
M1	0.064	0.028	0.030	0.017
Sterling M3	0.082	0.024	0.037	0.012
Japan				
M1	0.021	0.015	0.030	0.009
M2+CDs	0.011	0.008	0.011	0.006
France				
M1R	0.018	0.018	0.012	0.009
M2R	0.023	0.013	0.011	0.008
Germany, the Federal Republic of				
Central Bank Money	0.014	0.011	0.010	0.009
M1	0.039	0.023	0.018	0.018
M2	0.029	0.026	0.012	0.010
Italy				
M1	0.044	0.026	0.032	0.016
M2	0.052	0.029	0.031	0.016

Note: The variability levels correspond to the standard proportionate deviations of velocity around its trend for the relevant period or sub-period. Specifically, if v_t denotes the observed value of velocity in quarter t and $\bar{v}_t$ denotes the trend value of velocity, the variability levels correspond to standard deviations of $(v_t-\bar{v}_t)/\bar{v}_t$.

CHART 2

MAJOR INDUSTRIAL COUNTRIES

MONEY, REAL GNP, AND THE GNP DEFLATOR, 1975-85

(Change from the corresponding quarter of the preceding year, in percent)

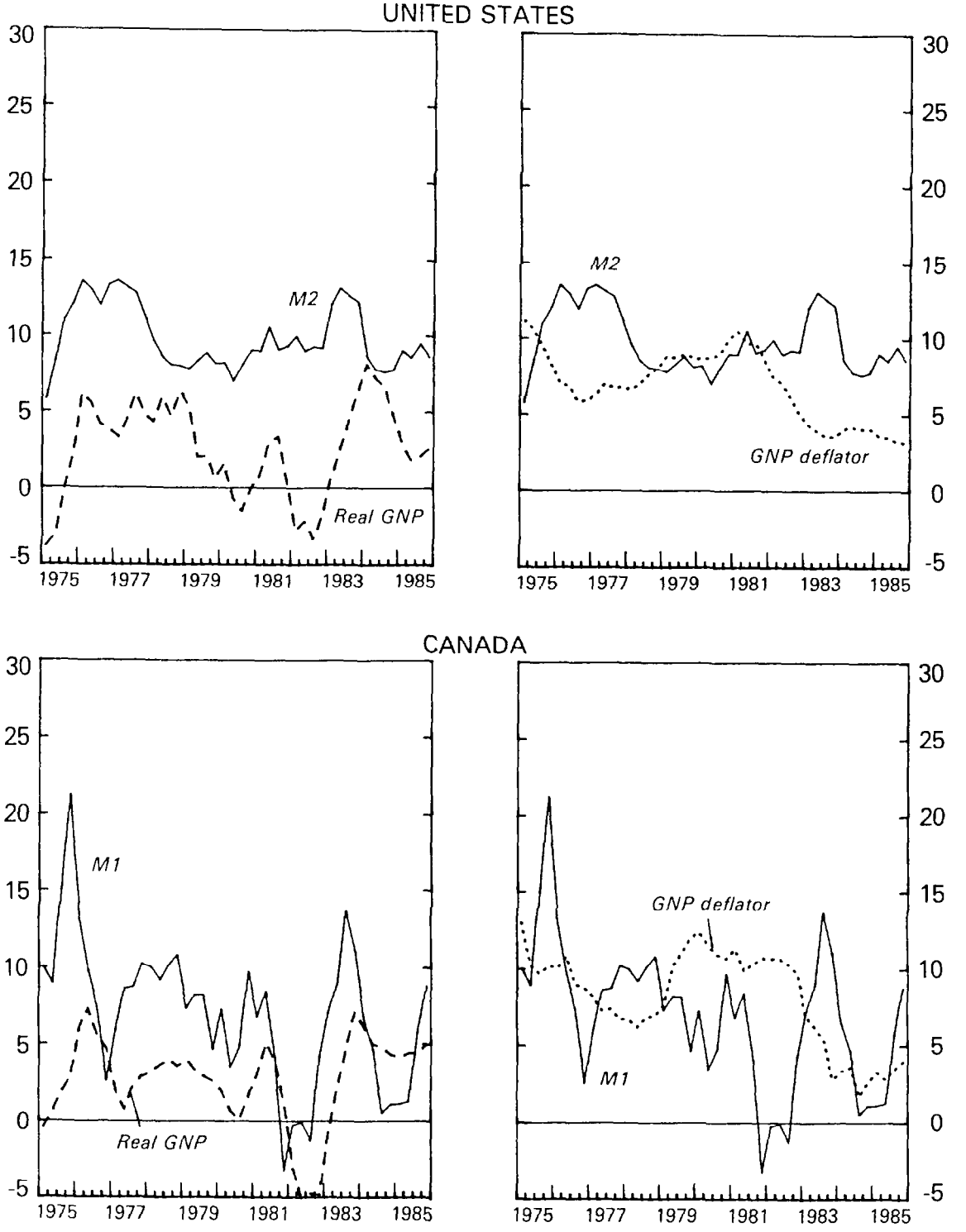


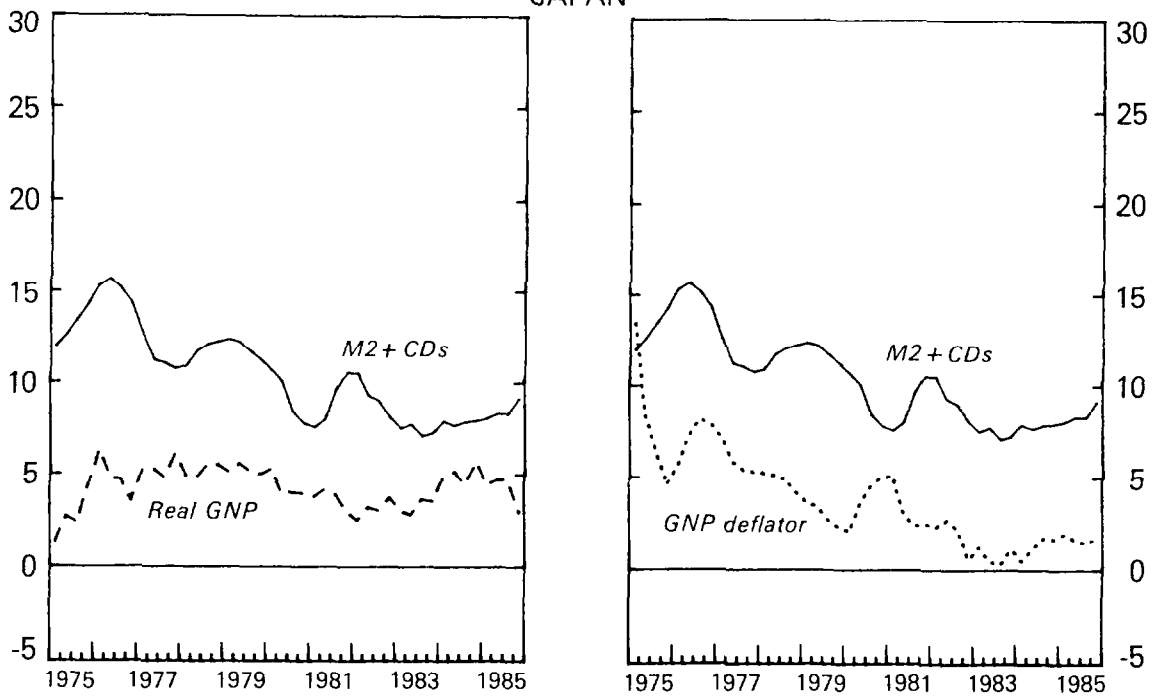
CHART 2 (continued)

MAJOR INDUSTRIAL COUNTRIES

MONEY, REAL GNP, AND THE GNP DEFLATOR, 1975-85

(Change from the corresponding quarter of the preceding year, in percent)

JAPAN



FED. REP. OF GERMANY

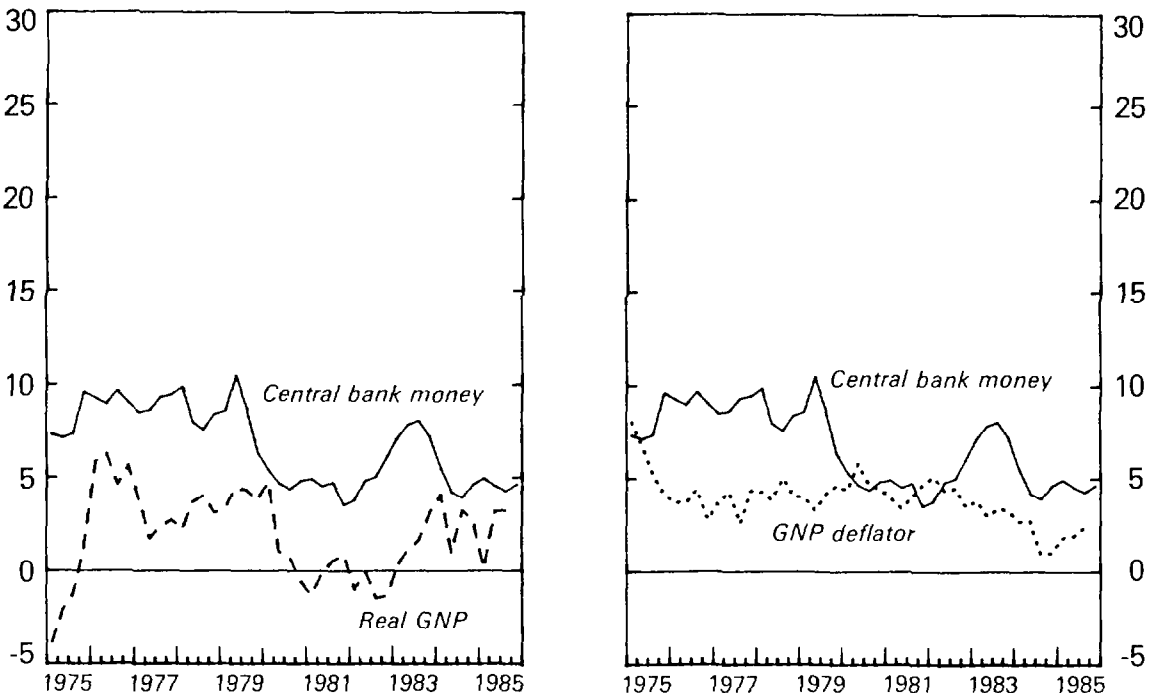


CHART 2 (continued)

MAJOR INDUSTRIAL COUNTRIES

MONEY, REAL GNP, AND THE GNP DEFLATOR, 1975-85

(Change from the corresponding quarter of the preceding year, in percent)

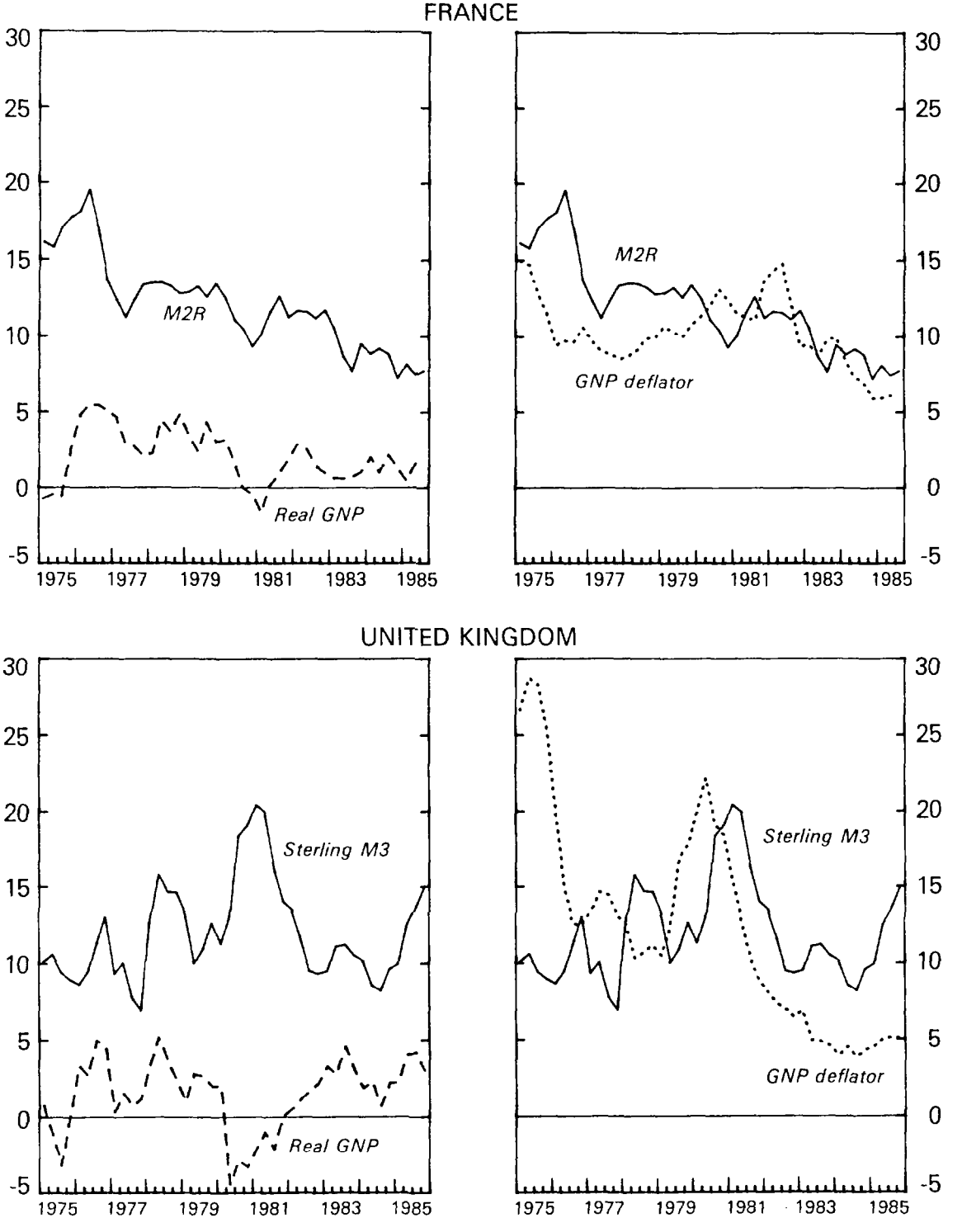


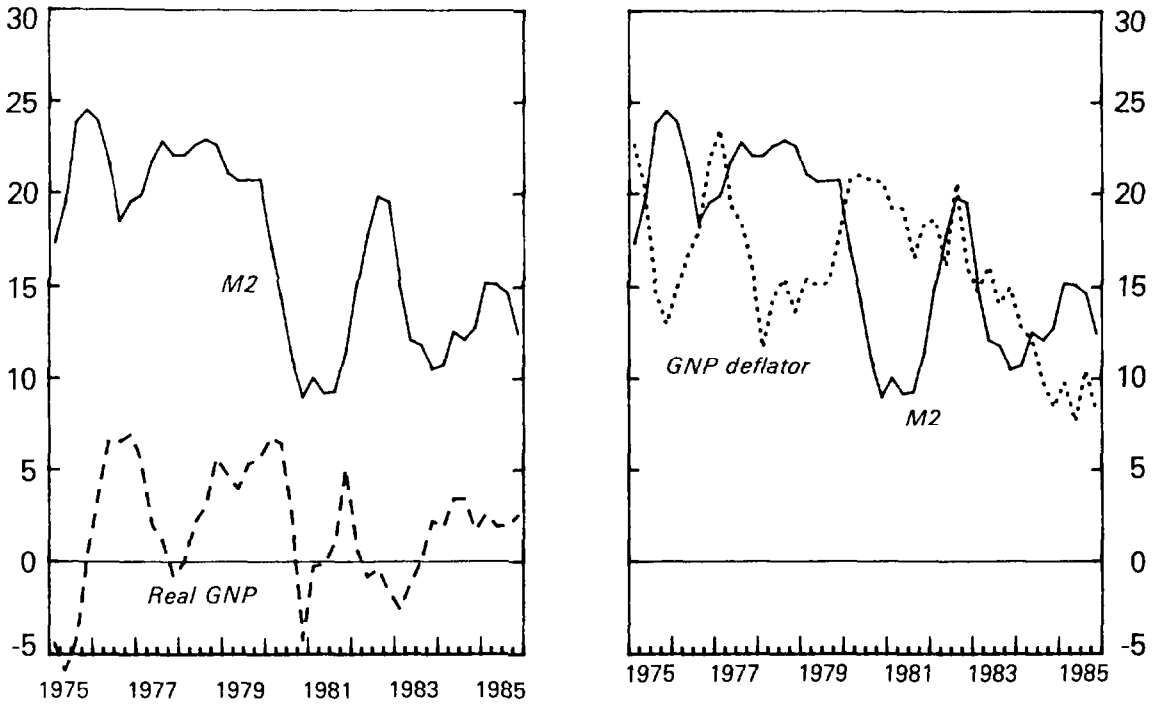
CHART 2 (concluded)

MAJOR INDUSTRIAL COUNTRIES

MONEY, REAL GNP, AND THE GNP DEFLATOR, 1975-85

(Change from the corresponding quarter of the preceding year, in percent)

ITALY



period for each of the seven countries. 1/ Some associations in the relative degrees of stability of the various series are visually evident from the chart. A summary of the associations can be provided by calculating correlation coefficients between the variability levels of real GNP growth, inflation, and money growth. It should be emphasized, however, that such correlations do not isolate the causes of any associations. A finding of strong positive correlations might indicate that variability in the money supply had a strong influence in generating variability of prices and output. Alternatively, such a positive correlation could reflect a process by which price or output variability led to money supply variability through the reactions of central banks, as policy makers shifted their policy stance in an attempt (less than fully successful) to stabilize price and output fluctuations.

Table 2 provides summary measures of the variability of output growth, price inflation, and money growth over the 1974-85 period and within each of the four-year subperiods. Table 3 provides some corresponding correlation coefficients, both between the variability of output growth and the variability of money growth and between the variability of price inflation and the variability of money growth. The data in Table 3 indicate that the degrees of variability in both real output growth and inflation were positively correlated with the degree of variability in money growth across the seven countries during the 1974-85 period and during the most recent two subperiods. 2/ Along the same lines, it may be noted from Table 2 that the four countries in which money growth was least variable during the 1974-85 period (namely, Germany, the United States, Japan, and France) include the three countries in which real GNP growth was least variable (Japan, France, and Germany) and the three countries in which inflation was least variable (Germany, France, and the United States).

2. The central bank experience with monetary targeting

A different set of empirical perspectives on the behavior of velocity is provided by reviewing the types of macroeconomic conditions and policy difficulties that central banks have confronted during the periods in which they have used monetary targets. These periods date back to 1975 for the United States, the Federal Republic of Germany, and Canada (although Canada abandoned the practice in 1982), to 1976 for the United Kingdom, and to 1977 for France. Italy and Japan have not adopted monetary targets, although in Italy economic policy has been based on plans

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1/ In Chart 2, the monetary aggregate that has been selected for each country is the aggregate that either has served longest as a target or appears to have received predominant attention as a monitoring concept.

2/ It may be noted, however, that with only seven observations it is not possible to place high degrees of confidence in rejecting the hypothesis that the "true" correlations are zero.

