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# Review

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Vol. 67, No. 5

May 1985

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*The Review is published 10 times per year by the Research and Public Information Department of the Federal Reserve Bank of St. Louis. Single-copy subscriptions are available to the public free of charge. Mail requests for subscriptions, back issues, or address changes to: Research and Public Information Department, Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, Missouri 63166.*

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The assumption of rational expectations has gained wide prominence in economic theory, to the point that one hears reference to the rational expectations "revolution." Rational expectations models have altered the way economists view the role of economic policy. In their strictest form, these models imply that government policies, including monetary policy, have no effect on real output — the policy ineffectiveness proposition.

In the first article of this *Review*, "Rational Expectations and the Effects of Monetary Policy: A Guide for the Uninitiated," A. Steven Holland has three major purposes: (1) to present the basic theory of rational expectations as it relates to monetary policy in a way that stresses its applicability to the real world, (2) to discuss some of the ways that rational expectations models can be altered to give results that refute the policy ineffectiveness proposition, and (3) to assess the overall contribution of rational expectations theory to our understanding of the role of monetary policy. The author points out that the policy recommendation that frequently arises from rational expectations models — a more predictable monetary policy — is essentially the same as that recommended by monetarists and depends critically on there being substantial costs to unpredictable money growth.

In the second article in this issue, "The New Bank Capital Adequacy Standards," R. Alton Gilbert, Courtenay C. Stone and Michael E. Trebing describe the new standards for capital adequacy recently adopted by the federal regulators of commercial banks and measure the adjustments by banks that will be necessary to meet the new standards. The authors discover that, for the banking industry as a whole, meeting the new minimum capital requirements will not require major adjustments. Less than 3 percent of all U.S. commercial banks fail to meet these capital standards; the increase in bank capital necessary to meet these standards is about one percent of existing bank capital. A large share of the increase in capital will have to be raised by a few of the nation's relatively large banks.

Gilbert, Stone, and Trebing also examine the effects of the 9 percent total capital standard that has been discussed recently by some government officials. If this standard were to be adopted in the near future, it would require sizeable adjustments by the banking industry. Currently, about half of all U.S. commercial banks would fail to meet the 9 percent standard; total capital in the U.S. banking industry would have to increase by about 29 percent to meet such a standard.

The stability and predictability of money demand is crucial in the formulation of monetary policy based on using monetary aggregates as intermediate targets. Although some have argued that recent financial innovations have rendered standard money demand functions useless, R. W. Hafer provides evidence in the third article of this issue, "Monetary Stabilization Policy: Evidence from Money Demand Forecasts," indicating that such arguments are not well-founded.

In this article, Hafer estimates two common versions of the short-run money demand function over the periods 1960–79 and 1960–84. Two tests are conducted: First, he tests for coefficient stability across the two periods. Evidence presented suggests that the estimated coefficients generally have remained stable. It does

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appear, however, that the models are subject to much larger errors during the past five years. This finding is explored in the second test, where quarterly forecast errors for the post-1979 period are examined. Although there are large forecast errors, they are offsetting in sign and magnitude. Moreover, their sum value is not different from zero. This finding, Hafer notes, leads to the conclusion that "arguments that monetary targeting to achieve desired long-term goals of stable income growth and price stability has become useless because of purported money demand instability are not supported by the evidence."

In the final article, "Money, Income and Currency Substitution: Evidence from Three Countries," Dallas S. Batten and R. W. Hafer investigate the hypothesis that foreign-generated disturbances to domestic money demand impinge on the relationship between domestic money growth and domestic economic activity. Using a reduced-form approach and three different variables to measure this phenomenon, known generally as currency substitution, they find no statistical support for this hypothesis in either Germany or Japan, and only weak support for the existence of currency substitution in the United States. Further analysis reveals that the U.S. result is most likely spurious. The authors conclude that, if currency substitution does exist, it is not measured appropriately by the variables that have appeared in the literature on this topic and that are employed in this study. Furthermore, in the absence of more appropriate measures, there is little empirical evidence that foreign shocks to domestic money demand are important enough to enter the monetary policymaking process.



# Rational Expectations and the Effects of Monetary Policy: A Guide for the Uninitiated

A. Steven Holland

**T**HE success or failure of any course of action often depends on the ability to anticipate events that have not yet occurred, or that have occurred but are not yet known. The real return on an investment, for example, can be predicted but not actually known at the time the investment decision is made. Since the failure to predict accurately the consequences of today's decisions can have significant costs, it pays for individuals to attempt to anticipate these consequences. To do this, a "rational" individual uses all of the information at his disposal to improve predictive accuracy. In general, this includes information about how the economy works and how the government conducts policy. Such an individual, thus, would have "rational expectations."

It is difficult to argue with the notion of rational expectations as described above, since the alternative implies that the individual ignores accessible information that would increase his foresight. It is, therefore, not surprising that the assumption of rational expectations has gained wide prominence in economic theory, to the point that one hears reference to the rational expectations "revolution." Rational expectations models, however, generally contain an additional element that has little to do with the formation of expectations: the assumption of equilibrium. In other words, supply is assumed to equal demand in all markets at all times. This is a departure from traditional "Keynesian" analysis, in which structural rigidities create disequilibrium, and a return to classical

(that is, pre-Keynesian) analysis. Therefore, rational expectations theory is also sometimes referred to as the "new classical" economics.

Rational expectations models have altered the way economists view the role of economic policy. In strictest form, these models imply that government policies, including monetary policy, have no effect on real output — the policy ineffectiveness proposition. This proposition contrasts sharply with the standard Keynesian analysis of the effects of monetary policy, that is, that increased money growth results in both greater real output and higher inflation, implying a trade-off between inflation and unemployment. It also contrasts with standard monetarist analysis, in which money is neutral in the long run, but has expansionary short-run effects. Not surprisingly, the policy ineffectiveness proposition has generated a great deal of controversy.<sup>1</sup>

This article has three major purposes: (1) to lay out the basic theory of rational expectations as it relates to monetary policy in a way that stresses its applicability to the real world, (2) to discuss some of the ways that rational expectations models can be altered to give results that refute the policy ineffectiveness proposition and, most importantly, (3) to assess the overall contribution of rational expectations theory to our understanding of the role of monetary policy. Regarding the latter, this paper stresses that the policy recommendation that frequently arises from rational expectations models — a more predictable monetary

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<sup>1</sup>For a sample of the variety of opinions among economists about rational expectations, see Lee (1984).



policy — is essentially the same as that recommended by monetarists and depends critically on there being substantial costs to money growth's unpredictability.<sup>2</sup>

## A "CLASSICAL" ECONOMY WITH IMPERFECT INFORMATION AND RATIONAL EXPECTATIONS

Expectations are rational in the manner described by Muth (1961) as long as the public's expectation of a variable to be forecast is based on what it knows about how that variable is determined.<sup>3</sup> For example, individuals have some knowledge of how production, employment and pricing decisions are made, and they use this knowledge in making forecasts. Rational expectations models go beyond this fairly simple assumption, however, by stressing that all individuals make consistently optimal decisions. This is usually taken to mean that all markets are in equilibrium, since in disequilibrium, transactions could be made that benefit both buyer and seller.