Table 2. Variability Levels for the Growth Rates of Money Supplies, Real GNPs, and GNP Deflators

	1974-85	1974-77	1978-81	1982-85
Canada				
M1	0.047	0.043	0.035	0.045
Real GNP	0.029	0.022	0.013	0.043
GNP deflator	0.036	0.031	0.021	0.033
United States				
M2	0.023	0.032	0.008	0.019
Real GNP	0.031	0.033	0.024	0.038
GNP deflator	0.023	0.017	0.010	0.013
United Kingdom				
Sterling M3	0.035	0.007	0.016	0.024
Real GNP	0.024	0.023	0.029	0.012
GNP deflator	0.068	0.063	0.042	0.013
Japan				
M2+CDs	0.024	0.017	0.017	0.009
Real GNP	0.009	0.006	0.006	0.009
GNP deflator	0.055	0.065	0.012	0.007
France				
M2R	0.030	0.024	0.013	0.016
Real GNP	0.018	0.021	0.019	0.008
GNP deflator	0.022	0.020	0.013	0.029
Germany, the Federal Republic of				
Central bank money	0.020	0.014	0.022	0.014
Real GNP	0.023	0.030	0.020	0.019
GNP deflator	0.016	0.018	0.006	0.012
Italy				
M2	0.046	0.025	0.051	0.026
Real GNP	0.035	0.048	0.031	0.018
GNP deflator	0.039	0.036	0.029	0.037

Note: The variability levels represent standard deviations of rates of growth over four quarters. Specifically, if x_t corresponds to the level of the money supply, real GNP, or the GNP deflator in quarter t, the variability level for the growth rate of x is computed as the standard deviation of $(x_t - x_{t-4})/x_{t-4}$ over the sample or subsample period.

Table 3. Correlations Across Countries Between the Variability Levels for the Growth Rates of Money, Real GNP, and the GNP Deflator

	1974-85	1974-77	1978-81	1982-85
Between money and real GNP	0.508	0.171	0.245	0.687
Between money and the GNP deflator	0.311	-0.489	0.343	0.659

that include projections for a range of monetary and credit aggregates, and since 1978 Japan has provided projections of year-on-year growth for broad money for each quarter in the first month of that quarter.

Table 4 sets out the target growth ranges that central banks have announced, along with the actual outcomes for the targeted aggregates. The United States and, at times, the United Kingdom, have aimed at targets for more than one aggregate simultaneously. In doing so, however, both countries have made changes over time in the relative priorities they have attached to hitting their different targets. In particular, the United States has announced twice in recent years (during the second half of 1982 and the fourth quarter of 1985) that its M1 target would be de-emphasized, whereas the United Kingdom maintained targets for M1 and PSL2 for only two years, and chose to downgrade its sterling M3 target in October 1985.

As Table 4 indicates, monetary targets have been specified sometimes as points and sometimes as ranges with widths of up to 5 percentage points. Because countries have aimed at different types of targets for different types of aggregates and under different types of macroeconomic conditions, it may not be very meaningful to compare their different rates of success at hitting the targets they have announced. Nevertheless, it may be noted that Canada missed its announced target range in just one of the first six years, and then only very marginally, before it abandoned the practice of monetary targeting in the seventh year. 1/ France held its monetary growth within 1 1/2 percentage points of its (point) target, or of the center of its relatively narrow target range, in five out of seven years, and only once missed its target by more than 2 percentage points. Germany exceeded its target by nearly 3 1/2 percentage points in 1978, but hit or fell below its target in each subsequent year. And the United Kingdom and the United States each hit their target ranges about half of the time.

Although it must be recognized that central banks cannot control their monetary aggregates precisely, an outcome of deviating from the center of a target range by as much as 1 or 2 percentage points over a period as long as a year can probably be considered as largely a matter of central bank discretion. A review of the individual experiences of central banks in different countries reveals a variety of reasons that they have chosen in some cases to aim either high or low in their target ranges, and in some cases to miss or modify the targets that they had previously announced.

In the Federal Republic of Germany, a factor that has influenced the Bundesbank on several occasions has been its concern to relieve the influences of exchange rate developments on domestic inflation and real

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1/ As indicated by footnote 3 of Table 4, it is somewhat arbitrary to describe the target periods for Canada as seven successive years.

Table 4. Targets and Outcomes For Monetary Growth Rates, 1975-85 1/ 2/

		1975	1976	1977	1978	1979	1980	1981	1982	1983	
Canada 3/											
M1	target		10.0-15.0	8.0-12.0	7.0-11.0	6.0-10.0	5.0-9.0	4.0-8.0	4.0-8.0	...	
	outcome		10.9	8.3	9.2	8.0	6.2	3.9	3.5		
France 4/											
M2, M2R	target			12.5	12.0	11.0	11.0	10.0	12.5-13.5	9.0	
	outcome			13.9	12.2	14.4	9.8	11.4	11.5	10.2	
Germany 5/											
CBM	target	8.0	8.0	8.0	8.0	6.0-9.0	5.0-8.0	4.0-7.0	4.0-7.0	4.0-7.0	
	outcome	9.9	9.3	9.0	11.4	6.4	4.8	3.5	6.1	7.0	
United Kingdom 6/											
M3, £M3	target		9.0-13.0	9.0-13.0	8.0-12.0	8.0-12.0	7.0-11.0	6.0-10.0	8.0-12.0	7.0-11.0	6
	outcome		7.3	15.4	11.4	10.3	19.4	12.8	11.2	9.5	
M1	target								8.0-12.0	7.0-11.0	
	outcome								12.3	14.0	
PSL2	target								8.0-12.0	7.0-11.0	
	outcome								11.5	12.6	
MO	target										4
	outcome										
United States 7/											
M1	target	5.0-7.5	4.5-7.5	4.5-6.5	4.0-6.5	3.0-6.0	4.0-6.5	3.5-6.0	2.5-5.5	4.0-8.0	4
	outcome	5.3	5.8	7.9	7.2	5.5	7.3	2.3	8.5	10.0	
M2	target	8.5-10.5	7.5-10.5	7.0-10.0	6.5-9.0	5.0-8.0	6.0-9.0	6.0-9.0	6.0-9.0	7.0-10.0	6
	outcome	9.7	10.9	9.8	8.7	8.3	9.6	9.5	9.2	8.3	
M3	target	10.0-12.0	9.0-12.0	8.5-11.5	7.5-10.0	6.0-9.0	6.5-9.5	6.5-9.5	6.5-9.5	6.5-9.5	6
	outcome	12.3	12.7	11.7	9.5	8.1	10.2	11.4	10.1	9.7	

1/ Annualized growth rates with outcomes corresponding to the target periods, except where indicated in the follow

2/ Definitions of the monetary aggregates correspond to those used by the national authorities in each country. A identical labels are comparable but not identical across countries, and in some cases countries have modified the cov monetary aggregates over time. In such cases, the numbers in the table correspond to the definitions existing during period. Apart from the widely employed concepts of the narrow M1 aggregates (generally defined as currency plus dome deposits) and the more broadly defined M2 and M3 concepts (which add to M1 domestic savings deposits and various mana of banks and other financial institutions), the aggregates on which the paper focusses (not all of which are included defined as follows. M1-A in Canada includes daily interest-bearing checkable accounts and nonpersonal notice deposit the components of M1 (currency and noninterest-bearing demand deposits). MO in the United Kingdom is the wide moneta as banks' holdings of cash, plus banks' operational balances at the Bank of England, plus notes and coin. PSL2 in th comprises sterling M3 (excluding deposits maturing in more than two years), money market instruments--treasury bills, deposits with local authorities and finance houses--certificates of tax deposit, building society shares and deposits similar forms of liquid savings instruments. Central bank money in Germany comprises currency held by nonbanks and a of banks' deposits, with the weights based upon required minimum reserves calculated at constant (January 1974) ratio circulation has a weight of 100 percent, sight deposits have a weight of 16.6 percent, time deposits 12.4 percent, an 8.1 percent; and only time deposits and savings deposits of less than four-year maturity are included in the latter t M2+CDs in Japan comprises currency in circulation, demand deposits, time deposits, and certificates of deposit.

3/ For Canada, the targets indicated for the years 1976-80 are the annualized target growth rates announced for th ning, respectively, in the second quarter of 1975, February-April 1976, June 1977, June 1978, and the second quarter targets indicated for the years 1981 and 1982 correspond to the objective announced for the period beginning in Augus which continued to apply until the practice of monetary targeting was discontinued in November 1982. Outcomes corres actual rates of growth between the beginning of successive target periods, except for 1981, which is an annualized ra October 1980 through December 1981, and for 1982, which is from December 1981 through December 1982. The somewhat ar of target periods and outcomes to calender years has been adopted from the Bank for International Settlements, 53rd A 1983, p. 71.

4/ For France, the target periods are from December to December for the years through 1982, and from November-Jan November-January averages for subsequent years. The target was specified for M2 from 1976 through 1983 and for M2R f

5/ For Germany, the 1975 target is for the rate of growth from December 1974 through December 1975; the targets d for rates of growth on an annual average basis; and beginning in 1979 the targets are for rates of growth between th the previous year and the fourth quarter of the target year.

6/ For the United Kingdom, the targets are for periods beginning in April for each year from 1976 through 1978, i February for subsequent years. For 1980 and subsequent years the outcomes are annualized rates for 14-month periods the target year through April of the following year. A target for M3 was set only in 1976; thereafter the indicated comes are for sterling M3.

7/ For the United States, target growth ranges correspond to annual percentage changes from the fourth quarter of through the fourth quarter of the target year, except in 1975, for which the target period was from March 1975 throu for the M2 target in 1983, which was from the February-March average through the fourth quarter. The targets also c tives set around the beginning of the target year, rather than any tentative objectives indicated earlier or any rev objectives during the target year. In February 1980, the U.S. monetary aggregates were redefined, and for 1980 and in the table are those for M1-B and shift-adjusted M1-B, respectively; M1-B was relabeled M1 in January 1982. Outco actual rates as reported at the ends of the policy periods.

Table 4. Targets and Outcomes For Monetary Growth Rates, 1975-85 1/ 2/

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Canada 3/												
M1	target		10.0-15.0	8.0-12.0	7.0-11.0	6.0-10.0	5.0-9.0	4.0-8.0	4.0-8.0	...	...	...
	outcome		10.9	8.3	9.2	8.0	6.2	3.9	3.5			
France 4/												
M2, M2R	target			12.5	12.0	11.0	11.0	10.0	12.5-13.5	9.0	5.5-6.5	4.0-6.0
	outcome			13.9	12.2	14.4	9.8	11.4	11.5	10.2	7.6	
Germany 5/												
CBM	target	8.0	8.0	8.0	8.0	6.0-9.0	5.0-8.0	4.0-7.0	4.0-7.0	4.0-7.0	4.0-6.0	3.0-5.0
	outcome	9.9	9.3	9.0	11.4	6.4	4.8	3.5	6.1	7.0	4.6	4.5
United Kingdom 6/												
M3, £M3	target		9.0-13.0	9.0-13.0	8.0-12.0	8.0-12.0	7.0-11.0	6.0-10.0	8.0-12.0	7.0-11.0	6.0-10.0	5.0-9.0
	outcome		7.3	15.4	11.4	10.3	19.4	12.8	11.2	9.5	11.9	
M1	target								8.0-12.0	7.0-11.0		
	outcome								12.3	14.0		
PSL2	target								8.0-12.0	7.0-11.0		
	outcome								11.5	12.6		
MO	target										4.0-8.0	3.0-7.0
	outcome										5.7	
United States 7/												
M1	target	5.0-7.5	4.5-7.5	4.5-6.5	4.0-6.5	3.0-6.0	4.0-6.5	3.5-6.0	2.5-5.5	4.0-8.0	4.0-8.0	4.0-7.0
	outcome	5.3	5.8	7.9	7.2	5.5	7.3	2.3	8.5	10.0	5.2	11.9
M2	target	8.5-10.5	7.5-10.5	7.0-10.0	6.5-9.0	5.0-8.0	6.0-9.0	6.0-9.0	6.0-9.0	7.0-10.0	6.0-9.0	6.0-9.0
	outcome	9.7	10.9	9.8	8.7	8.3	9.6	9.5	9.2	8.3	7.7	8.6
M3	target	10.0-12.0	9.0-12.0	8.5-11.5	7.5-10.0	6.0-9.0	6.5-9.5	6.5-9.5	6.5-9.5	6.5-9.5	6.0-9.0	6.0-9.5
	outcome	12.3	12.7	11.7	9.5	8.1	10.2	11.4	10.1	9.7	10.5	7.4

1/ Annualized growth rates with outcomes corresponding to the target periods, except where indicated in the following footnotes.

2/ Definitions of the monetary aggregates correspond to those used by the national authorities in each country. Aggregates with identical labels are comparable but not identical across countries, and in some cases countries have modified the coverage of their monetary aggregates over time. In such cases, the numbers in the table correspond to the definitions existing during each indicated period. Apart from the widely employed concepts of the narrow M1 aggregates (generally defined as currency plus domestic demand deposits) and the more broadly defined M2 and M3 concepts (which add to M1 domestic savings deposits and various managed liabilities of banks and other financial institutions), the aggregates on which the paper focusses (not all of which are included in the table) are defined as follows. M1-A in Canada includes daily interest-bearing checkable accounts and nonpersonal notice deposits, in addition to the components of M1 (currency and noninterest-bearing demand deposits). MO in the United Kingdom is the wide monetary base, defined as banks' holdings of cash, plus banks' operational balances at the Bank of England, plus notes and coin. PSL2 in the United Kingdom comprises sterling M3 (excluding deposits maturing in more than two years), money market instruments--treasury bills, bank bills, and deposits with local authorities and finance houses--certificates of tax deposit, building society shares and deposits, and other similar forms of liquid savings instruments. Central bank money in Germany comprises currency held by nonbanks and a weighted average of banks' deposits, with the weights based upon required minimum reserves calculated at constant (January 1974) ratios; currency in circulation has a weight of 100 percent, sight deposits have a weight of 16.6 percent, time deposits 12.4 percent, and savings deposits 8.1 percent; and only time deposits and savings deposits of less than four-year maturity are included in the latter two categories. M2+CDs in Japan comprises currency in circulation, demand deposits, time deposits, and certificates of deposit.

3/ For Canada, the targets indicated for the years 1976-80 are the annualized target growth rates announced for the periods beginning, respectively, in the second quarter of 1975, February-April 1976, June 1977, June 1978, and the second quarter of 1979. The targets indicated for the years 1981 and 1982 correspond to the objective announced for the period beginning in August-October 1980, which continued to apply until the practice of monetary targeting was discontinued in November 1982. Outcomes correspond to annualized actual rates of growth between the beginning of successive target periods, except for 1981, which is an annualized rate from August-October 1980 through December 1981, and for 1982, which is from December 1981 through December 1982. The somewhat arbitrary assignment of target periods and outcomes to calender years has been adopted from the Bank for International Settlements, 53rd Annual Report, June 1983, p. 71.

4/ For France, the target periods are from December to December for the years through 1982, and from November-January averages to November-January averages for subsequent years. The target was specified for M2 from 1976 through 1983 and for M2R in 1984 and 1985.

5/ For Germany, the 1975 target is for the rate of growth from December 1974 through December 1975; the targets during 1976-78 are for rates of growth on an annual average basis; and beginning in 1979 the targets are for rates of growth between the fourth quarter of the previous year and the fourth quarter of the target year.

6/ For the United Kingdom, the targets are for periods beginning in April for each year from 1976 through 1978, in June 1979, and in February for subsequent years. For 1980 and subsequent years the outcomes are annualized rates for 14-month periods from February of the target year through April of the following year. A target for M3 was set only in 1976; thereafter the indicated targets and outcomes are for sterling M3.

7/ For the United States, target growth ranges correspond to annual percentage changes from the fourth quarter of the previous year through the fourth quarter of the target year, except in 1975, for which the target period was from March 1975 through March 1976, and for the M2 target in 1983, which was from the February-March average through the fourth quarter. The targets also correspond to objectives set around the beginning of the target year, rather than any tentative objectives indicated earlier or any revisions of the objectives during the target year. In February 1980, the U.S. monetary aggregates were redefined, and for 1980 and 1981 the M1 targets in the table are those for M1-B and shift-adjusted M1-B, respectively; M1-B was relabeled M1 in January 1982. Outcomes correspond to actual rates as reported at the ends of the policy periods.

activity. The role of exchange market pressures in affecting the behavior of velocity and creating a dilemma for the Bundesbank is illustrated by experiences in 1977-78 and 1980-81.

In the first period, the predominant pressures came from the exchange rate of the deutsche mark against the U.S. dollar. The mark appreciated about 20 percent against the dollar from the middle of 1976 through the middle of 1978, and roughly 10 percent more during the second half of 1978. Partly in association with such exchange market developments, 1/ German real activity growth weakened and inflation rates declined. The Bundesbank held the growth of central bank money fairly close to its target in 1977 and the first half of 1978, but permitted a sharply increased pace of money growth after the middle of the latter year in response to external pressures. In its December 1978 Report, the Bundesbank explained its policy as follows: 2/

> In recent months the Bundesbank's policy has mainly been guided by the need to take account of the extremely unstable situation in the exchange markets.... on several occasions, under the prevailing domestic and external conditions it was extremely difficult for the Bundesbank to curb monetary growth. A switch to a more restrictive monetary policy seemed inappropriate as long as the economic upswing had not taken more definite shape.

The opposite experience occurred several years later. From the end of 1979 through February 1981, the mark depreciated more than 20 percent against the dollar, close to 25 percent against the pound, and more than 30 percent against the yen. Consistent with these depreciations, the domestic inflation rate began to rise in Germany and the Bundesbank chose to aim for central bank money growth around the lower limits of its target ranges in both 1980 and 1981. In its March 1981 Report, the Bundesbank explained its policy as follows: 3/

> The final objective of ... [monetary policy] is to maintain price stability. The formulation of the monetary growth target and the measures taken to achieve this target are an "intermediate" objective. It is important in this connection to pay attention to the balance of payments and the exchange rate of the Deutsche Mark as well because, in the prevailing circumstances, it is not possible to defend the value of money in the domestic economy while disregarding

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1/ It should be recognized, of course, that exchange market developments themselves are not "exogenous," although in the 1977-78 experience, the appreciation of the mark against the dollar may have been "caused" to a considerable extent by economic outcomes and prospects in the United States, which were "exogenous" to Germany.

2/ Monthly Report of the Deutsche Bundesbank, December 1978, p. 11.

3/ Ibid., March 1981, p. 9.

the special influences that may proceed from the external value of the currency. If, as hitherto, inflationary tendencies can largely be kept out of Germany, the principal condition for sound long-term economic growth and for a high level of employment will be safeguarded.

The experience in Canada illustrates the difficulties of relying on a monetary targeting strategy during a period of financial innovations. From 1975 until late 1982, the Bank of Canada operated with a target for its M1 aggregate, and through 1980 it consistently hit a sequence of progressively lower target ranges. Shortly after the period of monetary targeting began, however, the authorities were confronted with a shift in the demand for money apparently related to innovations in cash management accounts for businesses. This development made it difficult to judge the degree of monetary restraint implied by the target settings, and these difficulties were compounded by inflationary pressure arising from the sharp increases in oil prices. In retrospect, the degree of monetary restraint proved insufficient to keep the cost-price spiral from accelerating. During 1977 and 1978, the Canadian dollar depreciated against the U.S. dollar, even with U.S. inflation on the rise, and in 1979 Canadian inflation began to escalate.