An example of a model that incorporates these classical features is one in which each business firm maximizes the present value of expected real profit and each consumer maximizes the expected utility from real consumption. In such a model, a firm's production and employment of inputs generally depend on the current and expected future prices of its output and inputs relative to the general level of prices. Likewise, the demand for a firm's output is a function of its current and expected future relative prices and real consumer wealth.<sup>4</sup> A key element of the model is that the supply of output increases as the producer perceives an increase in the price of his output relative to prices in general.<sup>5</sup> As a simple example, consider a producer who uses only his own labor as an input, so that the relative price of his output equals his real wage. It pays for the producer to provide greater work effort in times of a higher real wage than in times of a

lower real wage. This increase in labor supply results in greater output.<sup>6</sup>

Relative prices are always changing due to a multitude of factors including consumers' tastes and preferences, the technology used in producing various products and the availability of productive inputs. An unanticipated change in one of these factors can be called a "real" shock. It is possible for real shocks to affect the aggregate price level as well as relative prices. At the same time, the aggregate price level could be changing due to a change in the supply of money. An unanticipated change in the money supply is a "nominal" shock.<sup>7</sup> For simplicity, it is assumed below that "aggregate" shocks are synonymous with nominal shocks, and real shocks are simply "relative" shocks.

## Confusion Between Aggregate and Relative Shocks

An important feature of most rational expectations models is the incomplete flow of current information across markets. Both producers and consumers lack complete information about current prices in other markets, so that supply and demand depend on *perceptions* of current relative prices rather than the actual (unknown) relative prices.<sup>8</sup>

The producer who observes an unexpected increase in his price does not know whether it results from a relative shock — consumers are unexpectedly demanding more of his product and less of others — or an aggregate shock — consumers demand more of all goods because of greater-than-anticipated money balances, resulting in a higher aggregate price level. This is an important distinction since the producer wishes to adjust output only in response to changes in relative prices, since he is maximizing real, not nominal, profit. Thus, if producers knew that rising prices were due only to an increase in the money supply, they would not adjust their output; instead, prices would increase in proportion to the increase in money supply. If the rational producer has experienced both

<sup>2</sup>Other descriptive treatments of rational expectations include Federal Reserve Bank of Minneapolis (1977), Berkman (1980), Mad-dock and Carter (1982) and Sheffrin (1983).

<sup>3</sup>More specifically, the forecast of a variable is its mathematical expectation based on some knowledge of the process that generates that variable.

<sup>4</sup>The rate at which future returns are discounted may also be important in determining both supply and demand.

<sup>5</sup>There is a supposition in rational expectations models that any change in relative prices is viewed as temporary. This is a reasonable assumption since a persistently higher relative price would attract additional entrants to the industry, thus driving the relative price back down.

<sup>6</sup>If the producer has to hire labor in addition to his own, an increase in the relative price of output leads to increased demand for labor, which drives up the real wage. Both the quantity of labor supplied and the level of production increase. This analysis also can be applied to inputs other than labor.

<sup>7</sup>We ignore the possibility that shocks arise from unanticipated changes in the demand for money.

<sup>8</sup>A model with this kind of partial information was first used by Phelps (1970), but also has been used by Lucas (1973), Barro (1976) and many others.



relative and aggregate shocks in the past, then he cannot be sure that an unanticipated increase in the market price of his output reflects one kind of influence or the other; the producer will tend to assume, initially, that unanticipated price changes reflect some combination of both, until more information becomes available.<sup>9</sup>

Unanticipated money growth has real effects in the rational expectations model described above. When money holdings rise faster than the anticipated price level, consumers perceive an increase in their real wealth. They increase their demand for goods and services, causing an unanticipated increase in the general price level. Producers believe that their relative prices have increased and accordingly increase their output. Thus, the real effects of unanticipated money growth arise because perceived relative prices deviate from actual relative prices.<sup>10</sup>

## THE NATURAL RATE HYPOTHESIS AND MONEY-INDUCED BUSINESS CYCLES

Although it was not stated explicitly, this analysis implies that unanticipated money growth causes output and unemployment to deviate from their "natural" levels in the short run. These natural levels refer to levels of output and unemployment that are consistent with a long-term rate of growth of output and a rate of unemployment to which the economy tends to return after a disturbance. This notion is referred to as the "natural rate hypothesis."

Business cycles can be viewed as persistent (but not permanent) deviations of actual output and unemployment from their natural levels. Rational expectations models have been used to explain the existence of business cycles, despite the fact that information on the aggregate price level becomes known to producers and consumers at fairly short intervals. Business cycles can occur if, for example, unanticipated money growth results in increased capital investment. This requires that firms consider currently perceived relative prices, which are affected by monetary surprises, to be a good indicator of future real returns on investment. The effect of a higher rate of investment is

greater productive capacity and greater output over several periods.<sup>11</sup>

The behavior of inventories also plays a potential role in the persistence of the effect of nominal shocks. A firm that maintains an inventory can increase its sales in response to a perceived change in its relative price by selling out of its inventory. In later periods, the firm seeks to rebuild its inventory to its desired level, which requires additional production and employment. If firms gradually adjust inventories to their desired levels, then the effects of unanticipated money on output levels may persist for a fairly long period of time.<sup>12</sup>

Monetary surprises also can have persistent effects if the public is unable to distinguish perfectly between permanent and transitory shocks. Applied to money growth, this means that unanticipated money growth might represent either a one-time aberration with a return to the former expected money growth path, a permanent shift to a higher rate of money growth, or something in between. If rational forecasters have observed both permanent and transitory shocks in the past, then they will regard any unanticipated change in the growth rate of money as being partly permanent and partly transitory. This means, for example, that expectations will adjust only gradually to an increase in the money supply that really is permanent. Forecasters, therefore, will underpredict the increase in money growth until their expectations adjust completely. In this way, nominal shocks can cause persistent changes in output and employment.<sup>13</sup>

<sup>11</sup>See Lucas (1975). Because the capital stock is not affected in the long run by nominal shocks, it must decline from its greater-than-normal levels at some point in the future. It is worth noting that, despite the fact that the anticipated real return on investment is increased by unanticipated money growth, the actual real rate of interest declines. A monetary surprise implies that the money stock rises above anticipated inflation; that is, perceived real money balances increase. This induces individuals to increase their purchases of securities and goods until the real interest rate declines by enough to induce them to hold the larger amount of money. See Barro (1981).

<sup>12</sup>Blinder and Fischer (1981) bring out this point and analyze the case in which desired inventory levels are related negatively to the real interest rate. The declining real rate induced by unanticipated money growth (see footnote 11) leads to an increase in production and employment so that inventories can rise to the new desired levels. Brunner, Cukierman and Meltzer (1983) take a different approach to the issue. In their model, goods have prices and quantities fixed for one period, but financial markets are free to adjust continually. The lower real interest rate caused by unanticipated money growth results in greater current consumption. With the demand for goods higher than their fixed supply, firms sell off part of their inventories, then replenish them in later periods.

<sup>13</sup>See Brunner, Cukierman and Meltzer (1980). Note that this permanent/transitory confusion implies that forecasts can display a persistent bias when viewed *ex post*, yet be completely rational *ex ante*.

<sup>9</sup>The more variable are aggregate shocks compared to relative shocks, the greater the proportion of a given unanticipated price increase attributed to aggregate influences. See Lucas (1973).

<sup>10</sup>Models that include this kind of wealth effect include Hercowitz (1981) and Cukierman (1982). They show that if the elasticities of supply and demand differ across markets, then monetary shocks also affect actual market-clearing relative prices and their variance.



## THE POLICY INEFFECTIVENESS PROPOSITION

The rational expectations model presented above is based on three major assumptions: (1) there exist distinct markets across which information does not flow smoothly, (2) prices adjust instantaneously so that each individual market is in equilibrium in every period, and (3) expectations are formed rationally. Sargent and Wallace (1975) have shown that, in such a world, output is not affected by the decision to follow any systematic monetary policy or "rule" — the policy ineffectiveness proposition. For example, it is irrelevant to the determination of output whether the monetary authority chooses to control interest rates or the money supply. The public expects a certain rate of money growth and adjusts its behavior in advance so that when the money growth actually occurs, it affects nominal magnitudes (the price level and the nominal rate of interest) but not real magnitudes. Only money growth that deviates from the rate implied by the monetary rule affects output, since it is unanticipated.<sup>14</sup>

This differs from the outcome when expectations are not formed rationally, that is, when individuals ignore information that helps to predict future money growth and inflation. In such a case, policymakers could exploit a trade-off between unemployment and inflation, increasing the growth rate of money in order to expand the economy. Since prices would lag behind changes in money, even policy actions that could be anticipated would affect real output and unemployment. Thus, to the extent that expectations are not rational, the particular monetary rule adopted has implications for the real sector.

### *The Importance of Flexible Prices*

The assumption of price flexibility in this analysis is critical to the conclusion that anticipated money growth has no effect on output. In reality, some prices do not adjust immediately to either aggregate or relative shocks. Fixed-price contracts and the costs of adjusting prices mitigate against instantaneous price adjustment.<sup>15</sup>

Price contracts exist, at least partly, as a means of economizing on search costs for buyers. Fluctuating prices make it more difficult for buyers to find the seller with the lowest price for a given product. Therefore, firms have an incentive to announce their prices in advance, because they will lose some customers who value this information if they do not.<sup>16</sup> Given the heterogeneity of goods produced in the economy, differing degrees of price flexibility arise. For example, goods that are storable tend to have less flexible prices than goods that are not storable, because firms can adjust inventory levels instead of prices to fluctuations in demand. In addition, goods that have customized features are more likely to have their prices fixed for some period than goods that are standardized across sellers.<sup>17</sup> Therefore, some prices respond quickly to changes in the money stock while others respond more slowly.

As long as some prices are set in advance of the time that monetary policy actions are taken, even anticipated money growth can have short-term real effects. For example, suppose a producer has a contract that specifies a nominal wage for his work force that remains fixed for a period of time. Assuming the contract cannot be renegotiated, any information that arrives after the contract is signed will not affect the nominal wage until the contract expires. The monetary authority, however, is free to react to the new information in accordance with its policy rule. If this policy action causes money growth (and the price level) to be higher than originally anticipated, the producer will anticipate a decline in the real wage it pays to labor over the remaining term of the contract. When the anticipated real wage declines, the quantity of labor demanded increases and so do employment and production.<sup>18</sup>

The existence of long-term contracts, therefore, im-

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<sup>16</sup>See Alchian (1969).

<sup>17</sup>For a more detailed discussion of the differences in price flexibility across products, see Bordo (1980), Gordon (1981) and Carlton (1982).

<sup>18</sup>See Fischer (1977). For an analysis of price inflexibility that takes a somewhat different approach, see Phelps and Taylor (1977). The problem with the analysis presented in the text is that it neglects the short-term labor supply effects that are so important in most rational expectations models. If both the supply and the demand curve for labor are relevant in the short run, then deviations of actual from expected inflation in either direction result in lower employment and output. Furthermore, if a firm's output price is fixed while its input prices and the output prices in other markets are flexible, then unanticipated inflation causes the price of inputs to rise relative to the fixed output price and the relative price of the fixed-price good to decline generally, resulting in reduced supply. It does not seem likely, however, that a firm that does not choose to have contracted wages would choose to have a contracted price.

<sup>14</sup>Note that if there were perfect information about all markets, then money growth could never affect output, for, as Lucas (1975, p. 12) points out, "... in an economy in which all trading occurs in a single, competitive market, there is 'too much' information in the hands of traders for them ever to be 'fooled' into altering real variables." This suggests that efficiency would be increased if there were a clearinghouse for contemporaneous price information. It is unlikely, however, that such an institution could provide complete information in a timely manner in a large economy.

<sup>15</sup>The analysis below treats price inflexibility as though it arises solely from the existence of explicit price contracts; we recognize that there also are other potential causes.



plies the potential for the monetary authority to affect real output in the short run, even if it follows a systematic policy. The structure of contracts depends, however, on the particular policy rule chosen. For example, if the policy rule allows the inflation rate to vary a great deal as a result of various shocks, then the expectations upon which contracts are based are more likely to be confounded than if the inflation rate is kept fairly stable. Therefore, under the former policy rule, contracts are more likely to include cost-of-living adjustment clauses and provisions for reopening contract negotiations and to have shorter duration than under the latter policy rule. This suggests that a change in policy from a rule in which inflation remains stable to one in which it is allowed to vary would not be effective in the long run, because the structure of contracts would change. These changes would cause prices to be more flexible, which would reduce or eliminate the effects of anticipated policy on the level of output.<sup>19</sup>

### *Expected Inflation and Capital Accumulation*

If the public expects the growth rate of money to increase, it will also expect higher inflation in the future. Given certain institutional characteristics of the economy, there are a number of ways in which expected inflation can affect the accumulation of capital, even with rational expectations. Thus, anticipated money will have real effects, and the policy ineffectiveness proposition will not hold. For example, higher expected inflation causes people to shift part of their money balances into real capital, because money provides a very low or negative real return during times of inflation.<sup>20</sup> On the other hand, higher expected inflation drives up the replacement cost of capital, while current tax law provides for depreciation allowances for businesses based on the historical cost of capital. Thus, the expected real return on capital investment is lowered, resulting in less capital accumulation.<sup>21</sup>

If the monetary authority were to continually exploit the existence of either a very low real return on money holdings or distortions arising from the tax

treatment of capital depreciation, however, it is likely that these institutional characteristics would be eliminated. This is not as straightforward as the adjustment of private contracts discussed above, since it implies legislative rather than private action. But as inflation persists, there will be a growing demand for savings instruments that combine the transaction features of money with a market rate of return, and investors will seek to eliminate the effects of inflation on the real value of depreciation allowances.<sup>22</sup> If the political system allows these adjustments to occur, then the policy ineffectiveness proposition would still hold in the long run.

### THE CASE FOR PREDICTABLE MONETARY POLICY

The foregoing analysis implies that, if a policy rule were to be enforced perfectly by the monetary authority, then in the long run everyone would have complete knowledge of the monetary rule, and contracts and institutions would adjust to it. Thus, the behavior of the money supply would not affect real output, and any cyclical behavior would arise purely from non-monetary sources.<sup>23</sup> On the other hand, the monetary authority can affect the behavior of output in the short term by departing from the rule or by altering the rule to take advantage of institutional arrangements that likely would not continue to exist if they were continually exploited.<sup>24</sup>

An important contribution of the rational expectations movement, therefore, is that it shows that the state of expectations and the institutional structure adjust to the way policy is conducted, thereby altering

<sup>19</sup>Friedman (1977) discusses the response of contracts to variable inflation.