Starting in late 1980, Canadian monetary policy was tightened considerably. However, continuing financial innovations, which were induced to some extent by the high levels of inflation and interest rates in Canada, generated further instability in the relationship between M1, nominal income, and interest rates. The shift of funds out of accounts included in M1 (currency and noninterest-bearing demand deposits) resulted, after mid-1981, in a relatively sharp divergence between the growth rates of M1 and M1-A (which includes interest-bearing checkable deposits and nonpersonal notice deposits). M1 velocity increased, M1-A velocity declined, and the Bank of Canada was led to conclude that since neither "the process of financial innovation" nor "the response of bank customers" could be reliably predicted, "appropriate ranges for the future growth of M1 cannot be chosen with any confidence." 1/ For the same reasons, it was felt that M1-A would also be an unreliable guide. Moreover, while the broader aggregates, such as M2, seemed to be less affected by financial innovations, in the view of the Bank of Canada the problems of controlability and interpretation were sufficiently great to make those aggregates unsuitable as well as intermediate targets for conducting monetary policy.

The Canadian experience through 1982 indicates that the consistent achievement and progressive lowering of monetary targets provides no guarantee that inflation rates will decline. Since the end of 1982, Canada has followed a different approach to monetary policy, based on a

1/ Bank of Canada, 1982 Annual Report, p. 27.

variety of economic and financial indicators, including in particular the exchange rate between the Canadian and U.S. dollars. In following such an eclectic approach, the Bank of Canada has described its "ultimate guiding objective" as "the achievement of long-term price stability," has stressed that it has not set an exchange rate target because it is not possible to know in advance what a sensible target path would be, but has emphasized that "the appropriate approach of monetary policy to the exchange rate is to resist sharp exchange rate declines that threaten to undermine our progress on inflation." 1/

In France, monetary policy objectives have been stated in the form of simple target numbers or relatively narrow target ranges for the growth of M2 (from 1977 through 1983) or M2R (in 1984 and 1985). The shift from M2 to M2R narrowed the definition of the targeted aggregate to a concept that includes only the M2 holdings of resident nonfinancial agents; as such, the French definition of M2R corresponds more closely to the definitions of M2 that are used in most other major industrial countries.

Although the French authorities announced simple target numbers for monetary growth during the 1977-81 period, in each of those years except 1979, the growth of the M2 aggregate was held within 1 1/2 percentage points of its target and would thus have fallen within the types of ranges announced by most other countries. As in Canada, however, that achievement did not prevent inflation rates from rising. One factor contributing to the rise in inflation was the substantial increase in oil prices.

Since the middle of 1982, French inflation rates have declined considerably. French M2R growth has also declined, although it has remained above its target levels and might have been higher still in the absence of financial innovations. In particular, M2R deposit balances have been withdrawn in quite significant amounts in recent years to purchase new types of liquid short-term mutual and investment funds, which banks have been offering to the public since late 1981, but which are not included in M2R. These funds have been invested predominantly in variable rate bonds or bonds nearing maturity, and apparently a perception that the capital risks of such assets are limited has made them attractive substitutes for other forms of liquid savings. Partly as a consequence of the implications of these developments for the interpretation of the aggregates, the Bank of France announced in November 1985 that it would redraw its monetary definitions and shift in 1986 to targeting a broader M3 aggregate.

As in other countries, the experience with monetary targeting in the United Kingdom illustrates the difficulties of setting policy during a period of extensive financial liberalization when different monetary aggregates are expanding at different rates. The U.K. authorities first

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1/ Bank of Canada, 1984 Annual Report, pp. 7-10.

announced a monetary target for the M3 aggregate in 1976; in 1977 they shifted to specifying a target for sterling M3. Under the Conservative Government that came to power in 1979, monetary targeting has been a centerpiece of the medium-term financial strategy. The strategy has involved the announcement of target ranges for sterling M3 for several years ahead, with a stated goal of progressively slowing its rate of expansion. The removal around mid-1980 of the supplementary special deposits scheme (the "corset"), which had restricted the deposit-taking activities of banks, contributed to a substantial overshooting of the sterling M3 target for 1980, and from mid-1980 onward the velocity of sterling M3 trended downward, in contrast to a strong previous uptrend. The budget presented in the spring of 1982 emphasized the difficulties of relying too heavily on sterling M3 as an indicator of monetary policy. Accordingly, in 1982 and 1983 the target for sterling M3 was supplemented with targets for M1 and PSL2. 1/ The practice of targeting M1 and PSL2, however, was abandoned after two years, in association with financial innovations that had altered the previous relationships of those aggregates with national income. At the same time, the authorities in 1984 adopted a target for M0, the wide monetary base.

Notwithstanding the fact that the targets were overrun for sterling M3 in 1980, 1981, and 1984 (as well as for M1 in 1982 and 1983 and PSL2 in 1983), the progressive lowering of monetary growth over the 1980-84 period contributed to a substantial decline in British inflation. During 1985, the authorities were confronted with conflicting signals from sterling M3, which had been expanding more rapidly than the upper bound of its target growth range, and M0, which was close to the lower bound of its target range. The authorities continued to regard the aim of monetary policy as that of insuring sustained and steady downward pressure on inflation. Moreover, the Chancellor of the Exchequer, in his October speech at the Mansion House, emphasized that

> ... it remains operationally necessary to conduct monetary policy through the use of intermediate targets--taking account of relevant information such as the behavior of the exchange rate--rather than by attempting to target money GDP directly.

At the same time, the British authorities stated their assessment that the recent behavior of sterling M3 had been affected by structural changes and was not inconsistent with declining inflation, given that narrower measures of money had been growing relatively slowly, that the exchange rate was relatively firm, that real interest rates remained high, and that forecasts for business activity did not suggest inflationary pressures. For those reasons, they decided to downgrade the sterling M3 target.

1/ PSL2 includes deposits at building societies, which are excluded from sterling M3; see Table 4, footnote 2.

In the United States, monetary policy has pursued target growth rates for multiple monetary aggregates since 1975. However, a major shift in monetary strategy was announced in October 1979, and another shift occurred around October 1982.

The performance of the monetary aggregates and inflation during the period prior to October 1979 contributed, in the opinion of some close observers, to an erosion of the credibility of U.S. monetary policy. 1/ Although M1 growth was held within its target ranges during 1975 and 1976, the Federal Reserve allowed M1 to overrun its targets in 1977 and 1978, and to land in the upper part of its range in 1979. In addition, during each of the latter three years the outcomes for M2 and M3 were either above or in the upper thirds of their target ranges. Moreover, through the beginning of 1979, new one-year targets were adopted every quarter, with a regular practice of rebasing to the outcome for the most recent period, which typically overshot the level specified by the previous target. 2/

In October 1979, as part of a broad anti-inflation program, the Federal Reserve decided to shift its operating techniques to a procedure that placed greater emphasis on controlling reserves directly through the specification of a "target" path for nonborrowed reserves, thus abandoning its previous procedure of maintaining the interest rate on federal funds within a relatively narrow range. 3/ In doing so, an "important objective" of the U.S. authorities was "to help convince the public that the Federal Reserve would in practice achieve its monetary targets ... and thereby increase the credibility of monetary policy and facilitate the transition to a noninflationary environment." 4/ Without question, in the ensuing years U.S. monetary policy regained its credibility by playing a major role in reducing U.S. inflation substantially, yet during each year of the 1980-82 period, the growth rates of M2 and M3 exceeded the upper bands of the initial targets for those years. M1 growth also exceeded its initial targets in 1980 and 1982. Just as the Canadian experience during the late 1970s indicated that adherence to monetary targets could not guarantee an improved inflation performance,

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1/ See Axilrod (1985a) for an expression of this opinion. It has been argued that the depreciation of the dollar during the 1977-79 period supports the opinion.

2/ The practice of respecifying targets each quarter ended with the specification of targets for the period from fourth-quarter 1978 through fourth-quarter 1979.

3/ A "target" range for the federal funds rate continued to be specified but was made much wider and was no longer regarded as binding.

4/ Axilrod (1985a), p. 16.

the U.S. experience during the early 1980s indicated that monetary policy could contribute to an improved inflation performance even if targets for the monetary aggregates were not achieved. 1/

The period since October 1979 has been described as one in which the U.S. monetary authorities were 2/

> ... confronted by shifts both in the demand for goods and services, given interest rates, and in the demand for money, given interest rates and income. Downward shifts in the demand for goods and services seemed evident from the psychological impact associated with initiation of the credit control program in early 1980 and during the recession of 1982 when inflationary expectations began to wane; upward shifts appeared as the credit control program was lifted and more recently in the wake of the turn to a quite expansionary fiscal policy .... Meanwhile, ... there were widespread institutional and regulatory changes introducing new instruments to serve as money or money substitutes ... that also led to shifts in the demand for money relative to historical experience.

Those shifts led to extremely wide fluctuations in interest rates under the operating procedures that had been adopted in October 1979. Partly for that reason, in October 1982 the Federal Reserve again decided to change its operating procedures, this time toward a more judgmental approach based on targeting on borrowed reserves. Since that time, U.S. monetary policy has been exercised with considerable discretion, but "as a continuing struggle to attain and maintain credibility in the face of continuing shocks and disturbances in money, credit, and goods markets". 3/

It is noteworthy that the Federal Reserve has been criticized strongly over the past decade both for deviating from its targets and for adhering to its targets. Just as associations have been drawn between the acceleration of inflation and the growth of monetary aggregates above their target ranges prior to October 1979, associations have also been drawn between the depth of the U.S. recession in 1982 and the Federal Reserve's adherence to its targets during the first half of that year. By the end of 1981, U.S. wage and price inflation had been brought down considerably, and most econometric forecasts were predicting a moderate pace of activity growth during 1982. Such strength failed to materialize

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1/ The reviews of the experiences in France and the United Kingdom have revealed similar disparities between the degrees of success at achieving intermediate targets and ultimate objectives.

2/ Axilrod (1985a), p. 22.

3/ Ibid., p. 14. During the period since October 1979, the Federal Reserve has redefined the monetary aggregates on several occasions, prompted by financial developments that altered the meaning and reduced the significance of the old measures.

during the first two quarters of the year, however, and the velocities of the U.S. monetary aggregates continued to drop sharply. Critics have argued that the Federal Reserve should have responded sooner than it did to counter the decline in velocity with an increase in monetary growth, particularly with short-term real interest rates in the range of 10 percent per year. But a substantial reduction in taxes was scheduled to become effective at mid-year, and it was difficult to predict what impact the fiscal stimulus would have on economic activity. By contrast, in the second half of 1982, the Federal Reserve changed its policy stance in the sense of allowing U.S. interest rates to decline sharply by permitting M2 and M3 to grow rapidly and to exceed the upper limits of their target ranges for the year as a whole. 1/ The recession continued through the fourth quarter, however, and the recovery did not gain strength until the second quarter of 1983.

During 1985, the Federal Reserve faced the choice of how to react to M1 growth considerably in excess of its target range. Although the economy was not in a recession, as it had been in the first half of 1982, signs of economic activity growth and inflationary pressures did not appear to be strong, and velocity levels had dropped significantly. Accordingly, in July the Federal Reserve rebased its M1 target at a higher level and also widened the target range. By the fourth quarter, M1 velocity had dropped even more, and the members of the Federal Reserve policy committee, as they had at previous meetings, agreed that

> ...the behavior of M1 needed to be judged in the context of the performance of the economy and the fact that the broader aggregates were growing at rates within their ranges. Under prevailing circumstances, and unless the dollar declined sharply further, the strength of M1 thus far did not appear to suggest strong inflationary consequences. 2/

Accordingly, it was decided that growth of M1 above its revised target range would be acceptable for the second half of the year.

3. What policy lessons does experience provide?

There is disagreement over the policy lessons that should be drawn from the observed behavior of velocity and the central bank experience with monetary targeting over the past decade. The disagreement distinguishes three schools of thought: advocates of fixed or passive monetary

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1/ A de-emphasis of the M1 target during the second half of 1982 was precipitated by uncertainty over how M1 would be affected when the public reinvested the very large volume ($31 billion) of all savers certificates that matured in October; see Axilrod (1985a), p. 18.

2/ Federal Reserve Board, Record of Policy Actions of the Federal Open Market Committee, meeting held on November 4-5, 1985.

rules, advocates of activist countercyclical monetary rules, and advocates of central bank discretion. Advocates of passive rules have not been dissuaded by the past decade of experience, but rather argue that discretion is inherently inflationary and destabilizing, and contend that the difficult choices that central banks have confronted can partly be attributed to the fact that they did not adhere sufficiently closely to the targets they announced. Advocates of activist rules suggest that some of the difficulties confronted by central banks could be alleviated by shifting from the types of fixed monetary targets that have been announced over the past decade to rules that provide an explicit prescription for countercyclical behavior. Advocates of discretion argue that no mechanical rule can respond adequately to all contingencies that may arise.

In order to provide a better appreciation for the sources of these disagreements and the strengths and weaknesses of the three schools of thought, the next part of the paper will review the different types of models that have been developed for analyzing the behavior of velocity and for drawing inferences about the appropriate conduct of monetary policy.

III. The Behavior of Velocity and the Case for Monetary Targets: Theoretical Foundations

As has already been emphasized, a focus on statistics and experience alone cannot isolate the extent to which the variability of velocity has been an "exogenous" development that has led central banks to exercise discretion, or the extent to which the exercise of central bank discretion may itself have "caused" velocity to become more variable. Because velocity reflects the joint behavior of the price level, the level of real output, and the money stock, the interpretation of the statistics and the central bank experiences requires a focus on the sources of short-term fluctuations in prices, output, and money and the transmission mechanisms through which "exogenous" changes in the money stock can influence prices and output.

This part of the paper provides a streamlined presentation and comparison of the different types of models that have been used to analyze the interrelationships between prices, output, and money and the behavior of velocity. Its purpose is to shed light on important conceptual issues in the debate over the appropriate conduct of monetary policy, which to a considerable extent has been confused by an inadequate recognition of the strengths and limitations of alternative analytic frameworks, and by misperceptions of the types of theoretical models and assumptions that support different conclusions.

Three different approaches have been developed for analyzing the behavior of velocity and for addressing questions about the appropriate conduct of monetary policy. The first approach has concentrated narrowly

on the demand for money; however, the lack of a complete framework of analysis (recognizing the endogenous nature of the arguments in the money demand function) limits the usefulness of such models for economies in which income, prices, and money interact simultaneously. A second approach, consisting of the so-called "disequilibrium" models, employs a complete macroeconomic framework and generally bases its analysis on the assumption that expectations about future price levels or inflation rates are formed adaptively (i.e., as weighted averages of the current and past values of those variables). The third approach, which has gained increasing attention in recent years, also employs a complete macroeconomic framework, but under the assumption that expectations about inflation rates and other endogenous variables are rational and forward looking, in the sense of taking account of relevant information about the structure of the macroeconomic system and expectations about the future values of exogenous variables, including the setting of monetary policy. Sections 1 and 2 provide an overview and criticism of the first two approaches. Section 3 then concentrates attention on the third approach and discusses how different types of complete macroeconomic frameworks can lead to different theoretical inferences about the behavior of velocity and the appropriate conduct of monetary policy.

1. The demand for money framework

In much of the literature, the behavior of velocity has been analyzed in terms of the "demand for money". A centerpiece of these analyses is the classic specification of the long-run money demand function, in which the demand for real money balances depends on the level of real income and a measure of the interest rate foregone by holding money. 1/ Specifically,

$$(1) \quad m_t^* = m_t^d - p_t = \beta_o + \beta_1 y_t - \beta_2 i_t$$

where: i = the nominal interest rate;

and as logarithms,

m^* = the desired level of "real" money balances;

m^d = the desired level of nominal money balances;

p = the domestic price level;

y = the level of real income and output.

1/ In this part of the paper, no distinctions are drawn between different monetary aggregates, and the interest rate is taken to be the relevant opportunity cost of holding money.

The subscript "t" denotes time, and velocity (v_t) is simply obtained (also expressed as a logarithm) by subtracting the level of income from both sides of equation (1). Thus:

$$(1') \quad v_t = y_t + p_t - m_t^d = -\beta_o + \beta_2 i_t + (1-\beta_1)y_t$$

As a special case of this general formulation, if the income elasticity of the demand for money (β_1) happened to equal one, then movements in velocity would depend only on movements in the nominal rate of interest. Moreover, velocity would be constant over time if, in addition, the demand for money was insensitive to the interest rate (i.e., if $\beta_2=0$). These features are in accordance with one extreme case of the simple Keynes-Hicks IS-LM model, in which prices are assumed to be fixed in the short run and the interest rate provides the transmission mechanism through which the money supply affects the level of output. The extreme case is that in which the demand for money is insensitive to the interest rate (i.e., in which the LM curve is vertical) but saving and investment are not, and in which the demand for money has a unitary income elasticity. In that case, an increase in the money supply would require income to change proportionately in order to restore equilibrium in both the goods and money markets. 1/ In such circumstances, velocity would not be affected by the change in the money supply.

While equation (1) has been widely adopted as a description of the long-run demand for money, much of the empirical literature has hypothesized that adjustment costs can result in short-run deviations of actual from desired real money balances. Typically, adjustment costs have been represented simply by adding a lagged dependent variable to equation (1). Thus, a typical short-run money demand function is: 2/

$$(2) \quad m_t - p_t = a_o + a_1 y_t - a_2 i_t + (1-\eta)(m_{t-1}-p_{t-1})$$

where: $a_o = \eta\beta_o$

$a_1 = \eta\beta_1$

$a_2 = \eta\beta_2$

1/ The increase in the money supply (which would shift the LM curve) initially would generate an excess supply of money and an excess demand for goods. As a result, the interest rate would decline, thereby stimulating investment and output until the level of income had increased proportionately to the money supply, therefore restoring equilibrium.

2/ Measurement errors in the arguments of the long-run money demand function may provide another motivation for the lagged term; see Goodfriend (1985).

and η is a coefficient of adjustment that describes the speed at which an excess demand for or supply of money is eliminated.

Throughout the past decade of monetary targeting, central banks have relied heavily on relationships like equation (2) in analyzing the behavior of their monetary aggregates. One difficulty is that the function has kept "shifting" over time; that is, the estimated parameters from fitting equation (2) over a given sample of data have generally led to poor predictions of the behavior of the demand for money, and hence velocity, when extrapolated into the post-sample period. This puzzle has been well documented for the United States, 1/ although it is by no means unique to that country. 2/ An enormous volume of literature has thus emerged, seeking to produce a more stable money demand function by suggesting alternative variables as arguments in the function or by experimenting with alternative estimation techniques and lag structures.

One line of argument for modifying equation (2) is the "financial innovations" approach. Some economists 3/ have argued that the modification of simple velocity functions to recognize institutional developments can improve the explanation of both long-run and short-run movements in velocity. The basis for this view is the fact that the introduction of attractive new financial instruments that are close substitutes for the components of a given monetary aggregate will decrease the demand for the aggregate at given levels of income and interest rates and, hence, will increase its velocity. 4/ As Part II has already discussed, several of the major industrial countries have experienced significant shifts in velocity associated with financial innovations; indeed, such shifts contributed importantly to the Canadian decision to abandon the practice of monetary targeting in 1982, and to the U.S. decisions to shift-adjust their aggregates and de-emphasize M1 in the early 1980s. Note, however, that while sustained changes in the level or trend of velocity might, at least partially, be explained by financial innovations, it is difficult

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1/ See, for example, Enzler, Johnson, and Paulus (1976). The problem has become known as the "Goldfeld puzzle," after the "failure" of Goldfeld (1976) to obtain a specification capable of explaining both the pre-1974 and post-1974 behavior of M1 demand in the United States.