<sup>20</sup>See Tobin (1965). Fischer (1979) incorporates the Tobin effect in a rational expectations model.

<sup>21</sup>See Feldstein and Summers (1978). A tax on nominal interest also implies that expected inflation affects capital accumulation, if borrowers and lenders of investment funds have different tax rates. For a discussion of the impact of expected inflation on real interest rates, see Holland (1984).

<sup>22</sup>Casual evidence suggests that these kinds of institutional adjustments are indeed occurring, as transaction balances now may pay interest, and the recent Treasury Department proposal to reform the tax system includes a provision to alter the way inflation affects the depreciated value of capital. The recent change to an indexed personal income tax can also be viewed in this light if the taxation of nominal interest has affected capital accumulation (see footnote 21).

<sup>23</sup>By a perfectly enforced monetary rule, I mean one in which there is no deviation of the quantity of money from what was intended due, for example, to changes in the demand for money. Shocks to money demand could have transitory effects on real output and employment.

<sup>24</sup>Taylor (1975) presents a different analysis of the behavior of output following a change in the monetary rule. In his model, there is a transition period during which forecasts display a persistent bias due to lack of knowledge about the nature of the change in policy. This is very similar to the notion of confusion between permanent and transitory shocks discussed above. The policy ineffectiveness proposition does not hold during this transition period, since the change in the monetary rule has real effects.



the results of the policy. Thus, the effects of a given policy will not necessarily be the same every time it is used. This implies that econometric models that do not incorporate rational expectations are unlikely to predict accurately the results of a change in policy. This is the basis of the "Lucas critique."<sup>25</sup>

Since it is often possible to attain important short-term benefits with policy measures that confound expectations, one might expect proponents of rational expectations to recommend secrecy in the conduct of monetary policy. This is not the case, however. Instead, they recommend that monetary policy be made as predictable as possible by sticking closely to pre-announced rules.<sup>26</sup> Implicit in this policy recommendation is the assumption that monetary variability — taken here to be synonymous with uncertainty — imposes long-term costs in excess of its short-term benefits.

### *The Effects of Monetary Variability*

In general, greater monetary variability reduces the efficiency of the price system by making it more difficult to distinguish relative price increases from general inflation. In the standard rational expectations model, it is difficult to distinguish between relative and aggregate shocks, and the variability of each kind of shock plays an important role. If aggregate shocks, taken to be monetary surprises, become more variable compared to relative shocks, then a firm is more likely to perceive any change in its price as the result of aggregate rather than relative forces. It, therefore, will respond less — in terms of changing its levels of output, employment and investment — to an actual change in relative prices, even when the change is due to relative shocks. This means that the price system is less effective as a mechanism for allocating resources.<sup>27</sup>

Reduced efficiency in allocating resources lowers the natural level of output and potentially raises the natural rate of unemployment. The economy has ways of adapting, however, to the greater uncertainty caused by more variable money growth, including the greater use of indexing and the shortened duration of contracts. These adjustments reduce the risk associated with monetary variability, implying that the real effects of monetary variability should diminish as high levels of variability persist through time. The adjustments impose their own costs, however, since a larger amount of resources is diverted to the contracting process from other, presumably more efficient, uses.<sup>28</sup> Thus, the economy still is likely to operate more efficiently in an environment of policy certainty than policy uncertainty. The analysis, therefore, implies that efficiency is enhanced by the use of well-defined and well-publicized policy rules.<sup>29</sup>

### CONCLUSIONS

The incorporation of rational expectations into macroeconomic analysis leads one to the conclusion that the effects of monetary policy actions on real output and employment depend critically on the state of expectations and the existing institutional structure. If the public has sufficient knowledge about how policy is conducted and if institutions have adjusted to the conduct of policy, then the growth of the money supply will have no effect on real output or employment at all.

The monetary authority can always affect output in the short run by acting in a way that confounds expectations. Proponents of rational expectations, however, generally recommend that the policy authority not attempt to fool the public as a way of achieving short-term goals, since there are potentially serious long-term costs associated with unpredictable policy. The most important of these are reductions in the "natural" levels of output and employment and a higher "natural" unemployment rate.

<sup>25</sup>See Lucas (1976).

<sup>26</sup>See, for example, Lucas and Sargent (1979).

<sup>27</sup>Cukierman (1982) shows that the difference between the perceived and actual relative price of a product grows larger, *ceteris paribus*, as monetary variability gets larger, implying a reduced efficiency of the price system. Cukierman and others also have shown that, under certain conditions, greater monetary variability is associated with greater variability of relative prices. Furthermore, greater monetary variability also has the potential to affect real interest rates. The instability created by highly variable money growth makes for increased uncertainty about future returns on capital and interest-earning assets and raises the demand for money relative to these assets. This causes higher real interest rates. In other words, risk-averse lenders require that a greater "risk premium" be added to interest rates to offset the greater uncertainty associated with the future real return (see Mascaro and Meltzer (1983)). The effect is not unambiguously positive, however, since risk-averse borrowers reduce their demand for loanable funds as risk increases, which would tend to reduce the real rate.

<sup>28</sup>Gray (1978) presents a model in which greater monetary variability leads to both greater use of indexing and reduced duration of contracts. She also shows that greater use of wage indexing has another potential cost: by preventing changes in real wages, it reduces the ability of the economy to respond to real shocks.

<sup>29</sup>In this analysis, the term monetary variability refers to the variability of unanticipated money growth. Note, however, that if there are long-term contracts, even the variability of anticipated money growth can have permanent real effects due to changes in the structure of contracts. For an example, see Canzoneri (1980).



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# The New Bank Capital Adequacy Standards

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**T**HE three federal agencies that regulate U.S. commercial banks — the Federal Deposit Insurance Corporation (FDIC), Federal Reserve (FED) and Office of the Comptroller of the Currency (OCC) — recently adopted new capital adequacy standards for bank supervision and regulation purposes.<sup>1</sup> The new minimum standards are 5.5 percent for the ratio of primary capital to total assets and 6 percent for the ratio of total capital to total assets.<sup>2</sup> In general, the new standards increase the minimum capital requirements for larger banks, while reducing them for smaller banks.

There are two reasons for the change in bank capital standards. First, the relatively large number of bank failures in recent years has become a matter of considerable public concern.<sup>3</sup> While bank failures averaged only 10 per year as recently as 1979 through 1981, the number of bank failures reached 79 in 1984. Twenty-nine banks failed in the first four months of 1985, and there are expectations that the number of failures during 1985 will equal or surpass that in 1984.<sup>4</sup> Many

people, including bank regulators, believe that higher bank capital ratios will reduce the number of bank failures that otherwise would occur.<sup>5</sup>

Second, the International Lending and Supervision Act of 1983 specifies, in part, that each "appropriate Federal Banking Agency shall cause banking institutions to achieve and maintain adequate capital by establishing minimum levels of capital." The changes in bank capital standards are intended to address the public and congressional concern about the adequacy of bank capital.

This article describes the new bank capital standards and estimates their potential impact on the U.S. banking industry, using data from the December 31, 1984, Report of Condition for U.S. commercial banks. In general, meeting the new standards will produce relatively small changes for the banking industry. Only 419 of the 14,404 banks surveyed have capital ratios below the new standards. These capital-deficient banks must raise about \$1.8 billion in capital, which represents a capital increase of about 7 percent for the deficient banks but only about 1 percent for the industry as a whole.

This article also examines the potential changes in capital and assets that the banking system would face if minimum capital ratios were raised to the higher levels recently suggested by a Treasury Department study group and the FDIC. The analysis suggests that the 9 percent capital-to-asset standard currently un-

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<sup>1</sup>The FDIC is the primary supervisory authority at the federal level for FDIC-insured, state-chartered banks that are not members of the FED. The FED supervises FDIC-insured, state-chartered member banks and regulates bank holding companies. The OCC supervises banks with national charters; these national banks are FDIC-insured and members of the Federal Reserve System.

<sup>2</sup>The FED has also announced new capital standards for bank holding companies (BHCs). The minimum ratios for primary and total capital for BHCs are the same as those for banks; however, there are differences in the items that are included in primary and secondary capital. This article does not analyze the effect of the new capital requirements on BHCs.

<sup>3</sup>For survey data showing public concern about the stability of the banking system, see Gross (1984), Blundell (1985) and "Bank Crisis Tied. . ." (1985). For predictions of more bank failures, see "More Bank Failures. . ." (1985) and Belsie (1985). Finally, for some comments on the political consequences of bank failures, see "Banking Confidence May. . ." (1985).

<sup>4</sup>For one estimate of the number of banks that will fail in 1985, see "Agriculture: FDIC Study Says. . ." (1985).

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<sup>5</sup>There is remarkably little evidence, however, that links the level of capital or the ratio of capital to assets with bank failure rates. For example, a regulatory impact study prepared by the OCC notes, "It is impossible to say how many bank failures will be avoided as a result of the [new capital] rule, how many there would have been if the rule had been in effect earlier, or the effect on the failure rate of other minimum ratios" (Office of the Comptroller of the Currency (1985)). In an appendix to the FDIC's report to Congress in 1983, four bank failure prediction studies were reviewed; none of them found bank capital ratios, as measured in the current regulations, to be of major importance in discriminating between failed and successful banks (Federal Deposit Insurance Corporation (1983)).



der discussion would require considerable changes for the U.S. banking system. At the present time the banking system, in the aggregate, has a total capital/asset ratio of slightly more than 7 percent. If the 9 percent standard were adopted, more than half of all U.S. commercial banks would be deficient. To meet the suggested 9 percent standard, the deficient banks would have to raise about \$52 billion in new capital or reduce their assets (and liabilities) by nearly \$523 billion. Thus, either the capital of U.S. commercial banks would have to rise by about 29 percent or the U.S. banking industry would have to "shrink" its assets by more than one-fifth.

## THE REGULATORY VIEW OF BANK CAPITAL

In general terms, bank regulators define a bank's capital as the difference between the book value of its assets and liabilities.<sup>6</sup> Bank regulators view capital as performing several important roles. It provides a financial "cushion" that enables banks to continue to operate even if they are temporarily sustaining losses. It is presumed to maintain public confidence in the soundness of individual banks and the banking system as a whole. And it is alleged to provide some degree of protection to depositors whose bank accounts are not fully insured.

Federal bank regulators divide bank capital into two categories: primary and secondary. The specific balance sheet items that constitute bank capital for regulatory purposes are presented in table 1.

Primary capital consists of the initial investment of shareholders, retained earnings and capital reserves set up to absorb possible future losses. Secondary capital consists of the sum of limited-life preferred stock, subordinated notes and debentures and certain other items (see table 1). Each bank's secondary capital is added to its primary capital to obtain its total capital for regulatory purposes. The regulatory agencies limit the amount of secondary capital included in total capital to no more than 50 percent of a bank's primary capital.

Regulators include subordinated long-term debt as

part of capital for two reasons: these debt instruments must have initial average weighted maturities of at least seven years, and, should the bank fail, investors in these debt instruments receive payment only after all depositors have received full payment.

Federal regulatory agencies, however, do not view subordinated long-term debt as equivalent to primary capital in determining the capital adequacy of banks; consequently, they impose certain limits on the extent to which it is counted as capital. If a bank experiences a major reduction in the value of its assets, primary capital provides a better buffer against bankruptcy than secondary capital. While dividends to shareholders can be cut to zero to maintain capital, a bank must continue to meet the interest payments to its subordinated debt holders if it is to remain in operation. Moreover, the holders of limited-life preferred stock and subordinated debt instruments must be paid when those debt instruments mature.

The amount of capital available per se does not provide useful information to regulators; capital must be measured *relative* either to some bank size factor (after all, larger banks are likely to have more capital than smaller banks, other things equal) or to the balance sheet items whose fluctuations bank capital is intended to cushion. Regulators are generally concerned with the amount of primary and total capital relative to some measure of the bank's total assets.

## THE NEW MINIMUM BANK CAPITAL STANDARDS

Under the new standards, the three federal agencies use both primary and total capital ratios in assessing the adequacy of a bank's capital. The primary capital ratio is the ratio of primary capital to adjusted total assets; the total capital ratio is the ratio of total capital to adjusted total assets. The primary and total capital figures used are end-of-quarter values. Adjusted total assets equal the average total assets held by banks over the previous three months, plus end-of-quarter values for reserves for loan and lease losses, minus those intangible assets not allowed for capital adequacy purposes. The new minimum primary capital ratio is 5.5 percent. This represents an increase in the minimum primary capital ratio of 0.5 percent for all FDIC-regulated banks and for OCC- and FED-regulated banks that have more than \$1 billion in assets; it represents a 0.5 percent reduction for OCC- and FED-regulated banks with assets less than \$1 billion. A brief discussion of the prior formally announced capital standards is contained in the insert on page 15.

<sup>6</sup>This view of capital is often referred to as the "accounting" definition of capital. In contrast, the "economic" definition of bank capital focuses on the market value (or net present value) of the bank. These two definitions yield identical values only if all assets (including "good will") and liabilities are carried on the bank's balance sheets at their current market values. In general, however, many bank assets, liabilities and capital account items are valued on a historical basis rather than at current market values.