2/ See, for example, Brittain (1981).

3/ See, for example, Bordo and Jonung (1981) and Lieberman (1980). For a review of the issues involved in the financial innovations approach, see Judd and Scadding (1982).

4/ Similarly, the velocities of monetary aggregates that include the new financial instruments will decrease.

to attribute reversible fluctuations in velocity to financial innovations, since there generally is no reason for the demand for the monetary aggregate to ever shift back to its pre-innovation level. 1/

A second line of argument for modifying equation (2) as a description of the short-run demand for money is based on the recognition that the nominal money supply for the economy as a whole is controlled by the monetary authorities. Thus, if the public wishes to adjust its real money balances, given the amount of money supplied by the authorities, such adjustment must take place through variations in the price level. 2/ 3/ More specifically, this approach hypothesizes that the current price level will increase relative to the previous period's price level whenever the level of actual holdings of nominal money balances is greater than the nominal-equivalent level of desired holdings of real money balances evaluated at the price level inherited from the previous period. 4/ Under that description of the price-adjustment process, the short-run demand for money function is then modified to take the following form:

$$(3) \quad m_t - p_t = a_o + a_1 y_t - a_2 i_t + (1-\eta)(m_t - p_{t-1})$$

The only difference between equations (2) and (3) is that the lagged dependent variable of equation (2) has been replaced in equation (3) by a current money supply aggregate deflated by the price level for the previous period, reflecting the hypothesis that the public slowly adjusts its holdings of real money balances through variations in the price level. A fundamental implication of this difference is that the aggregate demand for money equation "is really a model of price adjustment to

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1/ By increasing productivity, a financial innovation may lead to an increase in the amount of real output and income that can be sustained by a given stock of real money balances. Hence, it is possible that an increase in velocity may result from an increase in the level of income rather than a reduction in the amount of money demanded. In other words, it is possible that the income effect of a financial innovation on the demand for money will be greater than the substitution effect brought about by the innovation. If that is the case, money demand may increase (at a given price level) and still be consistent with a rise in velocity.

2/ This argument was initially made by Walters (1965) and later by Laidler (1982) and Coates (1982). Recently it has been extended by Carr and Darby (1981).

3/ This viewpoint is distinct from Goldfeld's (1973) suggestion that the public adjusts its real money balances through the passive supply of nominal money by the authorities.

4/ See Appendix I.I., equation (I.2), which is taken from Hetzel (1984).

nominal money supply changes." 1/ It should be emphasized, however, that equation (3) is a reduced form model that combines a demand for money function and a price adjustment hypothesis. Moreover, it is possible to obtain the same type of reduced form equation from a large number of models that use equation (1) as one of their structural components. Thus, unstable estimates of equation (3) would not necessarily imply that the demand for money was misspecified, but might rather reflect instability in other sectors of the economy.

Nevertheless, this approach correctly identifies the endogeneity of the price level and thereby makes a valuable contribution to understanding the behavior of velocity. Indeed, equation (3) implies that velocity depends (negatively) on the contemporaneous level of the money supply; an increase in the money stock in one period does not lead immediately (but only after a lag) to equi-proportionate increases in the levels of prices and nominal GNP.

$$(4) \quad v_t = -a_o + (1-a_1)y_t + a_2 i_t - (1-\eta)\, m_t + (1-\eta)p_{t-1}$$

This dependency of velocity on the contemporaneous money stock distinguishes equation (4) from the description of velocity corresponding to equation (2). In equation (4), the money supply is an exogenous variable; so too are the level of output and the interest rate.

A third line of argument for modifying equation (2) is to relate the behavior of money demand to exchange rate expectations. It can be argued that, in deciding on their holdings of money denominated in a given currency, individuals take into account not only expected rates of return on domestic-currency-denominated substitutes for the domestic money, but also expected rates of return on assets denominated in foreign currencies. The expected rate of change in the exchange rate is then introduced into the model in the form of a relationship between domestic and foreign interest rates. The implied association between the level of money demand and the expected level of the exchange rate is consistent with the fact that central bankers in a number of countries have experienced the choice of keeping their monetary aggregates near the centers of their target ranges and accepting undesirable consequences for exchange rates, or of damping undesirable exchange market pressures but moving toward or beyond the bounds of their monetary target ranges; recall the discussion of Germany's experience in Part II, Section 2.

The development of this line of argument in the literature, however, has not been entirely satisfactory, as is shown in Appendix II. This Appendix provides an extension of the analysis, which leads to the

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1/ See Carr, Darby, and Thornton (1985).

implication that an increase in the expected rate of depreciation of the domestic currency will raise velocity by making it attractive to hold less domestic currency at given levels of domestic income and interest rates. In particular, the expression for velocity is:

$$(5) \quad v_t = b_o - b_1 y_t + b_2 i_t + b_3 e^e_{t+1} + b_4 ({}^F M_t - {}^D M_t)$$

where the parameters b_1, b_2, b_3, and b_4 are all greater than zero, ${}^D M_t$ and ${}^F M_t$ respectively represent the world supplies of domestic and foreign currencies, and e^e_{t+1} is an expected future level of the exchange rate (in units of domestic currency per unit of foreign currency). As in equation (4), velocity depends negatively on the contemporaneous supply of the domestic currency; but again the behavior of velocity is described by the reduced form of a system of equations rather than by a structural money demand function alone. While equation (4) is based on the assumption that the price level is endogenous, equation (5) is derived from a model that takes the behavior of the contemporaneous exchange rate as endogenous. 1/ However, as in equation (4), the level of income and the interest rate are taken as exogenous, as is the expected future level of the exchange rate. Hence, the short-run interaction between money, income, and the interest rate is not completely explained, even though the nature of that interaction may be quite important for understanding the behavior of velocity.

It is beyond the scope of this study to cover the many other types of "extended" money demand models that have been developed in the literature. In general, however, the foregoing criticisms of the technique of analyzing the behavior of velocity with models that focus only narrowly on extended money demand functions, rather than on complete macroeconomic models, raises an important caveat for policy analysis. It is often argued, following Poole (1970), that it is preferable for central banks to adopt a monetary aggregate, rather than an interest rate, as an intermediate target only if the financial sector of the economy is subject to less variability than the real sector of the economy. Accordingly, empirical evidence that "the demand for money function keeps shifting" would seem to provide support for an interest rate target. The caveat, however, is that the argument is not based on a complete macroeconomic model. When a more extended model is employed, and when expectations are assumed to be rational, it can be shown that, in contrast to Poole's conclusion, setting an interest rate target can be counterproductive.

1/ The domestic price level is also endogenous in the model giving rise to equation (5) through the assumption of purchasing parity power.

2. Complete macroeconomic models with adaptive expectations

The need to explain velocity in the context of a more "complete" macroeconomic framework gives rise to the issue of model selection. This section considers a set of models that has become known as the "disequilibrium" framework. 1/ The focus here is restricted to the most popular class of disequilibrium models, which share two common assumptions: (a) that the process of price adjustment is slow, so that a "disequilibrium" in the money market can affect the level of output in the short run 2/; and (b) that expectations about prices or inflation are formed in an adaptive way, based on current and past values of those variables. 3/ Section 3 will analyze the behavior of velocity in models in which expectations about prices or inflation are rational and forward-looking, taking account of relevant information about the relationships between macroeconomic variables and the expected future courses of policy variables.

The disequilibrium models under consideration here incorporate a long-run money demand function of the kind described in equation (1). In addition, the models specify an equation describing the aggregate demand for output, 4/ a type of "Phillips curve" equation that determines the short-run behavior of inflation, and an equation that describes the formation of price expectations according to an adaptive error-learning hypothesis. 5/ Appendix I.II provides an example of such a model.

This framework explains the interrelations between money, output, and prices (and hence the behavior of velocity) in the following way. After an exogenous change in the money supply occurs, individuals find themselves holding a different level of real money balances than they desire; thus, they revise their expenditure plans and, in doing so, induce a shift in output away from its full employment level. However, the deviation from full-employment output is a temporary phenomenon;

1/ For examples of disequilibrium models applied to industrialized countries, see Laidler and Bentley (1981) and Knight and Wymer (1978).

2/ In this framework, the argument for using the money market disequilibrium as a variable explaining the behavior of output is claimed to be analogous to the "adjustment cost" argument for including a lagged dependent variable in the short-run demand for money.

3/ Some disequilibrium models have moved away from the adaptive expectations assumption to specifications in which expectations about prices take account of other relevant variables in the model. For examples, see Jonson (1976) and Laidler and O'Shea (1980).

4/ In general, the supply of output is assumed to adjust instantaneously to satisfy aggregate demand, regardless of the price level.

5/ In models that incorporate nonmonetary assets, additional equations describing the behavior of the real rate of interest are included, together with the Fisher hypothesis for linking nominal and real interest rates.

prices will react, although sluggishly, and will in turn influence expectations, generating a dynamic pattern of price and output adjustment that continues until prices have moved to the same extent as money and the disequilibrium in the money and output markets has vanished.

The disequilibrium model that is presented in Appendix I.II leads to the following reduced-form equation for velocity: 1/

$$(6) \quad v_t = z_o + (1-z_1)y_t^* - z_2(m_{t-1}^s - p_{t-1}) - z_3(\Delta m_t^s - \Delta p_{t-1}).$$

In this equation, z_1, z_2, and z_3 are positive coefficients; y* is the "long run" full employment level of output; Δm_t^s is the contemporaneous rate of growth of the money supply; and Δp_{t-1} is the previous period's rate of inflation. Notice that equation (6) describes the behavior of velocity completely in terms of exogenous variables (the money supply and the long-run level of output) or predetermined variables (the past values of the price level). Notice also that equation (6) shares with equations (4) and (5) the property that contemporaneous changes in the money supply have negative effects on velocity. Hence, all these equations imply that the variability of velocity is not independent of the behavior of the monetary authorities.

One important feature of the disequilibrium model is that changes in the money supply, even when they are entirely expected, are capable of influencing real variables such as the level of output. As will be emphasized in the following section, this type of "effectiveness" of monetary policy has an important policy implication; in particular, it implies that a countercyclical monetary policy rule can be used to dampen the business cycle, even when the rule is known to the public. 2/

3. Complete macroeconomic models with rational expectations

In recent years, economic theory has moved increasingly away from analysis based on the assumption that expectations are formed adaptively, or in some other ad hoc manner, and toward the assumption that expectations are formed rationally, in the sense that account is taken of

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1/ The example abstracts from the role of interest rates and, for additional simplicity, defines velocity with respect to the full-employment level of output.

2/ Although the above presentation has abstracted from the interest rate, in most disequilibrium models the choice of whether to specify a countercyclical rule in terms of a monetary aggregate or an interest rate is generally posed as an empirical issue depending on the estimated coefficients of the model.

whatever relevant information is available about the structure of the economy and the values of exogenous or predetermined variables. 1/ Although the notion that expectations are completely rational is an extreme assumption, the property of rationality in determining expectations is attractive, and the policy implications of the rational expectations assumption have received considerable attention.

Several different types of complete macroeconomic models have been used to address questions about the appropriate conduct of monetary policy under the assumption that expectations are formed rationally. It is now appreciated that the answers to these questions depend critically on the effectiveness of monetary policy, within the different types of models, at generating changes in the short run in the relative prices and other variables that influence the supply decisions of firms and factors of production, which in turn combine to influence the aggregate level of output for the economy as a whole. To illustrate these points, Subsection (a) presents a "classical" model in which monetary policy actions can affect the supply of output in the short run only if they surprise the public. For comparison, Subsection (d) presents a model in which multi-period labor contracts or other institutional rigidities make anticipated monetary policy "effective" in influencing microeconomic supply decisions. Subsections (b) and (c) use the classical model to discuss both the case for a money supply target and the choice of instruments for controlling the money supply.

It should be emphasized at the outset that the theoretical conclusions about alternative types of central bank rules, and especially the theoretical case against central bank discretion, have been challenged by arguments that the analytic models oversimplify the stability and predictability of macroeconomic relationships. Such arguments will be discussed in Part IV. It should also be emphasized, however, that the models discussed in this paper do not assume that economic agents have complete information about the structure of the economy; instead it is only assumed that private economic agents have as much information as central bankers. In addition, it should be noted that the results derived from these models are based on the assumption that agents have incomplete information on the current values of economic variables, in particular the general price level. Subsection (e) focusses on a practical implication of incomplete information that qualifies the theoretical conclusions.

1/ The assumption that expectations about the price level (or any other variable) can be described as a weighted average of the past levels of that variable (an assumption that typically characterizes adaptive expectations) is rational only if the actual behavior of the price level (or any other variable) follows a random walk; see Muth (1960).

a. A "classical" model with rapid price adjustment

In addition to assuming (a) that economic agents are optimizing units who use whatever relevant information is available when forming their expectations about future variables, the "classical" models hypothesize (b) that the supply of output depends positively on the gap between the current price level and prior expectations of the current price level, 1/ and (c) that prices adjust rapidly to allow for continuous clearing in all markets. 2/ Appendix I.III presents a typical example of such a model. Assumption (b), which has been labeled the Lucas aggregate supply relation, 3/ is based on the theory that optimizing firms will increase their production levels as the observed prices of their own output rise relative to their expectations about the general price level, on which information becomes available with a lag. Under that assumption, only an unexpected increase in the general price level can lead to an increase in the supply of output for the economy as a whole, because only an unexpected rise in the price level will be interpreted by firms (mistakenly) as an increase in the relative prices of the goods they are supplying. The lack of full current information prevents firms from distinguishing between relative and absolute movements of the price level. This is the source of the inverse correlation between inflation and unemployment, as depicted by the Phillips curve, in the classical model. Subsection (d) will present an alternative model that relies on a certain type of stickiness in the price-adjustment process, rather than on a current misperception of relative price changes, for influencing the supply decisions of micro-economic agents.

In models based on the rational expectations hypothesis, a forecast for one particular variable takes into account whatever relevant information is available about other variables that are known to affect the behavior of the forecast variable. In a model in which prices adjust rapidly to clear all markets continuously, rational individuals will know that changes in the money supply will rapidly affect the general price level. Thus, their expectations about the price level will depend on the expected level of the money supply. Accordingly, an unexpected increase in the money supply will lead to an unexpected increase in the general price level, which will result in an increase in output. On the other hand, if changes in the money supply are fully anticipated, they will not give rise to any "price surprises" and, hence, will not affect the level of output.

1/ This supply function in the classical model replaces the short-run Phillips curve employed as a price-equation by the disequilibrium models. Disequilibrium models provide a solution for the price level, but in contrast with the classical models, the solution is not obtained through the equalization of demand and supply functions, because of the assumption that supply always adjusts to demand independently of the price level.

2/ See, for example, Sargent and Wallace (1975).

3/ See Lucas (1973).

The important implications for monetary policy in this kind of model are derived from the fact that only the unexpected component of the money stock affects the supply of output, and even then only for the short period of time that it takes firms and other economic agents to perceive that their expectations were incorrect. By contrast, both the expected and the unexpected components of the money supply affect the price level. This is a "typical" result of combining the Lucas aggregate supply relation with the assumption of rational expectations and is "robust" under different specifications of the other equations in the model. Note also that even if the rate of growth of the money supply is anticipated and, therefore, does not affect output, it will nevertheless affect the nominal interest rate through its impact on inflation. 1/

The example of a classical model that is presented in Appendix I.III follows the literature in focusing on the case of a closed economy. In the example, the derived solution for velocity takes the following form:

$$(7) \quad v_t = c_0 + c_1 y^* + c_2 (m_t - m_t^e) + c_3 h_t + c_4 \varepsilon_t + c_5 n_t + c_6 u_t$$

In equation (7): m_t^e is the period t level of the money supply that is expected at the end of the previous period, such that $m_t - m_t^e$ equals the unexpected component of the money supply; h_t is the anticipated rate of growth of the money supply; ε_t, n_t, and u_t represent the effects of random disturbances on the demand for money, the demand for output, and the supply of output, respectively; and the c coefficients are functions of all the structural parameters in the model, reflecting the macroeconomic inter-relations across all economic sectors.

The presence of the random disturbances ε_t, n_t, and u_t reflect the important fact that the world is "stochastic" and, thus, that there are always some influences on economic decisions that cannot be totally captured in a particular model. The analysis through the end of Subsection (c) will assume that the disturbance terms are independent of their previous values.

Equation (7) reflects the fact that an unexpected change in the money stock affects the behavior of velocity through its effects on both the nominal interest rate and the level of output. However, although an unexpected increase in the money supply always increases the level of output, its effect on the nominal rate of interest may be positive or

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1/ This relation follows from the Fisher condition, whereby the nominal rate of interest is equal to the real rate of interest plus the expected rate of inflation.

negative, 1/ and thus its overall effect on velocity is ambiguous. By contrast, an expected increase in the money supply does not affect the level of output, but raises the inflation rate and the nominal interest rate, and hence has an unambiguous positive effect on velocity. The model also implies that unexpected changes in money cause velocity and the nominal interest rate to increase or decrease together, but lead to an ambiguous correlation between changes in output and changes in velocity. 2/

The conclusions drawn from the classical model differ in several important ways from the conclusions of the demand for money and disequilibrium approaches. In general, the ambiguous correlation between changes in output and changes in velocity within the classical macroeconomic framework emphasizes again that inferences drawn from the money demand approach may be misleading. In addition, equation (7) differs very significantly from the solutions for velocity presented in equations (4), (5), and (6) in that a distinction is made between the expected and unexpected components of the money supply. This distinction will give rise to important differences in the implications that are drawn about the appropriate role of monetary policy as a tool for stabilizing output and employment.

b. The case for a passive money supply target

Models with rapid price adjustment and rational expectations provide theoretical support for a money stock target. The support is based on two propositions: first, that the exercise of discretion by central banks can surprise the public temporarily and can thereby have short-lived effects on output, but can do no more to output than create variability around its expected time path; and second, that once discretion has been ruled out, a money stock target appears superior to a nominal interest rate target. 3/ These propositions are demonstrated in this subsection. The analysis does not address the question of whether a money stock target is superior to a target for some other nominal magnitude, such as nominal GNP; that issue is discussed in Part IV of the paper.

1/ The intuition for the ambiguous effect on the nominal interest rate is that an unexpected increase in the money supply will stimulate output and income, which will in turn increase money demand by an amount that may be either more or less than the increase in the money supply, thereby creating either upward or downward pressure on the interest rate, see Appendix I.III.

2/ See Appendix I.III.

3/ By contrast, in both the disequilibrium models and the "expanded" money demand models, the choice between a money stock or an interest rate target depends on the relative variability of real and monetary disturbances and on the estimated values of the coefficients in the model.

Two sets of distinctions should be kept clear throughout the analysis. The first is the distinction between discretion and rules, and the second is the distinction between "active" and "passive" rules. As defined in Part I, discretion should be understood to refer to monetary policy that does not follow a prespecified and preannounced rule. However, the fact that central bankers choose to "follow a rule" does not imply that they must try to achieve a "fixed" 1/ target for the monetary aggregate (a passive rule). An alternative is for the monetary authorities to follow an activist rule under which the authorities' target for the controlled variable is specified to react countercyclically to the current and past values of relevant economic variables, such as prices and output, or to serve as an automatic stabilizer in reacting to various types of disturbances to macroeconomic conditions. Such activist rules will be considered in Subsections (d) and (e).