Table 1

**Components of Bank Capital As Measured by the Federal Bank Regulatory Agencies**

Item		Description
<b>PRIMARY CAPITAL MEASURE</b>		
equity capital	common stock	Aggregate par or stated value of outstanding common stock
	perpetual preferred stock	Aggregate par or stated value of outstanding perpetual preferred stock. Preferred stock is a form of ownership interest in a bank or other company which entitles its holders to some preference or priority over the owners of common stock, usually with respect to dividends or asset distributions in a liquidation. Perpetual preferred stock does not have a stated maturity date and cannot be redeemed at the option of the holder. It includes those issues that are automatically converted into common stock at a stated date.
	surplus	Amount received from the sale of common or perpetual preferred stock in excess of its par or stated value.
	undivided profits	Accumulated dollar value of profits after taxes that have not been distributed to shareholders of common and preferred stock as dividends.
	capital reserves	Contingency and other capital reserves. Reserves for contingencies include amounts set aside for possible unforeseen or indeterminate liabilities not otherwise reflected on the bank's books and not covered by insurance. Capital reserves include amounts set aside for cash dividends on common and preferred stock not yet declared and amounts allocated for retirement of limited-life preferred stock and debentures subordinated to deposits.
Plus:	mandatory convertible instruments <sup>1</sup>	Debt issues that mandate conversion to common or perpetual preferred stock at some future date; they must meet the following conditions to be included in primary capital: <ol style="list-style-type: none"> <li>1. The securities must mature (convert to common or preferred stock) in 12 years or less.</li> <li>2. The aggregate amount of mandatory convertible securities counted as primary capital may not exceed 20 percent of primary capital net of mandatory convertible securities.</li> <li>3. The issuer may redeem the securities before maturity only with the proceeds of the sale of common or perpetual preferred stock.</li> <li>4. The holder of the security cannot accelerate the payment of principal except in the event of bankruptcy, insolvency or reorganization.</li> <li>5. The security must be subordinated in right of payment to all senior indebtedness of the issuer.</li> </ol>
	reserves for loan and lease losses	Amount set aside to absorb anticipated losses. All charge-offs of loans and leases are charged to this capital account, and recoveries on loans and leases previously charged off are credited to this capital account.
	minority interest in consolidated subsidiaries	The sum of the equity capital of the subsidiaries in which the bank has minority interest multiplied by the percentage ownership of the bank in the subsidiaries.
Minus:	equity commitment notes	Debt obligations which the issuer must repay only from the proceeds of the sale of common or perpetual preferred stock. These notes are included in mandatory convertible instruments, but excluded from primary capital.
	intangible assets <sup>2</sup>	Generally these assets represent the purchase price of firms that have been acquired in excess of their book value.



Table 1 (Continued)

	Item	Description
<b>SECONDARY CAPITAL MEASURE</b>		
	limited life preferred stock <sup>3</sup>	Preferred stock with a maturity date.
Plus:	subordinated notes and debentures <sup>3</sup>	Debt obligations of issuer, with fixed maturity dates, that are subordinated to depositors in case of insolvency. Subordinated notes and debentures issued by depository institutions are not insured by the federal deposit insurance agencies.
	mandatory convertible instruments not eligible for primary capital <sup>4</sup>	See mandatory convertible instruments definition above.

<sup>1</sup>Only up to 20 percent of primary capital excluding mandatory convertible instruments.

<sup>2</sup>The FDIC and OCC subtract *all* intangible assets except for purchased mortgage servicing rights. The FED subtracts only the "goodwill" portion of intangible assets.

<sup>3</sup>The limited life preferred stock and subordinated notes and debentures included in secondary capital must have an original weighted average maturity of at least seven years. All three federal banking agencies limit the aggregate amount of secondary capital to less than 50 percent of the amount of a bank's primary capital.

<sup>4</sup>The amount that exceeds 20 percent of primary capital excluding mandatory convertible instruments; equity commitment notes excluded from primary capital.

## A Brief History of Capital Adequacy Standards

Before December 1981, there were no uniform policies on capital adequacy among the three federal bank regulators. Minimum capital requirements applied only to the minimum *dollar* amounts of capital necessary for new banks. None of the regulators had formally stated minimum requirements for the ratio of total capital to total assets. Instead, each regulator typically compared capital ratios for banks grouped together by common characteristics, including asset size, and attempted to persuade those banks that had relatively low capital ratios to raise them.

In December 1981, the three federal banking agencies announced minimum primary capital ratios for the banking organizations that they regulate. The FDIC set its minimum primary capital standard at 5 percent. The OCC and the FED adopted primary capital standards of 5 percent for banks and bank holding companies with total assets of \$1 billion or more (called regional banks) and 6 percent for smaller banks and bank holding companies (called community banks). This dichot-

omous capital standard largely reflected the actual differences in average capital ratios that existed when the standards were adopted. No minimum capital ratios were established at that time for the 17 largest banking organizations (termed multinationals). Instead, their capital adequacy, as judged by the appropriate regulatory agency, depended on the unique characteristics of each organization.

The OCC and the FED also announced total capital standards at this time for regional and community banking organizations. A regional bank was considered under-capitalized if its total capital ratio was less than 5.5 percent, marginally capitalized if it ranged between 5.5 and 6.5 percent, and adequately capitalized if it exceeded 6.5 percent; the total capital standards for community banks were 0.5 percent higher for each category.

In June 1983, the FED and the OCC specified minimum capital standards for the 17 multinational banking organizations that were identical to those previously announced for regional banks.



Table 2

### Capital, Assets and Capital Ratios for U.S. Commercial Banks: December 31, 1984, Report of Condition

	Number of Banks	Capital (billions of dollars)		Assets (billions of dollars)	Average Capital Ratios		Aggregate Capital Ratios	
		Primary	Total	Total	Primary	Total	Primary	Total
All U.S. Commercial Banks	14,404	\$174.3	\$180.1	\$2,443.3	11.0%	11.0%	7.1%	7.4%
By Asset Size:								
Less than \$25 million	5,501	8.3	8.4	78.0	14.5	14.5	10.6	10.8
\$25 million to \$300 million	8,162	49.8	50.5	583.6	8.9	9.0	8.5	8.7
\$300 million to \$1 billion	466	17.8	18.3	232.2	7.7	7.9	7.7	7.9
\$1 billion to \$5 billion	209	28.3	29.6	413.4	6.9	7.2	6.8	7.2
Greater than \$5 billion	66	70.1	73.3	1,136.0	6.4	6.7	6.2	6.5

The new minimum ratio for total capital is 6 percent of adjusted total assets. The FED continues to use "zones" for total capital ratios; however, it has eliminated the differences that previously existed between the smaller and larger banks. The FED considers banks to be "under-capitalized" if their total capital ratios are less than 6 percent, "marginally capitalized" if their total capital ratios lie between 6 and 7 percent, and "adequately capitalized" if their total capital ratios exceed 7 percent. These changes affect only the larger banking organizations with assets exceeding \$1 billion; smaller banking organizations already were subject to these standards.

These new standards for capital adequacy represent minimum capital ratios for all commercial banks. The federal banking regulators will require specific banks to meet higher capital ratios if they have high off-balance-sheet exposure or if their assets are considered to be relatively risky — that is, to have relatively high probability of significant declines in value.<sup>7</sup>

### A BRIEF LOOK AT THE U.S. COMMERCIAL BANKING INDUSTRY

Before describing the impact of the new capital standards on the U.S. commercial banking industry, it is first necessary to describe the industry itself in brief detail. The latest statistics covering the capital, assets and capital-asset ratios for U.S. commercial banks are shown in table 2. There are several key points that will prove useful when assessing the impact of the new

capital standards on individual banks and the banking industry.

First, for the banking industry as a whole, the primary and total capital ratios are well above the minimum standards established by the bank regulatory agencies. The *average* primary capital ratio (that is, the sum of the individual banks' primary capital ratios divided by the number of banks) for the 14,404 banks is 11 percent; the average total capital ratio is also 11 percent. An alternative way to assess the capital adequacy of the banking system is to divide the total amount of capital (primary or total capital) of all banks by the total quantity of adjusted total assets of all banks. This global view of capital adequacy yields the *aggregate* capital ratios shown in the last two columns of table 2. Although these aggregate capital ratios (7.1 percent for primary capital and 7.4 percent for total capital) for the entire banking system are considerably lower than the banks' average capital ratios, they are still comfortably above the new minimum capital adequacy standards.