The analysis of macroeconomic models under the rational expectations assumption leads to a number of strong conclusions that are here labeled as "theoretical" to indicate that these conclusions have been challenged (for reasons that will be discussed in Part IV). In addition to presenting a theoretical case against central bank discretion and suggesting that a monetary target is preferable to an interest rate target, this subsection demonstrates that the assumptions of rapid price adjustment and rational expectations together provide a theoretical case in favor of passive rules and against active countercyclical rules. Subsection (d) will show that this case is not necessarily reversed when prices adjust slowly. However, it will be shown that if prices in some markets are sticky for a length of time that is sufficient to allow anticipated monetary policy to influence relative prices in the short run, a case can be made for an activist countercyclical monetary rule.

An underlying premise of the theoretical case against central bank discretion is the inference that unexpected fluctuations in money growth around its expected path lead to unexpected fluctuations in prices and output. In the classical model, monetary policy cannot improve welfare by changing the expected path of output over time, since as soon as the behavior of the money stock becomes anticipated it no longer affects output. 2/ Thus, discretion can only create unexpected variability, and to the extent that unexpected fluctuations in prices and output are

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1/ Fixed in the sense that the target is set at a level that is independent of the state of the economy. Of course, random shocks are allowed to influence the outcome for the target variable to the extent that the authority does not have full control of the target variable.

2/ The long-run ineffectiveness of discretion is not unique to rational expectations models; the argument holds whenever an "expectations augmented Phillips curve" is used to explain the relation between output and prices, since such a relation is predicted to vanish in the long run (i.e., expectations are always rational in the long run).

undesirable in the short run, 1/ central bank discretion will tend to reduce welfare by leading directly to unexpected fluctuations in those variables. By contrast, and to anticipate the discussion of a different model in Subsection (d), to the extent that monetary policy is capable of affecting output in the short-run through channels other than "surprise", the rational expectations hypothesis provides a case for monetary policy to react in a systematic way to dampen the impacts of any disturbances to the economy, but it also provides a case for avoiding any discretion or additional surprise in its own response to disturbances. This line of agrument leads to the conclusion that central banks should minimize the unpredictable elements of their behavior and constitutes the theoretical case in favor of a central bank rule.

One of the issues that has received attention in the literature is whether a money supply rule is preferable to a nominal interest rate rule. As a result of this attention, it is now widely recognized that a nominal interest rate target may have the undesirable feature of leading to an indeterminate price level in the long run. 2/

To see how the price level indeterminacy may result, consider a slight variation of the long-run demand for money function presented in equation (1): 3/

$$(1'') \quad m_t = \beta_o + \beta_1 y^* - \beta_2 i_t + p_t + \varepsilon_t$$

Now, assume a passive interest rate rule, such that the authorities always allow the money supply to adjust to the level consistent with some fixed nominal interest rate target, $\bar{I}$. 4/ In that case, any increase in the price level will be followed by a proportional increase in the supply

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1/ Following the arguments in Subsection (a), unexpected changes in the money stock will "cloud the picture" for economic agents, who will then be confused between changes in the relative and absolute levels of prices and will hence make suboptimal decisions about their levels of production.

2/ Sargent and Wallace (1975) prove that indeterminancy can apply even in the short run. See Appendix I.IV for a similar mathematical proof based on the model presented in Appendix I.III.

3/ The only differences between equations (1) and (1'') are that the long run level of output has been substituted for the current level, and that a random shock ε_t has been added to stress the fact that economic variables follow stochastic paths.

4/ There is no need to assume a passive interest rate rule to obtain a result in which prices are indeterminate. In fact, Sargent and Wallace (1975) assume a sophisticated rule allowing for feedbacks in response to shocks to output and prices and still obtain the same result.

of money in order to maintain the interest rate at its target level; consequently, there are an infinite number of combinations of the price level and the money supply that are consistent with any target level of the interest rate. Thus, monetary policy does not provide a nominal anchor to hold down the price level. This indeterminacy result can be viewed as a price instability problem. 1/

The instability problem does not arise when the authorities choose a money stock target. In fact, assuming that central banks decide on a passive target for the rate of growth of the money supply, the solution for velocity will be given by equation (7) without the term $(m_t - m_t^e)$, which equals zero since the unanticipated component of the money supply vanishes. Under such circumstances, fluctuations in the levels of prices, output and velocity will depend only on the random disturbances that are not under the control of the authorities. By setting a passive money supply rule, central banks cannot totally eliminate output and employment fluctuations, but they can minimize them. 2/

A separate issue is whether a passive money-supply rule is preferable to an activist rule for adjusting the money supply in reaction to disturbances to the economy. Here, the answer depends not only on whether expectations are formed rationally, but also on the existence of institutional constraints that may prevent or delay some prices from responding to anticipated changes in the money supply. For the type of model that we have been discussing, with rapid price adjustment and rational expectations, an activist rule cannot stabilize output following disturbances to the economy, and accordingly is no better than a passive rule, given that a rational public would take the rule into account in the process of

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1/ The instability result arises because in the context of flexible prices and predictable monetary behavior, rational agents will expect the real money supply to remain constant as long as the interest rate rule is being followed. However, if the authorities had chosen instead to have a "mixed target," in which interest-rate fluctuations are resisted in the short run while over time the interest rate is gradually adjusted to offset departures of the money stock from its target path, with a view to adhering to monetary targets in the long run, the solution for the actual levels of prices and the money supply may be either stable or unstable. That is, two forces act simultaneously: on the one hand, the money supply target provides an anchor for the price level, but on the other hand trying to smooth interest rate fluctuations constrains the behavior of the interest rate, preventing it from attaining the path consistent with price stability (see Lane (1984)).

2/ Notice that since the variability of velocity under a passive rule would reflect only the random shocks ϵ_t, u_t, and n_t, the expected level of velocity would be a constant whose value depended on the expected level of output.

forming its expectations and adjusting rapidly to the disturbances. 1/ Moreover, as stated above, since the money stock affects the level of prices, the simplest anticipated monetary rule aimed at controlling the inflation rate would appear to be the least costly and the most efficient: a passive rule is an optimal rule in the context of rapid price adjustment. Subsection (d), however, will consider a model in which a different price-adjustment process provides a theoretical case for an active rule.

c. The choice of instruments for controlling the money supply

The previous section has discussed the theoretical case for adopting a money supply rule, but an important policy issue remains: which of its policy instruments should the monetary authority use in attempting to adhere to a money supply rule when it can only control the money supply indirectly? This issue received considerable discussion in the United States, for example, during the years surrounding the shift in the operating procedures of the Federal Reserve in October 1979. Although that discussion focussed in part on political considerations, the issue can be addressed on economic grounds by comparing two alternative techniques of monetary control. The first technique attempts to achieve a money stock target by manipulating interest rates; the second operating technique is to control some monetary base. 2/

The analysis depends on a description of the relationship betweeen the money supply, the monetary base and the level of interest rates. A simple but appealing form of that relationship is: 3/

$$(8)\quad m_t = b_t + \gamma i_t + \omega_t$$

1/ One modification of the analysis that might allow an activist monetary rule to affect the level of output in an environment of rapid price adjustment and rational expectations would be to assume that the monetary authority had superior information about the nature of the rule and/or the complete "model" governing the behavior of the economy. However, Barro (1976) has shown that even under such circumstances an activist rule is not superior to a passive rule if the criterion is to minimize fluctuations in output about its long-run value.

2/ The theoretical analysis is conducted under the assumption that the economy is closed, which may not be a completely improper assumption to the extent that the money supply is exogenous in an environment of flexible exchange rates.

3/ This functional form assumes that the ratio of the money stock to the unborrowed base (the "multiplier") depends on the interest rate. The addition of a constant to the right-hand side of equation (8) would not affect the analysis significantly.

where b_t is the monetary base and ω_t is a random disturbance to the banking system.

Notice that the money supply is no longer an exogenous variable; it is now a policy variable with a target level that the monetary authorities try to achieve by controlling one of their two instruments, but without control over the random disturbance ω_t.

The implications for the levels of prices and output that can be derived from these alternative instruments are presented in Appendix I.V. In each case, velocity depends on the expected level of output (y^*) and a combination of the different random disturbance terms (n_t, u_t, ε_t, and ω_t). Under an interest rate regime

$$(9) \quad v_t = d_o + d_1 y^* + d_2 n_t + d_3 u_t - \varepsilon_t$$

while under a monetary base regime

$$(10) \quad v_t = f_o + f_1 y^* + f_2 n_t + f_3 u_t - f_4 \varepsilon_t - f_5 \omega_t$$

where the d's and the f's are functions of the parameters in the system.

How do equations (9) and (10) compare? Notice that the random disturbance to the financial sector, ω_t, is present in the latter but not the former. That does not necessarily imply, however, that the choice of a monetary base instrument is inferior to the choice of an interest rate instrument for controlling the money supply. It can be shown, for instance, that a random shock to the demand for money, ε_t, affects velocity proportionally under the interest rate regime, but affects velocity less than proportionally under a monetary base regime; 1/ that feature would favor choosing the latter instrument if the disturbances in the money market were believed to have a larger variance than other disturbances in the system. In general, therefore, such considerations suggest that the appropriate choice of instrument is an empirical question that depends on both the values of the structural parameters in the economy and the relative variances of the random disturbances affecting the system.

d. A model that supports an activist money-supply rule

Two basic conclusions have been derived from the analysis of the classical model with rapid price adjustment and rational expectations. First, if the objective of the authorities is to stabilize output, prices,

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1/ See Appendix I.V.

and hence, velocity, the best policy is a monetary rule that eliminates any unanticipated behavior by the monetary authorities. Second, if a money supply rule is chosen but the money supply is not a variable under the direct control of the authorities, the best choice of control instrument will reflect the structural parameters in the economy and the relative variances of the different types of disturbances. It should be emphasized, as well, that if the authorities adopt and gain credibility in their adherence to a money supply rule, the absence of unanticipated behavior by the monetary authorities by itself adds a stabilizing element to the economy, thereby easing the authorities' task of estimating the true structural parameters in the system.

This subsection now considers how changes in the structural model can modify the theoretical conclusions by providing a channel for anticipated changes in the money supply to affect the level of output. Contrary to previous conjectures, 1/ it is now recognized that the "policy ineffectiveness" proposition does not simply derive from the assumption that prices adjust rapidly; anticipated monetary policy may be "ineffective" at influencing output even when prices adjust slowly. The general nature of the price-adjustment process, however, does have an important bearing on the effectiveness of monetary policy. In particular, if producers engage in contracts (to purchase labor or to supply output) that set prices over a fixed multi-period horizon, a countercyclical monetary policy response to the unanticipated disturbances can affect the profit-maximizing supply of output.

Consider first an economy similar to the classical model presented in Subsection (a), but with the modification that prices adjust toward their equilibrium levels in a process that can be described as a case of slow partial price adjustment:

$$(11) \quad p_t - p_{t-1} = \lambda(\bar{p}_t - p_{t-1})$$

where the partial adjustment coefficient λ is positive but less than one, and $\bar{p}_t$ is the market clearing value of the price level. 2/ It is sometimes contended that such partial adjustment processes for the aggregate price level reflect the costs that microeconomic units would incur if they changed their prices continuously or too frequently.

1/ See, for example, Phelps and Taylor (1977).

2/ Since $\bar{p}_t$ corresponds to the market clearing value of the price level, its solution will be identical to the one discussed in Subsection (a) and derived in Appendix I.III.

What are the implications for monetary policy in this context? 1/ Consider the expectations held at time t-1 about the outcomes for variables at time t. Since agents are rational, any expected change in the money supply will be expected to affect the equilibrium price level ($\bar{p}_t$). Consistently, based on equation (11), the public will correctly expect the observed price level to increase by a fraction λ of the change in $\bar{p}_t$. Prices will not adjust completely to their new long-run equilibrium level, but the amount that prices do adjust will not surprise the public. Accordingly, to the extent that only unexpected changes in the general price level can lead firms to adjust their output (recall the discussion of the microeconomic foundations for the Lucas' aggregate supply relation in Subsection (a)), any expected change in the money supply will not affect the behavior of output. Thus, neither active nor passive monetary rules will be able to dampen fluctuations in output, and passive rules will be preferable on grounds of simplicity and efficiency.

From equation (11), it is clear that the only difference between the solutions for the price level under rapid adjustment ($\bar{p}_t$) and slow adjustment (p_t) is that the latter is a fraction λ of the former plus a fraction $(1-\lambda)$ of the previous period's price level. 2/ Appendix I.VI obtains the solutions for the level of output, the price level and velocity. The level of output is independent of the expected change in the money supply but does depend on the value of the partial adjustment coefficient λ, given the past history of the economy. In addition, the nominal interest rate is affected by the expected change in the money supply because the level of prices does not immediately adjust by the full proportionate amount of the change in the money supply, and because the level of output does not adjust at all; thus, the interest rate must adjust in the short run to maintain equality between money demand and the money supply. Moreover, just as the interest rate is affected by expected changes in the money stock, so is the level of velocity, even though the level of output is not. The implied solution for velocity depends on the speed of adjustment λ and is identical to equation (7) in the limiting case in which prices adjust fully every period (i.e., for $\lambda=1$).

The economic intuition for the results just derived is based fundamentally on the microeconomic foundations for the aggregate supply function. These foundations reflect the assumption that the profit-maximizing levels of output for microeconomic producers depend on relative prices, such that firms will not adjust their levels of output in response to a change in the general price level unless they believe that relative prices have changed. In the model just examined, firms observe their own

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1/ The case against an active monetary rule based on rational expectations models with sticky prices of the sort developed here was first presented by McCallum (1977).

2/ Since the previous period's price level is a predetermined variable, current monetary policy cannot affect it.

price level before they obtain complete information about the current general price level, and will only believe that relative prices have changed if they make errors in predicting the general price level. Accordingly, the assumption of a slow price-adjustment process is not sufficient for an active countercyclical monetary policy rule to affect output, since under such a rule both the actual and the expected levels of prices will adjust "slowly" but equally, without generating expectational errors. Thus, a case for activism must be based on an alternative framework for generating perceptions of relative price changes. One alternative framework emphasizes the existence of institutional constraints that prevent prices in some markets from adjusting to unexpected disturbances with the same speed as the money supply would adjust under a countercyclical rule. Under such institutional constraints, some prices will remain inflexible even though expectations of the general price level are allowed to adjust.

To develop these arguments more formally, consider a case of long-term contracting in which the stickiness in the behavior of prices is introduced by assuming that firms and workers enter into labor market contracts that last for two or more periods. In particular, suppose that while firms are free to adjust the price of their own output, the contracts in the labor market specify nominal wages over a multi-period horizon. 1/ To simplify the analysis, also assume that under the contracts the real wage rate is expected to remain constant in the sense that the contracts specify the nominal wage rate as follows:

$$(12) \qquad {}_{t-i}w_t = {}_{t-i}p_t^e \qquad\qquad i = 1, 2, \ldots n$$

In equation (12), ${}_{t-1}w_t$ is the nominal wage to be paid in period t as specified in contracts drawn up at (t-i), and ${}_{t-i}p_t^e$ is the period t-i expectation of the price level that will prevail in period t.

In every period, firms are constrained by those labor contracts signed in the past. As profit maximizing units, firms will increase their output if they perceive that the actual price level in their market is greater than their prior expectations, since according to equation (12), this will imply that actual prices have increased relative to the wage rate set by the contract, and hence that the profit rate has increased. The important consequence of these contracting arrangements is that with a multiplicity of firms, existing contracts will overlap in time, and, in

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1/ The case for active monetary policy based on multi-period wage contracts has been developed by Fischer (1977). Taylor (1979) obtained the same result by assuming that multi-period arrangements affect output prices, as well as wages.

the aggregate, output supply decisions will be based not only on a single period's errors in price expectations, but rather on multi-period expectational errors about the current price level. 1/

The case for an active monetary rule in this context is straightforward: between the time a contract is drawn and the last year of operation of that contract, there is scope for the monetary authority to react to new information about recent economic disturbances. Since the contracts have fixed the nominal wage, current monetary policy that affects the price level will affect the real wage and hence will influence output supply decisions. 2/

In this context, an anticipated active monetary rule can be used as an effective tool to minimize fluctuations in the level of output. Appendix I.VII shows the price and output solutions implied by the simplifying case in which two-year nominal wage contracts prevail. The corresponding velocity equation is:

$$(13) \quad v_t = k_0 + k_1 y^* + k_2 m_t^e + k_3 h + k_4 (m_t - m_t^e) + k_5 \varepsilon_t + k_6 n_t + k_7 u_t$$

where the k's are functions of the structural parameters in the model. As equation (13) shows, both the expected and unexpected components of the money stock affect velocity as a result of the effects that the money stock has on both the output level and the interest rate.

e. Incomplete information and the distinction between activist rules and discretion

The theoretical conclusions that have been discussed in this part of the paper are based on models and assumptions which oversimplify issues that many central bankers and economists consider to be quite relevant. Accordingly, the debate over the appropriate conduct of monetary policy in practice has not been resolved.

Before turning to a more complete overview of the policy debate in Part IV, it may be useful to focus somewhat further on the distinction between activist rules and discretion, and to emphasize again that the

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1/ Of course, the "previous periods" that are relevant here are those within the life of the contract. For instance, if a firm is engaged in a two period contract, it will be concerned with the expectations of the current price level formed two years ago when the contract was signed.

2/ Contracts that involve fixed nominal interest rates are also prominent in reality, and in that context it is widely appreciated that monetary policy can have important wealth effects on debtors and creditors, although on balance the sum of such wealth effects will not necessarily affect the aggregate output of the economy.

theoretical case for an activist rule does not presume that central banks or other economic agents have complete information about either the behavioral relationships in the economy or the current values of economic variables. As employed by the models discussed in this paper, the rational expectations hypothesis simply assumes that private economic agents have as much information (or ready access to information) as the central bank, and that they use whatever relevant information is available in forming their expectations.

If the existence of contracts or other institutional rigidities provides scope for monetary policy to have short-run effects on output through channels other than surprise, there may well be a case for using an activist monetary policy to counter the impacts of disturbances or shocks to the economy, depending on the objectives of the central bank. For example, a variety of monetary policy actions were discussed as possible responses to the unexpected oil-price increases of the 1970s, ranging from tightening policy in resistance to increases in the general price level to easing policy in resistance to declines in output and employment. 1/ Whatever the objectives that the monetary authorities have a mandate to pursue, however, they will want to react to a "surprise" in oil prices in a way that stabilizes prices and output around whichever feasible time path is most prefered. In theory, an activist rule that is consistent with the central bank's objectives and known to the public can serve as an automatic stabilizer following surprising disruptions to the economy, whereas a discretionary response is inferior to an "optimal" activist rule to the extent that it adds another element of surprise which increases the variability of output relative to the most desirable path that an activist rule would be capable of achieving.

Although the distinction between discretion and a rule can be defined clearly in theory as simply a matter of whether behavior follows a pre-specified and preannounced formula, some have argued that the distinction becomes clouded in practice when attempts are made to specify a rule for reacting to the different types of disturbances that central banks may seek to infer from a large but incomplete set of information. In theory, incomplete or inexact information about the structural forms of economic relationships, or about the values of structural parameters and the measured data on economic variables, does not preclude the design of an "optimal" activist rule: any "optimal" quantitative method for interpreting whatever information is available will imply an "optimal" specification for a monetary rule. In reality, however, few central bankers or economists employ strictly quantitative methods for interpreting information: most empirical economic model builders and forecasters (both inside and outside central banks) make it a regular practice to superimpose judgment or discretion in selecting, modifying, and generating forecasts from their models.

1/ See Fischer (1985).

That perspective provides one of the main arguments that has been put forth in support of central bank discretion, as will be discussed further in Part IV. It should be recognized, however, to be an argument about the difficulties of designing an "ideal" activist rule in the context of incomplete and inexact information, which by no means precludes the selection of a simplified activist rule that may be less than ideal.

IV. The Policy Debate Over Monetary Targeting

Part III has reviewed the theoretical foundations for analyzing the behavior of velocity and has clarified the types of assumptions that support different "theoretical" conclusions about the appropriate conduct of monetary policy. The assumption that expectations are formed rationally provides a theoretical case against central bank discretion (even in an environment in which the price adjustment process occurs slowly). In addition, the assumption that monetary policy can induce short-run effects on output through channels other than "surprise"--as a result, perhaps, of the existence of fixed nominal wage contracts or other institutional rigidities--provides a theoretical case for central banks to follow activist countercyclical rules rather than pursuing the types of fixed or passive targets that they have announced over the past decade.

A qualification to the theoretical conclusions is that the complications of interpreting information about economic behavior may in reality limit the options for activist rules to a set of simplified formulas. That qualification leaves open all of the possible preference orderings between passive rules, simplified activist rules, and discretion. A simplified activist rule may be preferred if there is scope for anticipated monetary policy to stabilize output and a desire to avoid the variability that can be associated with discretion. On the other hand, under the same scope for stabilizing output, discretion may be preferred if it is felt that the simplifications of an activist rule leave scope for important gains from overriding the rule. Or as a third possibility, a passive rule may be preferred if it is felt either that monetary policy can have only a weak stabilizing influence on output or that the potential stabilizing influence is outweighed by the potential destabilizing influences of discretion or an oversimplified activist rule. 1/

With that central perspective on why the policy debate remains unresolved, 2/ this part of the paper now turns to providing a somewhat more expansive overview of the issues that have been raised. Section 1

1/ The possibility that an oversimplified activist rule may generate explosive cycles in economic activity has been demonstrated through simulations of macroeconomic models.

2/ Another issue that makes it difficult to resolve the debate is the "observational equivalance problem" suggested by Sargent (1976), which is the difficulty of distinguishing empirically between models in which anticipated monetary policy affects output and models in which it does not.

focusses on the discussion of alternative variables that might be designated as targets in formulating rules for central bank behavior. Section 2 then returns to the more central debate over rules versus discretion.

1. Alternative target variables

The debate over the appropriate conduct of monetary policy has included a focus on the pros and cons of targeting a number of alternatives to a money supply measure, including a nominal or real interest rate, an exchange rate, the price level or the inflation rate, and the level of nominal GNP or some other aggregate from the national income and product accounts. Discussions of the advantages and disadvantages of the proposed target variables have focused on at least five issues: 1/ (i) the effectiveness of the proposed target variables in providing an anchor for the price level and other nominal variables; (ii) the relative magnitudes of important structural parameters and the types of unexpected "shocks" that may disturb macroeconomic conditions; (iii) the issue of stretching out the economic adjustments to unexpected disturbances; (iv) the timeliness and quality of data and the imprecision of central bank control over the proposed target variables; and (v) certain political considerations.

The selection of a money supply, 2/ the price level, or the level of nominal GNP as a target would place a direct anchor on that particular nominal variable and would presumably place an indirect anchor on all other nominal variables in the economy. By contrast, as discussed in Subection III.3.b, the selection of an interest rate as a target might be ineffective for stabilizing prices and other nominal variables. 3/

The issue of targets or target zones for exchange rates has received considerable attention. France, the Federal Republic of Germany, Italy, and other members of the European Monetary System have pursued exchange

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1/ See, for example, McCallum (1985), Axilrod (1985b), Poole (1985), Tobin (1984, 1985), and Hall (1984).

2/ The choice of which monetary aggregate to target is still another issue. In practice that choice has taken into consideration the relative predictability of the velocities of the different aggregates, as well as their controlability and the timeliness with which data become available.

3/ Hester (1981) has argued, however, that different types of instability problems can arise if real interest rates are unconstrained; in particular, high real interest rates can destroy socially valuable financial institutions, industrial enterprises, farms and households, while negative real interest rates can induce indiscriminate borrowing. In this context, however, it may be noted that negative real interest rates can result from imposing ceilings on nominal interest rates for the purpose of preventing high real interest rates.

rate objectives over much of the past decade, and to varying extents other countries have also adjusted monetary conditions to stabilize their exchange rates. It has been contended, however, that one major difficulty with an exchange rate target is the instability of the empirical relationships between the exchange rate and other economic variables, including both the variables that central banks directly control and ultimate target variables such as the levels of prices and output.

The issue of whether anticipated changes in the money supply are effective in stabilizing output is one of the central considerations in the choice of a target variable (as well as in the choice between an active or passive rule). If anticipated changes in monetary policy variables have no short-run effects on output, for example, the adoption of a nominal GNP target would not be desirable; monetary policy actions could only stimulate nominal GNP by fueling inflation.

Under the assumption that anticipated monetary policy can indeed have short-run effects on output, the choice between targeting the price level, the money supply or the level of nominal GNP depends to some extent on the relative magnitudes of different types of disturbances and certain structural parameters. Consider, for example, the "shocks" or "disturbances" to the prices of oil and other commodities that have disrupted macroeconomic conditions since the early 1970s. With a price level target, the pressures that are exerted by such shocks on the general level of prices must be offset by adjusting monetary policy instruments, which essentially transfers the pressures to (or increases the pressures on) output and employment variables; in that regard, the recessions of the mid-1970s and early 1980s might have been significantly deeper if policy instruments had been adjusted to offset entirely the impacts of the oil-price shocks on the general price levels of the industrial countries. 1/ By contrast, with a nominal GNP target, the policy authorities have some flexibility to absorb shocks by allowing both prices and output to adjust in a manner that constrains only the nominal value of output. In this case the closer to zero is the price elasticity of aggregate demand, the stronger is the policy response that is required to offset a supply-related price shock. And if the price elasticity is one, monetary policy may be irrelevant for responding to supply shocks to the extent that such shocks do not affect the level of nominal GNP.

Among the contributions to the debate, Hall (1984) has proposed a flexible price standard that would allow central banks to accept some fluctuations in the price level in order to stabilize employment and output in the short run, but would place limits on the extent to which the price level could deviate from a long-run target. Hall's proposal

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1/ By the same token, Fischer (1985) argues that the recessions were in fact deeper than they would have been if central banks had not attempted to offset any of the price-level effects of the oil shocks.

goes beyond the discussion of alternative target variables and raises the issue of specifying a central bank rule in a manner that allows a stretching out of the economic adjustments to unexpected disturbances. This type of proposal can also be viewed as a combination of rule and discretion; as such, it will be discussed further in Section 2.

Part of the debate between money supply targets and nominal GNP targets has focussed on the relative timeliness and quality of data and the relative imprecision of central bank control over the two types of variables. It has been argued that money supply data are available on a more timely basis and are subject to less substantial revisions than data on nominal GNP; such arguments are more forceful for narrow monetary aggregates than for broad aggregates. In addition, it has been contended that central banks have very imprecise control over nominal GNP but do have the ability to control the monetary aggregates fairly closely on average over periods of several quarters. 1/

Political considerations have also been raised in addressing the pros and cons of alternative targets. To the extent that the money supply may be a variable to which the public is less directly sensitive than interest rates, exchange rates, unemployment, or prices, a money supply target might also subject the central bank to less intense political pressures than other possible targets. Regardless of whether that feature might be desirable, however, the issue it raises would not be relevant if the objective was to specify a rule that entirely eliminated the discretion of the central bank.

2. The debate over rules versus discretion

The debate over rules versus discretion has involved a number of arguments. The theoretical arguments in support of rules, as provided by the different types of rational expectations models, have already been reviewed in Part III.

A related set of arguments has focused on the "time inconsistency" of policy rules previously selected as optimal, 2/ which is a problem that arises to the extent that in each period of time the opportunity to exercise discretion provides central banks with an incentive to abandon a previously-selected policy course 3/ in an attempt to "surprise" other economic agents. If the "surprise" is an increase in the money supply

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1/ The discussions in Subsection III.3c and Appendix I.V indicate the different types of disturbances that can affect the central bank's control over the money supply, even when it is a targeted variable.

2/ See Kydland and Prescott (1977).

3/ The policy course selected as optimal in the past is thus "time inconsistent," since at a subsequent time the authorities perceive that they can do better by changing course.

intended to reduce unemployment in the short run, rational economic agents will recognize this incentive, and their reactions will raise the expected and actual rate of inflation that is associated with the equilibrium level of unemployment in the long run. One proposed solution for obtaining superior outcomes for inflation and unemployment over the long run is thus to remove the central bank's discretion to make period-by-period attempts to "surprise" the public.

Turning to arguments that have been presented in support of central bank discretion, it has been contended that:

> ... policy rules are a myth of economic theorists' simplified models. It is in practice impossible ... to prescribe in advance for all contingencies ... [and] not credible that responsible officials will not react to the circumstances of the day as they and their constituents perceive them. 1/

Thus, it is alleged to be impossible in practice to prescribe a rule that will not sooner or later become outmoded or regretted in the light of events that were not anticipated when formulating the rule (e.g., events such as major changes in oil prices or exchange rates, financial or technological innovations, and major crop failures or other output shortfalls). Implicitly, moreover, the argument that it would be infeasible politically to abide by a rule that failed to prescribe in advance for the circumstances of the day is an argument that society would sooner or later incur welfare losses if it locked itself in to a mechanical rule. Consistent with this view, attention has been drawn to the recent evolution of monetary policy in the United States:

> In October 1979 and February 1980 our Federal Reserve announced two monetarist decisions. The first concerned its operating procedures.... The other concerned its targets for intermediate monetary aggregates: the Fed intended to lower their growth rates steadily ... until they would no longer accommodate inflation. This intention was stated unconditionally; it was to be carried out regardless of the state of the real economy.
>
> In August-October 1982 the same Fed, under the same chairman, abandoned the second of these two decisions.... Over the ... recovery that followed the Fed's policy reversal, I think it is safe to say, its operations have been oriented to macroeconomic performance, with the aggregates in a subordinate role....
>
> We all know the reasons and the rationales for the 1982 decisions. Because of a big negative velocity shock in 1982, adherence to the monetary targets was producing a lot less nominal GNP than

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1/ Tobin (1982), p. 46.

> expected or intended. The consequences for the real economics of the United States and the rest of the world were scary. So were the prospects of financial disasters, overseas and at home. That financial and institutional innovation and deregulation were altering in uncertain ways and degrees the meanings--read velocities--of the monetary aggregates was both a valid consideration and a useful rationale. 1/

A different but related type of argument that has been presented against mechanical rules--particularly rules in which a monetary aggregate is specified as a target variable--is the suggestion that over time, changes in institutions or economic behavior can defeat the purpose of a rule even if the central bank succeeds in hitting its quantitative target. Thus, the adoption of a particular monetary aggregate as a target variable might induce changes that destabilized the velocity of that aggregate, since:

> ... statistical relationships derived from the past depended on the particular kind of policy aim pursued by the authorities over the period considered .... In other words, although velocity has been fairly stable in the past this would be no guarantee of its stability in the future if the authorities chose to alter the rules of the game. 2/

Moreover, the extent to which the adoption of a rule actually induces the changes in institutions or economic behavior is not a central consideration in the argument. An environment of regulations, taxes, and rewards to technological change provides numerous incentives for institutions and economic behavior to change in ways that are effective for circumventing the regulations and taxes, or for reaping the rewards of technological change. Thus, regardless of whether or not central banks act with discretion or follow rules, it is possible that financial innovations will emerge over time to introduce attractive substitutes for the components of any monetary aggregate that they might choose to monitor or target.

While it seems undeniable that the theoretical case against central bank discretion is weakened by recognizing the oversimplifications and abstractions of the analytic models, it is equally noteworthy that the opponents of mechanical central bank rules have increasingly recognized the importance of the credibility and reputation of the monetary authorities, which are generally earned through predictable behavior. It is also noteable that in addition to the arguments for rules versus discretion, some support has emerged for intermediate positions. Axilrod (1985b, p. 600) has argued that rules have the virtue of holding central

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1/ Tobin (1985), pp. 605-06.
2/ Goodhart and Crockett (1970), p. 176.

banks "reasonably responsible and accountable ... [but should] be implemented rather flexibly, and may even be changed (with public announcement) for clear and sufficient cause." Hall (1984) has proposed a scheme (mentioned in the previous section) whereby central banks would be committed to an "elastic price standard" which specified a fixed price-level target that they must continuously aim to hit in the long run, but which also left it for central banks to exercise discretion in choosing how rapidly to guide the economy toward that target in the short run. In Hall's judgment:

> ... jumps in oil prices and in other determinants of the overall price level ... are critical for the design of monetary strategy. More than anything else, the strategy must be formulated to deal intelligently with the burst of inflation and higher unemployment set off by each shock ....
>
> It is neither practical nor desirable to dictate to the Fed exactly how it should proceed .... As financial markets evolve and the Fed learns how best to operate to achieve the target, procedures will change and performance will improve. 1/

Thus, Hall would specifically fix a price target at some level p* and permit the actual price level to deviate from its target by a percentage no greater than a specified "elasticity" parameter times the percentage departure of the unemployment rate from an estimate of its equilibrium or natural rate. Beyond that, the central bank would be free to exercise its discretion and would be judged only by performance.

Rogoff (1985) has contributed a different approach toward middle ground in terms of a formal model that analyzes the optimal degree of commitment to a central bank rule. Rogoff argues that society can design its institutions to counteract the inflationary bias that has been associated with central bank discretion by the rational expectations models and the time inconsistency problem. In particular, societies can appoint and give discretion to central bankers who will pursue lower inflation rates (and accept higher unemployment rates) than might appear to be socially optimal in the short run in order to counteract any bias toward inflation over the long run.

V. Summary and Concluding Observations

In adopting strategies for monetary policy over the past decade, the authorities have confronted a number of basic questions. These include: (1) is it possible and/or desirable to adjust monetary targets in light of financial innovations and changes in the regultory environment?;

1/ Hall (1984), pp. 145-46.

(2) how far should concern about exchange rate variability temper the pursuit of monetary objectives?; and (3) does the restoration of "reasonable" price stability increase the scope for central bank discretion?

To a large extent, such questions can only be answered by adopting a particular position in the general debate over the appropriate roles of rules and discretion in the conduct of monetary policy. Accordingly, while this paper has to some extent reviewed the specific issues that central banks have confronted, its larger purpose has been to balance the lessons from empirical experience and theoretical analysis in providing a perspective for the main issues in the general policy debate. Part II has presented a statistical analysis of the variability of velocity and has also reviewed the macroeconomic conditions and difficulties that central banks have experienced during the past decade of monetary targeting. Part III has reviewed the theoretical foundations that have been developed for analyzing the behavior of velocity and the case for a money supply target. Part IV then collected together the major arguments in the continuing debate over the appropriate conduct of monetary policy.

Part II began by providing a statistical description of the behavior of velocity since the mid-1970s in each of seven major industrial countries. No attempt was made to unravel the causes of the observed variability of velocity. Two types of statistical material were presented. The first set of material focussed on quarterly data and provided comparisons of the variability of the velocities of different monetary aggregates within countries, of similar monetary aggregates across countries, and of particular monetary aggregates during different time periods. These comparisons suggested: (1) that in recent years the velocities of M1 aggregates have been more variable than both the velocities of the broader aggregates in all countries and the velocities of the wide monetary base and central bank money concepts that have been targeted in the United Kingdom and the Federal Republic of Germany, respectively; (2) that Japan and the Federal Republic of Germany experienced the lowest variability of velocity over the 1974-85 period; and (3) that variability levels in most cases were no greater during 1982-85 than during previous four-year periods.

A second set of statistical material shifted focus from the variability of the quarterly data on velocity to the correlations between the variability levels of rates of inflation, rates of real GNP growth, and rates of money supply growth over the entire 1974-85 period and several four-year subperiods. Correlation coefficients for the cross section of seven countries indicate that relatively low variability of monetary growth has been associated with relatively low variability of real output growth and relatively low variability of inflation.

A focus on statistics alone, however, cannot provide an adequate perspective on the observed variability of velocity. The statistics can be misleading without a firm understanding of the inter-relationships

between prices, output, and money and the transmission mechanisms through which an "exogenous" change in any one of those three variables may influence the other two. In particular, the statistics do not isolate either the extent to which the variability of velocity has "caused" central banks to exercise their discretion to deviate from their announced monetary targets, or the extent to which the exercise of central bank discretion has "caused" velocity to be variable.

Some additional empirical perspectives are provided by reviewing the macroeconomic conditions that central banks have experienced in pursuing their monetary targets over the past decade. These conditions have presented central banks with observed or prospective shifts in velocity which, in turn, have been associated with a variety of developments, including unanticipated exchange market pressures, unanticipated global "shocks" to the price of oil, the unpredicted effects of financial innovations on the demands for different types of money or money substitutes, and other factors leading to unexpected shifts in the strength of domestic economic activity and/or inflationary pressures.

Although an appreciation of the difficulties that central banks have faced provides an understanding for why central banks have chosen to exercise discretion, a review of the experience cannot provide unambiguous inferences about the appropriate conduct of monetary policy without an analysis of the origins of the difficulties that central banks have experienced and the extent to which the behavior of the central banks themselves may have contributed to the macroeconomic conditions they confronted. Just as the focus on purely statistical material cannot separate the channels of causation between the variability of velocity and the exercise of central bank discretion, the review of experience does not separate the channels of influence between the macroeconomic conditions that central banks have confronted and the discretion they have exercised.

Part III has addressed the issue of causation with the objective of providing an organized and streamlined presentation and comparison of the different types of models and assumptions that have been employed to analyze the behavior of velocity and to debate the appropriate conduct of monetary policy. To a considerable extent, the debate has been confused by an inadequate recognition of the strengths and limitations of alternative analytic frameworks, and by misperceptions of the types of theoretical models and assumptions that support different conclusions. One popular class of models has concentrated attention on the demand for money, with some attempts to make allowances for financial innovations, exchange rate expectations, and the price-adjustment process. Such a narrow focus on "extended" money demand functions, however, is subject to the general criticism that the level of output, the interest rate, and in some cases, the price level are taken as exogenous, even though the influence of central bank behavior or those variables may be quite important for understanding the behavior of velocity and for drawing inferences

about the appropriate conduct of monetary policy. Several other classes of models have been developed for analyzing the behavior of velocity within a "complete" macroeconomic framework, including a class of so-called "disequilibrium" models, which has analyzed velocity under the assumption that expectations about prices or inflation rates are formed adaptively (based only on current and past values of those variables).

In recent years, however, the analysis of velocity and its implications for monetary policy has been refocused not only away from models of money demand toward complete macroeconomic models, but also away from the assumption of adaptive expectations toward the assumption that expectations are formed rationally in the sense of taking account of whatever relevant information is available about the relationships between economic variables, the current and past values of economic variables, and the expected future values of exogenous variables, including the expected course of monetary policy. These models recognize that economic agents have incomplete information about the economy, but assume that private economic agents have as much information (or access to information) as central banks. Although the notion that expectations are completely rational is an extreme assumption, and there remains considerable reluctance to accept the implications of any theoretical model without appropriate qualifications, the property of rationality in determining expectations is attractive, and the policy implications of the rational expectations assumption have received considerable attention. It should be emphasized, as well, that many different types of complete macroeconomic models can be analyzed under the rational expectations assumption. In distinguishing among the different models, some important differences in theoretical conclusions are associated with different types of assumptions about the existence and nature of labor contracts or other institutional factors that introduce rigidities into nominal wages or prices. It is the existence of such rigidities that provides a mechanism for anticipated monetary policy to affect the relative prices (or other variables) that influence the supply decisions of firms and factors of production, and thereby to affect the aggregate output of the economy.