The reason for the large disparity between the average and aggregate capital ratios for banks is clearly discernible when the banks are divided into the selected asset-size categories shown in table 2. The distribution of the banking system's capital and assets is highly skewed among the 14,404 U.S. commercial banks. The 66 largest banks hold about 41 percent of total capital and 46 percent of the total assets of the U.S. banking system; they also have the lowest average capital ratios. In contrast, the 13,663 banks (95 percent of the total number of banks) in the two smallest asset-size categories hold only about 33 percent of the capital and 27 percent of the total assets of the banking

<sup>7</sup>For one recent FDIC directive for greater-than-minimum capital ratios, see Luke (1985).



system; these small banks have the highest average capital ratios.

The broad conclusion that emerges from the data in table 2 is that the new capital standards seem unlikely to produce substantial changes in the U.S. banking industry as a whole. The average and aggregate capital ratios exceed the new minimum standards by wide margins. However, the data suggest that, since capital ratios decline as bank size increases, larger banks are likely to be affected by these standards to a greater degree than the smaller banks.

## SOME EFFECTS OF THE NEW BANK CAPITAL STANDARDS

Bank data from the December 31, 1984, Report of Condition for U.S. commercial banks were used to assess the impacts that the new standards would have had if they had been in effect at that time. Of the 14,404 banks analyzed, only 419 had capital ratios that fell below the new standards. Selected statistics for these capital-deficient banks are presented in table 3.

The 419 capital-deficient banks hold about 14 percent of the capital and 18 percent of the assets of the entire banking system. While only 3 percent of all banks do not meet the new standards, about 13 percent of the banks with assets of \$1 billion to \$5 billion and more than 21 percent of the banks in the largest asset size category are capital-deficient. Moreover, the 14 largest capital-deficient banks hold about 78 percent of the capital and assets of all deficient banks as a group.

There are several ways that capital-deficient banks can bring their capital ratios into line with the minimum standards specified by the bank regulators. Two such methods are considered in the last four columns of table 3. The purpose of these calculations is to present some estimates of the magnitude of the adjustments to capital or liabilities that these banks face in achieving the minimum capital standards.

One way in which capital-deficient banks can raise their capital ratios would be to increase their capital (and assets). These adjustments could involve selling new shares, retaining a greater amount of earnings or selling existing assets that have been carried on their books at below-market values.<sup>8</sup> These adjustments would increase both capital and assets by equal

amounts, leaving liabilities unchanged. The increases in bank capital necessary to achieve the new minimum standards are shown in the next-to-last column of table 3. The required additions to total capital are divided into the minimum amounts of primary capital and the maximum amounts of secondary capital that would be consistent with provisions of the new capital requirements on the composition of total capital.

To bring their capital ratios up to the minimum standards, the capital-deficient banks would have to raise slightly less than \$1.8 billion. This represents only a 1 percent increase in the capital of the entire banking industry and about a 7.4 percent increase in the capital of the deficient banks. The 14 largest deficient banks would have to raise the lion's share of this additional capital — nearly \$1.1 billion.

Although the larger banks face the largest prospective *dollar* increases in capital, the relative magnitudes of the increases are greater for the smaller banks with deficient capital. The largest deficient banks would have to increase their total capital by about 6 percent. For deficient banks in the smallest size class, however, the necessary increase is about 23 percent.

There is growing interest in the use of secondary capital sources for raising new capital.<sup>9</sup> Many banks may consider issuance of debt instruments to be a less costly way of raising capital than selling stock. Banks avoid diluting the shares of existing stockholders when they issue debt instruments. This option, however, is available primarily to the 14 largest deficient banks, which could raise up to 83 percent of the capital they need from secondary sources.<sup>10</sup> In contrast, the remaining 405 capital-deficient banks must use primary capital sources for at least 71 percent of the capital they need.<sup>11</sup>

The last column in table 3 shows what the deficient banks would have to do if they chose to raise their capital ratios by shrinking their assets and liabilities, while holding their capital unchanged. If these assets were sold to nonbank firms, the banking industry's assets would decline by \$28 billion, or slightly more than 1 percent; the assets of the deficient banks would

<sup>8</sup>For discussions of the use of subordinated debt to meet the new capital standards, see Horvitz (1984), Rose (1985) and Childs (1985).

<sup>10</sup>This analysis applies only to the primary and secondary capital of commercial banks. If banking organizations adjust to the new capital requirements by issuing more capital securities, most of those capital securities sold to the nonbank public will be issued by the holding companies that own the banks with deficient capital.

<sup>11</sup>Some analysts have questioned the ability of smaller banks to use secondary capital sources; see, for example, Ostrowski (1985).

<sup>8</sup>For recent results of such sales, see Thompson, Wilson and Frank (1984) and Advertisement (1985).



decline by about 6.6 percent. Again, as noted above, the 14 largest banks would bear the largest share of the asset reductions — over 60 percent.

Several general conclusions emerge from the data in tables 2 and 3. The new minimum capital standards will affect only a small proportion of all U.S. commercial banks — slightly less than 3 percent. For the industry as a whole, the standards can be met by relatively minor percentage increases in capital or reductions in assets and liabilities. The 419 deficient banks would have to raise nearly \$1.8 billion in new capital to satisfy the minimum standards; alternatively, they could reduce their assets and liabilities by \$28 billion. Either approach would result in changes of about 7 percent in their capital or asset holdings, respectively. The bulk of these capital or asset adjustments, however, is concentrated in the 14 largest capital-deficient banks, which would have to raise about \$1.1 billion in new capital or reduce their assets and liabilities by nearly \$17 billion.

## SOME EVIDENCE ON RECENT CHANGES IN BANK CAPITAL

Banks have raised their capital substantially in recent years. The remaining increase in capital necessary to meet the new requirements is small relative to these recent capital increases. One recently published survey reported that U. S. commercial banks raised \$10.2 billion in 1983 and \$12.5 billion in 1984 via stock or debt financing; banks with assets of more than \$5 billion raised nearly \$12 billion (96 percent of the total capital raised by all banks) in 1984.<sup>12</sup> The OCC estimates that, over the three-year period ending on December 31, 1983, national banks added about \$2.3 billion per year to their capital accounts from retained earnings and additions to loan loss reserves alone.<sup>13</sup>

The impact of the recent changes in bank capital in terms of capital adequacy under the new standards can be estimated by applying the new capital standards to the March 31, 1984, Report of Condition data and measuring the changes in bank capital (and potential bank capital deficiencies) that have occurred from March 31 to December 31, 1984.<sup>14</sup> When analyzed

in this fashion, U. S. commercial banks raised their total capital by \$16.3 billion from the end of March to the end of December 1984; in so doing, the number of potentially capital-deficient banks fell from 501 to 419.

## SOME POTENTIAL EFFECTS OF THE NINE PERCENT BANK CAPITAL STANDARD

There have been suggestions recently that even higher bank capital standards might be desirable.<sup>15</sup> One prospective standard that has received considerable attention lately has been the "nine percent capital solution": a total capital standard of nine percent, with primary capital equal to at least six percent of adjusted total assets.<sup>16</sup> The results of applying this standard to U.S. commercial banks, using the December 31, 1984, Report of Condition, are shown in table 4.