One of the inferences that has been drawn from the analysis of complete macroeconomic models (including models in which the price adjustment process occurs slowly) is that if expectations are indeed formed rationally, unanticipated behavior by the monetary authorities creates variability in output and prices but has no stabilizing effects that could not also be achieved if the monetary authorities allowed their behavior to be completely anticipated by precommitting themselves to follow a monetary rule; thus, to the extent that output and price variability is undesirable, other things equal, the assumption that expectations are rational provides a theoretical case against central bank discretion. Whether or not the monetary rule should be a fixed target or a formula for activist responses to counter disturbances to the economy depends on whether changes in monetary policy variables can affect output through channels other than surprise.

The analysis of complete macroeconomic models has also demonstrated that the pursuit of an intermediate target for a nominal interest rate can be counterproductive or ineffective for stabilizing the price level in the long run; in that sense, an interest rate target appears to be inferior to a money supply target. Given that a central bank may choose to target a monetary aggregate that it cannot control directly, however, the question of whether to adopt an interest rate as a control instrument in aiming at the money supply target arises as a separate issue from the question of whether to adopt an interest rate as a target per se. Reliance on an interest rate as an operating instrument or control variable is not necessarily inferior to monetary base control: the optimal choice depends on both the structural parameters of the economy and the relative variances of the different types of unexpected disturbances to the economy.

Needless to say, many central bankers and economists consider that conclusions based on theoretical models and assumptions, including in particular the theoretical case against central bank discretion, tend to oversimplify a number of relevant issues; accordingly, the debate over the appropriate conduct of monetary policy has not been resolved. Part IV has collected together the main arguments in both the debate over rules versus discretion and the related debate over alternative variables that might be chosen as targets in prescribing central bank rules. Discussions of the pros and cons of alternative target variables have focussed on at least five issues: (1) the effectiveness of the proposed target variables in providing an anchor for the price level and other nominal variables; (2) the relative magnitudes of different types of unexpected disturbances to the economy and of certain important structural parameters; (3) the associated issue of stretching out the economic adjustments to unexpected disturbances; (4) the timeliness and quality of data and the imprecision of central bank control over the proposed target variables; and (5) certain political considerations. In the general debate over rules versus discretion, the theoretical case for central bank rules that has been provided by the rational expectations assumption has been supplemented with a related set of arguments about "time inconsistency." From the opposite point of view, the predominant objection to rules is the contention that it is impossible in practice to anticipate all the macroeconomic disruptions to which it would be socially desirable for the central bank to react, and accordingly, that rigid adherence to any mechanical rule would be socially undesirable and politically infeasible. A second and somewhat related argument against rules is the possibility that once a variable is chosen as a target, new institutions or adjustments in economic behavior may develop over time to defeat the underlying objectives for having a target, even if the target is achieved in a strictly quantitative sense.

Part of the debate over rules versus discretion has supported intermediate positions. As one intermediate position, it has been argued that rules or guidelines have the virtue of holding central banks reasonably

responsible and accountable, but should be changed or implemented flexibly when sufficient causes arise. A second intermediate position is the proposal that central banks be committed to a target for the average value of the price level or some other objective over the long run, but with scope to exercise discretion in cushioning the impacts of disturbances to output and employment in the short run. A third and somewhat similar intermediate position is to shift the focus of analysis explicitly toward the issues of the appropriate degree of commitment to a central bank rule and the types of institutional arrangements that might induce or constrain central banks to exercise an appropriate amount of discretion.

Nevertheless, while the past decade has provided central banks with a wide range of experience and has focussed considerable attention on the theoretical foundations for analyzing the appropriate conduct of monetary policy, it has provided no strong consensus of opinion on how the practice of central banking can actually be improved. Disagreements remain on almost all of the issues that arise in designing a strategy for monetary policy, and those disagreements in turn reflect basic differences in the "views of the world" that are held by the advocates of discretion, the proponents of fixed or passive targets, and the supporters of activist countercyclical rules. From one point of view, activist countercyclical rules have an advantage over the types of passive targets that central banks have announced over the past decade to the extent that monetary policy is capable of operating, through channels other than surprise, to counter the effects on output of various types of disturbances to the economy. From a second point of view, discretion has an advantage over activist rules to the extent that it is impossible in practice to devise a mechanical rule that prescribes adequately in advance for all contingencies. Yet, from a third point of view, passive rules have an advantage over discretion to the extent that the exercise of discretion can be destabilizing and inflationary over the long run.

These three different points of view summarize the issues that are central to the debate. The issue raised by the first point of view is the extent to which monetary policy can have systematic effects in the short run, through channels other than surprise, on the relative prices or other variables that influence the supply decisions of firms and factors of production at the microeconomic level, and thus on the scales of output and unemployment at the macroeconomic level. The issue raised by the second point of view is the extent to which activist rules that are sufficiently simple to put into practice could provide appropriate responses to different types of economic disturbances. And the issues raised by the third point of view are the extent to which expectations are forward looking, and the implications of forward-looking expectations for the degree to which discretionary policies can be destabilizing and inflationary over the long run.

APPENDIX I

Mathematical Derivations of the Main Theoretical Results

I.I Derivation of the Short-run Demand for Money Function Under the "Price-Adjustment" View

This view suggests that the long-run demand for money equation of the main text:

$$(I.1) \quad m_t^* = m_t^d - p_t = \beta_o + \beta_1 y_t - \beta_2 i_t$$

should be complemented with an adjustment equation such as:

$$(I.2) \quad p_t - p_{t-1} = \eta(m_t - (m_t^* + p_{t-1}))$$

The hypothesis embodied in equation (I.2) states that the percentage change in the price level is proportional to the difference between the exogenous nominal money supply (m_t) and the nominal money equivalent of the public's desired level of real money balances evaluated at the price level of the previous period ($m_t^* + p_{t-1}$).

In combination, equations (I.1) and (I.2) yield the following short run demand for money function:

$$(I.3) \quad m_t - p_t = a_o + a_1 y_t - a_2 i_t + (1-\eta)(m_t - p_{t-1})$$

which is identical to equation (3) in the main text. Notice that equation (I.3) can also be solved for the price level as follows:

$$(I.3') \quad p_t = \frac{-1}{1-(1-\eta)L}(a_o + a_1 y_t - a_2 i_t) + \frac{\eta}{1-(1-\eta)L} m_t$$

where L is a one period lag operator. Thus, equation (I.3) can be considered to be a model of price adjustment to nominal money supply changes.

I.II A Simple Disequilibrium Model

A simple version of a disequilibrium model can be represented as follows: 1/

1/ This model follows Laidler (1985).

$$(II.1) \quad m_t^d = p_t + \beta_o + \beta_1 y_t^*$$

$$(II.2) \quad y_t = y_t^* + \gamma_1 (m_t^s - m_t^d)$$

$$(II.3) \quad \Delta p = \delta (y_t - y_t^*) + \Delta p_{t-1}^e$$

$$(II.4) \quad \Delta p_t^e = d \Delta p_t + (1-d) \Delta p_{t-1}^e$$

where the new variables still undefined in the paper are:

Δp_t = the rate of inflation

Δp_{t-1}^e = the expected rate of inflation during period t-1

Equation (II.1) is a long run interest rate-inelastic demand for money function where the long run or "natural" rate of output is assumed to represent the relevant income term. Equation (II.2), the output determination equation, embodies a key argument of disequilibrium models: deviations of money supply from the long run money demand level are assumed to cause short-run deviations of output from its full employment level. Equation (II.3) is a "Phillips curve" equation which postulates that the observed level of inflation depends both on deviations of output from its full employment level and on the expected level of inflation. Equation (II.4) describes the formation of price expectations in an adaptive way.

The model has three observable endogenous variables: the level of output, the price level and the desired level of money balances. The solution for the price level takes the following form: 1/

$$(II.5) \quad p_t = z_o - z_1 y_t^* + m_t^s - z_2 (m_{t-1}^s - p_{t-1}) - z_3 (\Delta m_t^s - \Delta p_{t-1})$$

1/ The solution to the complete model takes the following form:

$$X_t = A_o + A_1 X_{t-1} + A_2 E_t + A_3 E_{t-1} + A_4 \Delta X_{t-1} + A_5 \Delta E_t$$

where X_t is a 3x1 vector of observable endogenous variables: y_t, p_t, m_t^d; A_o is a 3x1 vector of intercepts; A_i (i=1,...,5) is a 3x3 matrix of coefficients; E_t is a 3x1 vector of exogenous variables; X_{t-1} and E_{t-1} are 3x1 vectors of lagged endogenous and exogenous variables, respectively; and ΔX_{t-1} and ΔE_t are 3x1 vectors of first differences.

where z_1, z_2, z_3 are positive "reduced form" coefficients. From equation (II.5) it is straightforward to derive an implied reduced-form equation for velocity which is indentical to equation (6) in the main text.

I.III Price, Output and Velocity Behavior in an Equilibrium Rational-Expectations Model

Consider the following model, which is similar to a framework used by Sargent and Wallace (1975):

$$(III.1) \quad y_t^s = y^* + \delta(p_t - {}_{t-1}p_t^e) + u_t$$

$$(III.2) \quad y_t^d = \alpha_0 - \alpha_1 r_t + n_t$$

$$(III.3) \quad m_t^d = p_t + \beta_0 + \beta_1 y_t - \beta_2 i_t + \varepsilon_t$$

$$(III.4) \quad i_t = r_t + {}_tp_{t+1}^e - p_t$$

$$(III.5) \quad m_t^d = m_t^s$$

$$(III.6) \quad y_t^d = y_t^s$$

$$(III.7) \quad {}_tp_{t+1}^e = E({}_tP_{t+1}/\Omega_t)$$

In these equations the new variables are:

r_t = the real rate of interest;

y_t^d = the log of the demand for real output;

${}_{t-1}p_t^e$ = the period t price level that is expected at the end of period $t-1$;

where E is the expectations operator; and u_t, n_t, and ε_t are uncorrelated white noise disturbances.

Equation (III.1) is the Lucas (1973) "surprise" aggregate supply function, as motivated in the main text. Equation (III.2) postulates that the aggregate demand for current-period output depends inversely on

the real rate of interest, consistent with intertemporal optimizing behavior of microeconomic units. Fiscal variables are not included in the aggregate demand function since it would require assumptions about the way in which debt-financed fiscal deficits influence private behavior. 1/ Equation (III.3) is a stochastic version of equation (1) in the main text. Equation (III.4) is Fisher's interest rate parity condition; equations (III.5) and (III.6) are market clearing conditions; and equation (III.7) is the rational expectations hypothesis in the sense of Muth (1961), in which Ω_t denotes the available information set during period t.

Although the particular specification of this model requires some ad hoc assumptions, 2/ the model can be viewed to provide a rational expectations solution for the behavior of velocity. Substituting equation (III.4) into equation (III.3), the model solves for the equilibrium levels of prices, output and the real interest rate as functions of the money supply (which is assumed to be exogenous in this model) and the random disturbances. The stochastic process that describes the behavior of the money supply is assumed to take the simple form:

$$(III.8) \quad m_t = m_{t-1} + h + x_t$$

where h is a fixed trend rate of growth and x_t is a random disturbance that is normally distributed with mean 0, variance σ_x^2, and an independent distribution from the other stochastic variables in the model.

The model is solved under the assumption that the information set upon which agents base their expectations is formed by all the past values of the relevant variables at every point in time. Thus, at the end of period t-1, the expected level of the money supply in period t will be $_{t-1}m_t^e = m_{t-1} + h$, since agents will know the value taken by the variable m up to period t-1, and will update their expectations by the observed constant rate of monetary growth. Correspondingly, x_t represents the unexpected component of the money stock.

The method of "undetermined coefficients" 3/ is used to solve this model. The solutions for the price level, the level of output, and the nominal interest rate are:

1/ Whether or not such deficits represent a net increase in private real wealth is a controversial issue (see Barro (1974)) that is not addressed in this paper.

2/ Specifically, restrictions concerning the technology of transactions and/or the utility function must be imposed to generate a demand for money function that depends on the level of income. In addition, if capital markets are assumed to be perfect, the real interest rate should be an argument in the supply of output function.

3/ See McCallum (1983).

$$(III.9)\quad p_t = \theta_0 + \theta_1 y^* + \theta_2 m_{t-1} + \theta_3 h + \theta_4 x_t + \theta_5 \varepsilon_t + \theta_6 n_t + \theta_7 u_t$$

$$(III.10)\quad y_t = y^* + \delta\theta_4 x_t + \delta\theta_5 \varepsilon_t + \delta\theta_6 n_t + (\delta\theta_7 + 1) u_t$$

$$(III.11)\quad i_t = r_t + {}_t p^e_{t+1} - p_t = \frac{1}{\beta_2}[(\theta_0+\beta_0) + (\theta_1\beta_1)y^* + (\theta_3-1)h + (\theta_4+\beta_1\delta\theta_4-1)x_t + (\theta_5+\beta_1\delta\theta_5+1)\varepsilon_t + (\theta_6+\beta\delta\theta_6)n_t + (\theta_7+\beta_1\delta\theta_7+\beta_1)u_t]$$

where:
$$\theta_o = a_o/a_1$$
$$\theta_1 = -1/a_2$$
$$\theta_2 = 1$$
$$\theta_3 = (a_1+a_2)/a_1$$
$$\theta_4 = (a_1+a_2)/(\delta+a_1+a_2)$$
$$\theta_5 = a_3/(\delta+a_1+a_2)$$
$$\theta_6 = a_4/(\delta+a_1+a_2)$$
$$\theta_7 = -1/(\delta+a_1+a_2)$$

A solution for the behavior of velocity is obtained by substituting the solutions (III.10) and (III.11) into equation (III.3).

$$(III.12)\quad v_t = \frac{a0}{a_1} + \left(\frac{a_2-1}{a_2}\right)y^* + \left(\frac{\delta(a_1+a_2-1)}{\delta+a_1+a_2}\right)x_t + \left(\frac{a_2}{a_1}\right)h + \left(\frac{a_3(\delta+1)}{\delta+a_1+a_2}\right)\varepsilon_t + \left(\frac{\delta\, a_4+a_4}{\delta a_1+a_2}\right)n_t + \left(\frac{a_1+a_2-1}{\delta+a_1+a_2}\right)u_t$$

where $a_0 = (\beta_2 \alpha_0 - \alpha_1 \beta_0)/(\beta_2 + \beta_1 \alpha_1)$

$a_1 = \alpha_1/(\beta_2 + \beta_1 \alpha_1)$

$a_2 = \alpha_1 \beta_2/(\beta_2 + \beta_1 \alpha_1)$

$a_3 = -\alpha_1/(\beta_2 + \beta_1 \alpha_1)$

$a_4 = \beta_2/(\beta_2 + \beta_1 \alpha_1)$

Thus, when x_t is replaced by $m_t - m_t^e$, equation (III.12) is identical to equation (7) in the main text, where the c's are functions of the structural coefficients: the αs, βs, and δ.

I.IV Price Level Indeterminacy Under an Interest Rate Rule

a. The long run case: Consider the model formed by equations (III.1) to (III.7) in Appendix I.III. In the long run when expectations are realized and the expected value of the random disturbances equal zero, equation (III.1) implies:

$$(IV.1) \quad y_t = y^*$$

Now assume a fixed interest rate rule where the interest rate is set at the constant level $\bar{i}$. Substituting equation (IV.1) into the long-run version of equation (III.2) and solving for the price level we obtain:

$$(IV.2) \quad p_t = p_{t+1} + \frac{1}{\alpha_1}[\alpha_0 - y^* - \alpha_1 \bar{i}]$$

Equation (IV.2) is a nonconvergent difference equations and hence the solution for the price level is indeterminant. The long-run indeterminacy of the price level extends to the long-run nominal money supply, moreover, which adjusts passively to money demand according to:

$$(IV.3) \quad m_t = \beta_0 + \beta_1 y^* - \beta_2 i + p_t$$

b. The short run case: Assuming $i_t = \bar{i}$, solve the model in Appendix I.III for the price level as a function of the exogenous variables (y^*, u_t, n_t), the policy target ($\bar{i}$) and the expectational variables ($_{t-1}p^e_t$, $_tp^e_{t+1}$):

$$(IV.4) \quad p_t = \frac{1}{\alpha_1+\delta}\left[\alpha_o + \alpha_1\, {}_tp^e_{t+1} + \delta\, {}_{t+1}p^e_t - \alpha_1\bar{i} - y^* + n_t - u_t\right]$$

Taking expectations on both sides of (IV.4) conditional on the period t-1 information set, we obtain:

$$(IV.5) \quad {}_{t-1}p^e_t = {}_{t-1}p^e_{t+1} - \bar{i} + \frac{1}{\alpha_1}\left[\alpha_o - y^* + n_t - u_t\right]$$

Equation (IV.5) is a nonconvergent difference equation. Thus, the expected price level, and hence the actual price level (because expectations are rational) are indeterminant. Notice that this result would not hold under the assumption of adaptive expectations since in that case, price level expectations would be tied down to the behavior of prices in the past. Thus, the prior evolution of prices would provide an anchor for the current price level.

I.V Price and Output Fluctuations Under Alternative Techniques of Monetary Control

The analysis in this section follows the methodology presented in Parkin (1978) and is based on an equilibrium-rational expectations framework. Specifically, the model in Appendix I.III will now be solved under the new assumption that the monetary stock is not an exogenous variable under the direct control of central bankers; instead the monetary authorities have to manipulate either the interest rate or the unborrowed monetary base in order to attempt to achieve a particular money supply target. The assumed relationship between the money supply, the unborrowed base and the interest rate has been presented in the main text as equation (8) and will be repeated here for convenience:

$$(V.1) \quad m_t = b_t + \gamma i_t + \omega_t$$

where b_t is the unborrowed monetary base and ω_t is a normally distributed random disturbance to the banking system that is assumed to have an expected value of zero and to be uncorrelated with the other disturbances in the model.

APPENDIX I

Throughout the analysis it will be assumed that the public and the authorities share the same information set, that the authorities announce and try to achieve a target level $\bar{m}$ for the money supply, and that the public believe that the authorities will behave as announced. Given $\bar{m}$, the authorities (and the public) are assumed to use equations (III.1)-(III.7) and (V.1) to forecast the expected levels of output and prices, conditional on settings for the chosen policy instrument, i_t or b_t. 1/ Thus:

$$(V.2) \quad y_t^e = y^*$$

$$(V.3) \quad y^* = \alpha_o - \alpha_1 i_t + \alpha_1 p_{t+1}^e - \alpha_1 p_t^e$$

$$(V.4) \quad \bar{m} = p_t^e + \beta_o + \beta_1 y^* - \beta_2 i_t$$

$$(V.5) \quad \bar{m} = b_t + \gamma i_t$$

Note that this system of equations contains none of the random disturbance terms, since the expected values of those disturbances are zero. If the chosen instrument is the interest rate, then equation (V.5) provides a forecast of the expected level of the unborrowed base, conditional on the deterministic value of i_t:

$$(V.5') \quad \bar{m} = b_t^e + \gamma i_t$$

Alternatively, if the chosen instrument is the unborrowed base, equation (V.5) provides a conditional forecast for the expected interest rate:

$$(V.5'') \quad \bar{m} = b_t + \gamma i_t^e$$

and the "expected" interest rate should also replace i_t in equations (V.3) and (V.4).

The solution to the system (V.2)-(V.4), with (V.5') or (V.5'') as appropriate, determines the level of the chosen instrument that is expected to be consistent with achieving $\bar{m}$. The choice of which instrument to

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1/ This is equivalent to taking the expected value of the system formed by equations (III.1)-(III.7) and equation (V.1).

control, however, depends not on the expected outcomes for money, output and prices, which are the same under either instrument, but rather on comparisons of how widely the actual outcomes may vary around their expected values under the alternative control instruments, given the variances of the random disturbance terms. These comparisons rely on the solutions for the actual levels of output, prices and the money supply 1/ when the deterministic value of the control instrument is substituted into the system of equations (III.1)-(III.7) and (V.1). Those solutions will now be considered.

For the case of interest-rate control, the solution 2/ to system (V.2)-(V.5) implies that the value of the interest rate should be set as:

$$(V.6) \quad i_t = \frac{\alpha_0}{\alpha_1} - \frac{1}{\alpha_1} y^*$$

Substituting equation (V.6) into equations (III.1)-(III.7) and (V.1) the solutions for the actual levels of the endogenous variables are then:

$$(V.7) \quad p_t = \frac{\alpha_0 \beta_2 - \alpha_1 \beta_0}{\alpha_1} - (\frac{\alpha_1 \beta_2}{\alpha_1}) y^* + \bar{m} + \frac{1}{\delta + \alpha_1} (n_t - u_t)$$

$$(V.8) \quad y_t = y^* + \frac{1}{\alpha_1} n_t + (\frac{\alpha_1 - 1}{\alpha_1}) u_t$$

$$(V.9) \quad m_t = \bar{m} + \varepsilon_t + \frac{(1+\beta_1)}{\alpha_1(\delta+\alpha_1)} n_t - \frac{(1+\beta_1(1-\alpha_1))}{\alpha_1(\delta+\alpha_1)} u_t$$

$$(V.10) \quad b_t = -\frac{\gamma\alpha_0}{\alpha_1} + \frac{\gamma}{\alpha_1} y^* + \bar{m} + \varepsilon_t - \omega_t + \frac{(1+\beta_1)}{\alpha_1(\delta+\alpha_1)} n_t - (\frac{1+(1-\alpha_1)\beta_1}{\alpha_1(\delta+\alpha_1)}) u_t$$

Notice that when the money supply is a target and the interest rate is an instrument, the price level is not indeterminate. By contrast, the indeterminacy of the price level under an interest rate target (as

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1/ Note that the actual level of the money supply does not have to be equal to its target (or expected) level since only the instrument is set deterministically.

2/ The method of "undetermined coefficients" is used once more to solve this rational expectations model.

demonstrated in Appendix I.IV) would arise from the fact that the nominal money supply was not tied down through its target level.

The velocity solution implicit from equations (V.7)-(V.10) is:

$$(V.11)\quad v_t = \frac{(\beta_2\alpha_0-\beta_0\alpha_1)}{\alpha_1} + \frac{(\alpha_1-\alpha_1\beta_1-\beta_2)}{\alpha_1}\, y^* + \frac{(1-\beta_1)}{\alpha_1}\, n_t$$

$$- \frac{(1-\beta_1)(1-\alpha_1)}{\alpha_1}\, u_t - \varepsilon_t$$

which is equivalent to equation (9) in the main text. Note that money supply terms do not appear in equation (V.11), in contrast with the velocity equation when the money supply was not controlled (equation (III.12)). In equation (V.11) the behavior of velocity is determined by all the random disturbances in the system, excluding the disturbance affecting the banking sector. The absence of ω_t is due precisely to the choice of the instrument: setting the interest rate in a deterministic way isolates the real sector from disturbances in the banking system.

Next consider the case of unborrowed monetary base control. The solution to the system (V.2)-(V.5) implies that the value of the unborrowed base should be set as:

$$(V.12)\quad b_t = \frac{-\gamma\alpha_0}{\alpha_1} + \frac{\gamma}{\alpha_1} y^* + \bar{m}$$

Substituting equation (V.12) into equations (III.1)-(III.7) and equa- (V.1), the solutions for the actual levels of output, prices, the interest rate and the money supply can be obtained. In particular, the solution for the level of output is:

$$(V.13)\quad y_t = y^* + \frac{1}{d}[\,\delta\gamma(1-\alpha_0) + (\alpha_1\gamma+\alpha_1\beta_2+\alpha_1)u_t$$

$$+ (\delta\gamma+\delta\beta_2)n_t + \delta\alpha_1\,\omega_t - \delta\alpha_1\varepsilon_t\,]$$

where: $\quad d = \gamma(\alpha_1+\delta) + \alpha_1\beta_2 + \delta\beta_2 + \delta\alpha_1\beta_1$

The expression for velocity is:

$$(V.14)\quad v_t = (1-\beta_1-\beta_2)y^* +$$

$$\frac{d}{j}\,[\,j+(\alpha_1\gamma+\alpha_1\beta_2+\alpha_1-\beta_1\alpha_1-\beta_1\alpha_1\gamma-\beta_2)u_t$$

$$+\ (\beta_2+\delta\gamma+\delta\beta_2-\beta_1\delta\gamma)n_t$$

$$-\ (\beta_2\alpha_1+\beta_2\delta-\delta\alpha_1+\beta_1\delta\alpha_1)\omega_t$$

$$-\ (\gamma\delta)\varepsilon_t\,]$$

where j is a composite of the parameters in the system. Equation (V.14) is equivalent to equation (10) in the main text.

I.VI Price, Output and Velocity Behavior in a Slow Price Adjustment--Rational Expectations Model

Consider the model presented in Appendix I.III and replace the goods market equilibrium condition (equation III.6) by the assumption of slow price adjustment:

$$(VI.1)\quad p_t - p_{t-1} = \lambda(\bar{p}_t - p_{t-1})$$

where $\bar{p}_t$ corresponds to the level to which prices would rise if they were fully flexible and, hence, its solution corresponds to equation (III.9). Substituting (III.9) into equation (VI.1), the solution for the actual level of prices is obtained:

$$(VI.2)\quad p_t = \lambda\theta_0 + \lambda\theta_1 y^* + \lambda\theta_2 m_{t-1} + \lambda\theta_3 h + \lambda\theta_4 x_t + \lambda\theta_5\varepsilon_t$$

$$+\ \lambda\theta_6 n_t + \lambda\theta_7 u_t + (1-\lambda)p_{t-1}$$

Taking expectations of both sides of equation (VI.2) conditional on the relevant information available through the end of period t-1, we obtain:

$$(VI.3)\quad {}_{t-1}p_t^e = \lambda\theta_0 + \lambda\theta_1 y^* + \lambda\theta_2 m_{t-1} + \lambda\theta_3 h + (1-\lambda)p_{t-1}$$

Substituting equations (VI.2) and (VI.3) into equation (III.1), the solution for the supply of output (and hence, the level of employment) is obtained:

$$(VI.4)\quad y_t = y^* + \lambda\delta\theta_4 x_t + \lambda\delta\theta_5 \varepsilon_t + \lambda\delta\theta_6 n_t + (\lambda\delta\theta_7+1)u_t$$

Equations (VI.2) and (VI.4) can now be substituted into equation (III.3) to obtain the solution for the nominal interest rate:

$$\begin{aligned}(VI.5)\quad i_t = \frac{1}{\beta_2}[&(\lambda\theta_0+\beta_0) + (\lambda\theta_1+\beta_1)y^* + (\lambda\theta_2-1)m_{t-1} \\ &+ (\lambda\theta_3-1)h + (\lambda\theta_4-1+\lambda\beta_1\delta\theta_4)x_t \\ &+ (\lambda\theta_5+\lambda\beta_1\delta\theta_5+1)\varepsilon_t + (\lambda\theta_6+\lambda\beta_1\delta\theta_6)n_t \\ &+ (\lambda\theta_7+\lambda\beta_1\delta\theta_7+\beta_1)u_t \\ &+ (1-\lambda)p_{t-1}]\end{aligned}$$

Finally, the solution for velocity can be obtained using equations (VI.2), (VI.4), and (III.8):

$$\begin{aligned}(VI.6)\quad v_t = &\lambda\theta_0 + (\lambda\theta_1+1)y^* + (\lambda\theta_4-1+\lambda\delta\theta_4)x_t \\ &+ (\lambda\theta_3-\lambda)h - (1-\lambda)m_t^e + (\lambda\theta_5+\lambda\delta\theta_5)\varepsilon_t \\ &+ (\lambda\theta_6+\lambda\delta\theta_6)n_t + (\lambda\theta_7+\lambda\delta\theta_7+1)u_t \\ &+ (1-\lambda)p_{t-1}\end{aligned}$$

I.VII The Effects of Long-term Contracts in the Labor Market on the Behavior of Output and Velocity

Assume that firms and workers engage in contracts that set the nominal wage rate for two subsequent periods. In addition, assume that these contracts specify the nominal wage rate according to equation (12) in the main text:

$$(VII.1)\quad {}_{t-i}w_t = {}_{t-1}p_t^e \qquad i = 1,2$$

where, expressed in logs, ${}_{t-1}w_t$ is the nominal wage to be paid in period t as specified in contracts drawn up at (t-i) and ${}_{t-i}p_t^e$ is the expectations of the price level in period t evaluated at the end of period t-i.

Since contracts overlap in time, when period t arrives, some firms will be in the first year of their contracts and some others will be in the second year of their contracts. Firms will find it optimal to increase

their supply of output every time their actual price level exceeds the fixed-in-advance wage rate since that would imply a lower-than-anticipated real wage. Thus, at the aggregate level, the supply of output will take the following form:

$$(VII.2) \quad y_t^s = y^* + \delta_1(p_t - {}_{t-1}w_t^e) + \delta_2(p_t - {}_{t-2}w_t^e) + u_t$$

Substituting equation (VII.1) into (VII.2), the output supply function can be expressed in terms of price level "surprises."

$$(VII.2') \quad y_t^s = y^* + \delta_1(p_t - {}_{t-1}p_t^e) + \delta_2(p_t - {}_{t-2}p_t^e) + u_t$$

To derive the implications of this kind of aggregate supply function for the levels of prices and output, the model in Appendix I.III will now be solved under the assumption that equation (VII.2') replaces equation (III.1). As in Appendix I.III, the method of undetermined coefficients is used to solve the model. The solutions for the price level, the level of output, and the nominal interest rate are:

$$(VII.3) \quad p_t = \hat{\theta}_0 + \hat{\theta}_1 y^* + \hat{\theta}_2 m_{t-1} + \hat{\theta}_3 h + \hat{\theta}_4 x_t + \hat{\theta}_5 \varepsilon_t + \hat{\theta}_6 n_t + \hat{\theta}_7 u_t$$

$$(VII.4) \quad y_t = y^* + \delta_2 \hat{\theta}_2 m_{t-1} + (\delta_1+\delta_2)\hat{\theta}_4 x_t + (\delta_1+\delta_2)\hat{\theta}_5 \varepsilon_t + (\delta_1+\delta_2)\hat{\theta}_6 n_t + ((\delta_1+\delta_2)\hat{\theta}_7+1)u_t$$

$$(VII.5) \quad i_t = \frac{1}{\beta_2}[(\hat{\theta}_0+\beta_0) + (\hat{\theta}_1+\beta_1)y^* + (\hat{\theta}_2+\beta_1\delta_2\hat{\theta}_2-1)m_{t-1} + (\hat{\theta}_3-1)h + (\hat{\theta}_4-1+\beta_1\delta_1\hat{\theta}_4+\beta_1\delta_2\hat{\theta}_4)x_t + (\hat{\theta}_5+1+\beta_1\delta_1\hat{\theta}_5+\beta_1\delta_2\hat{\theta}_5)\varepsilon_t + (\hat{\theta}_6+\beta_1\delta_1\hat{\theta}_6+\beta_1\delta_2\hat{\theta}_6)n_t + (\hat{\theta}_7+1+\beta_1\delta_1\hat{\theta}_7+\beta_1\delta_2\hat{\theta}_7)u_t]$$

where:

$$\hat{\theta}_0 = a_0/a_1$$

$$\hat{\theta}_1 = -1/a_1$$

$$\hat{\theta}_2 = (a_1+a_2+\delta_1)/(a_1+a_2+\delta_1+\delta_2)$$

$$\hat{\theta}_3 = 1 + (a_2\hat{\theta}_2)/a_1$$

$$\hat{\theta}_4 = (a_1+a_2\hat{\theta}_2)/(a_1+a_2+\delta_1+\delta_2)$$

$$\hat{\theta}_5 = a_3/(a_1+a_2+\delta_1+\delta_2)$$

$$\hat{\theta}_6 = a_4/(a_1+a_2+\delta_1+\delta_2)$$

$$\hat{\theta}_7 = -1/(a_1+a_2+\delta_1+\delta_2)$$

Substituting the solutions (VII.4) and (VII.5) into equation (III.3), the solution for the behavior of velocity is obtained:

$$\begin{aligned}(\text{VII.6}) \quad v_t = {} & \hat{\theta}_0 + (\hat{\theta}_1+1)y^* + (\hat{\theta}_2-1+\delta_2\hat{\theta}_2)m_{t-1} \\ & + (\hat{\theta}_3-1)h + (\hat{\theta}_4-1+\delta_1\hat{\theta}_4+\delta_2\hat{\theta}_4)x_t \\ & + (\hat{\theta}_5+\delta_1\hat{\theta}_5+\delta_2\hat{\theta}_5)\varepsilon_t \\ & + (\hat{\theta}_6+\delta_1\hat{\theta}_6+\delta_2\hat{\theta}_6)n_t \\ & + (\hat{\theta}_7+\delta_1\hat{\theta}_7+\delta_2\hat{\theta}_7+1)u_t\end{aligned}$$

Equation (VII.6) is equivalent to equation (13) in the main text where the ks are functions of the $\hat{\theta}$s and the expression ($m_t^e = m_{t-1}+h$) has been used.

APPENDIX II

Currency Substitution and the Behavior of Velocity

As part of the literature relating currency substitution and velocity behavior, Brittain (1981) provides a model in which currencies are regarded as elements of internationally diversified portfolios. In his view, two direct implications are: (i) movements in domestic velocity may be explained, at least partially, by shifts in the composition of the international money portfolio; and (ii) velocities across countries are interrelated. Following this approach the arguments of the demand for domestic money should include a term reflecting the expected opportunity cost of holding various currencies. Thus, the proposed function would expand equation (1) in the main text in the following way:

$$(VIII.1) \quad m_t^d - p_t = \beta_o + \beta_1 y_t - \beta_2 i_t + \beta_3 (i_t^f - i_t)$$

where i_t^f is a foreign interest rate.

The innovation in equation (VIII.1) is the addition of the uncovered interest rate differential in the arguments of the money demand function. Brittain's underlying hypothesis is that the higher the foreign interest rate relative to the domestic rate, the higher is the opportunity cost of holding the foreign currency and hence the higher is the demand for the domestic currency. Accordingly, a derived equation for velocity will incorporate the international portfolio variable $(i_t^f - i_t)$ with a negative sign. It should also be obvious that equation (VIII.1) assumes substitution across <u>two</u> currencies, but that nothing prevents the expansion to more monies.

Brittain's model bears some similarity to the so-called "currency substitution approach to exchange rate determination" developed by Girton and Roper (1976, 1981), Calvo and Rodriguez (1977) and Bilson (1978). However, it can be shown that Brittain's model, as represented by the single equation (VIII.1) does not correctly deal with the issue of currency substitution. This contention is based on the following arguments.

Brittain's hypothesis is that domestic residents will hold balances of both domestic and foreign currencies, but his model does not specify the domestic demand function for foreign currency. Such a specification can be added by drawing on the currency substitution literature, which emphasizes that demand functions for the two types of money should be specified symmetrically, except for considerations that influence the ratio of domestic to foreign money holdings. The ratio of the two types of money holdings depends on the differential between the <u>real</u> returns on the two monies which, under the assumption of zero nominal interest payments on money, equals the differential expected rate of inflation. Thus, the demands of domestic residents for the two types of moneys will

depend on the expected inflation differential along with the domestic interest rate and domestic income. In addition, under the assumption of ex ante purchasing power parity, the differential expected rate of inflation will equal the expected rate of change in the exchange rate. Hence, the relevant system of equations consistent with currency substitution would be:

$$(VIII.2)\quad {}^{d}m_t^d - p_t = \beta_o + \beta_1 y_t - \beta_2 i_t - \beta_3(e^e_{t+1} - e_t)$$

$$(VIII.3)\quad {}^{f}m_t^d + e_t - p_t = \gamma_o + \beta_1 y_t - \beta_2 i_t + \beta_4(e^e_{t+1} - e_t)$$

In these equations: e_t is the exchange rate, defined as the domestic currency price of the foreign money; ${}^{d}m^d$ and ${}^{f}m^d$ refer to the domestic demands for domestic and foreign currencies, respectively; and the superscript "e" refers to expectations.

Conditions (VIII.2) and (VIII.3) have several appealing properties. Notice that the demand for foreign money is expressed in terms of its purchasing power over domestic goods (Bilson (1981)), implying that neither currency is discriminated against when used for transactions purposes. Also the coefficients of the interest rate on the nonmonetary asset and of the level of income are the same in both equations, consistent with the notion that the relative holdings of the two currencies should be independent of changes in those variables. In addition, an increase in the expected rate of appreciation of the foreign currency reduces the demand for domestic money and increases the demand for foreign money. Combining equations (VIII.2) and (VIII.3) we obtain:

$$(VIII.4)\quad {}^{d}m_t^d - ({}^{f}m_t^d + e_t) = a_o - a_1(e^e_{t+1} - e_t)$$

where $a_o = \beta_o - \gamma_o$; $a_1 = \beta_3 + \beta_4$.

What does currency substitution then imply for velocity? It is clear that for given levels of the currency holdings of domestic residents, equation (VIII.4) would be a model of exchange rate determination, where the formation of exchange rate expectations would remain to be specified. However, if the currencies are also demanded in the rest of the world, it is still necessary to specify the "foreign country" demand functions. Assuming that those functions are similar in nature to equations (VIII.2) and (VIII.3), the "integrated" resulting equation for the exchange rate will be of the form:

$$(VIII.5)\quad e_t = A_o + A_1\, e^e_{t+1} + ({}^{D}M_t - {}^{F}M_t) \qquad ; A_1 > 0$$

where ^{D}M and ^{F}M represent the exogenous world supplies of domestic and foreign currencies, respectively. If the solution for the exchange rate is then substituted back into equation (VIII.2), the income velocity of domestic currency will take the form:

$$(VIII.6)\quad v_t = y_t + p_t - {}^{d}m_t = b_o - b_1 y_t + b_2 i_t + b_3 e^{e}_{t+1} + b_4({}^{F}M_t - {}^{D}M_t)$$

where $b_1, b_2, b_3, b_4 > 0$. Equation (VIII.6) is identical to equation (5) in the main text.

Notice that for given levels of output and the interest rate, velocity will fluctuate with changes in the expected value of the exchange rate and with changes in the difference between the two nominal supplies of monies. 1/ This result has been derived by using the system of equations implied by the proper interpretation of currency substitution, which improves upon Brittain's focus on a single money demand equation.

1/ Strictly speaking, models of currency substitution will derive implications for the "world" income velocity of a given currency rather than for "national" concepts of velocity.

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