The nine percent capital standard would significantly affect the banking system if it were to be adopted in the near future. More than half of all banks currently would fail to meet this standard. Moreover, the deficient banks hold about 80 percent of the banking system's capital and about 87 percent of its assets. The basic problem facing the industry is that the nine percent standard greatly exceeds the banking system's present capital-asset structure. As was noted earlier (see table 2), the aggregate total capital ratio for the entire banking industry is only 7.4 percent, well below the 9 percent level.

The additional capital that would be needed to meet the nine percent standard, as shown in table 4, is about \$52 billion. This represents a 29 percent increase from the present industry level; almost 95 percent of the increase, however, could be met from secondary capital sources.

To put this figure into perspective, we noted earlier that the banking system increased total capital by about \$16 billion from March to December of last year. It would take about two and one-half years of similar

<sup>15</sup>For example, Sen. William Proxmire recently suggested that banks should be required to meet a 10 percent capital requirement. See Bureau of National Affairs (1985).

<sup>16</sup>A suggestion for a capital standard of 9 to 11 percent was included in a recent study by the Administration's Cabinet Council on Economic Affairs Working Group on Financial Institutions Reform. See Department of the Treasury (1985). On May 6, 1985, the Board of Directors of the FDIC requested public comment on the 9 percent total capital requirement for all FDIC-insured banks. For comments on the higher capital standards, see Noble (1985) and Wallace and Reimer (1985).

<sup>12</sup>See "Banks' Financings Rose . . ." (1985). These capital issues were primarily sold by the bank holding companies, not by individual subsidiary banks.

<sup>13</sup>See *Federal Register* (1985).

<sup>14</sup>The Report of Condition for March 31, 1984, is the first to include the information necessary to calculate the capital ratios as measured under the new standard for capital adequacy.



Table 3

**Analysis of U.S. Commercial Banks That Do Not Meet the New Capital Standards:  
December 31, 1984, Report of Condition**

	Number of Banks Deficient In		Total Number of Deficient Banks	Capital (millions of dollars)		Assets (millions of dollars)	Increase In Capital Needed To Achieve New Standards (millions of dollars)			Decrease in Assets Needed to Achieve New Standards (millions of dollars)	
	Primary Capital	Total Capital		Primary	Total		Total	Minimum Primary Capital	Maximum Secondary Capital		Total
All Banks	242	398	419	\$23,767.8	\$24,319.8	\$430,448.0	\$676.1	\$1,114.2	\$1,790.3	\$28,477.5	
By Asset Size:											
Less than \$25 million	63	105	108	81.2	83.4	1,671.4	13.8	5.4	19.2	306.0	
\$25 million to \$300 million	141	223	233	946.0	969.7	18,849.1	119.3	63.2	182.5	2,929.7	
\$300 million to \$1 billion	17	34	36	943.1	991.6	18,243.5	93.6	43.8	137.4	2,200.0	
\$1 billion to \$5 billion	16	24	28	2,977.8	3,183.6	57,128.7	264.3	91.6	355.8	5,799.3	
Greater than \$5 billion	5	12	14	18,819.7	19,061.6	334,555.0	185.2	910.2	1,095.4	17,242.5	

Table 4

**Analysis of Deficient U.S. Commercial Banks Under the Proposed Nine Percent Capital Standard:  
December 31, 1984, Report of Condition**

	Number of Banks Deficient In		Total Number of Deficient Banks	Capital (millions of dollars)		Assets (millions of dollars)	Increase In Capital Needed To Achieve Nine Percent Standard (millions of dollars)			Decrease in Assets Necessary to Achieve Nine Percent Standard (millions of dollars)	
	Primary Capital	Total Capital		Primary	Total		Total	Minimum Primary Capital	Maximum Secondary Capital		Total
All Banks	498	7,668	7,668	\$138,155.0	\$143,275.0	\$2,114,876.0	\$2,752.1	\$48,951.8	\$51,704.0	\$522,935.0	
By Asset Size:											
Less than \$25 million	115	2,089	2,089	2,520.7	2,533.4	32,771.4	20.4	436.7	457.0	4,622.0	
\$25 million to \$300 million	266	4,938	4,938	28,946.9	29,413.1	388,870.0	201.6	5,931.7	6,133.3	62,057.7	
\$300 million to \$1 billion	48	387	387	13,635.9	14,049.7	194,842.0	172.1	3,654.4	3,826.5	38,734.7	
\$1 billion to \$5 billion	40	190	190	24,951.9	26,021.2	379,495.0	518.3	8,413.3	8,931.6	90,370.3	
Greater than \$5 billion	29	64	64	68,099.1	71,257.2	1,118,897.0	1,839.8	30,515.8	32,355.5	327,150.0	



increases, while keeping liabilities unchanged, for the banking system to adjust to the nine percent capital standard.

Because the capital ratios generally decline as bank size increases (table 2), the largest banks would have to raise the biggest percentage of the total capital needed. In the largest size category, 64 (of 66) banks would be deficient; they would have to raise more than \$32.4 billion in new capital, an increase of 44 percent. In contrast, only about 38 percent of the banks in the smallest asset size category would be deficient; the \$457 million they would have to raise represents only a 5 percent increase in their capital.

The last column in table 4 shows that, if banks leave their capital unchanged, they would have to reduce their assets and liabilities by about \$523 billion. In other words, the banking industry would shrink by more than 21 percent. The 64 largest deficient banks would have to reduce their assets by nearly 29 percent (\$327 billion).

## SUMMARY

The U.S. banking industry can meet the new capital standards recently announced by the nation's three federal banking regulatory agencies with relatively small changes in capital or assets. As of December 31, 1984, slightly less than 3 percent of all U.S. commercial banks did not meet the minimum capital standards for all commercial banks recently adopted by the Federal Deposit Insurance Corporation, the Federal Reserve and the Office of the Comptroller of the Currency. Deficient banks can meet these standards by raising about \$1.8 billion in new capital or reducing their assets (and liabilities) by slightly more than \$28 billion. Neither of these alternatives (nor some combination of these changes that would achieve the same result) represent significant changes in the capital/asset structure of the banking system; the necessary changes in assets and liabilities or capital represent only about 1 percent of the amounts held by U.S. commercial banks.

On the other hand, the 9 percent total capital standard that has been recently proposed would require considerable adjustment by the banking system if it were imposed in the near future. The capital ratios of more than half of all banks currently fall below the 9 percent standard; indeed, in the aggregate, the U.S. banking system's total capital ratio is only slightly above 7 percent. To meet the 9 percent capital standard, deficient banks would have to raise

about \$52 billion in new capital or reduce their assets and liabilities by about \$523 billion. Thus, either U.S. bank capital would have to rise by nearly 29 percent, or the assets of the U.S. banking industry would have to shrink by more than one-fifth.

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# Monetary Stabilization Policy: Evidence from Money Demand Forecasts

R. W. Hafer

**E**STIMATED money demand relationships are a key ingredient in the formulation of monetary policy. Recently, some analysts have argued that financial innovations have rendered the money demand relationship unstable. Because of this, intermediate monetary targeting — a policy that is based on the predictability of money demand — has been viewed as a dubious policy procedure to follow.<sup>1</sup>

In this article, we investigate the stability of two commonly estimated money demand functions. Specifically, we examine whether there has been a statistically significant change in the estimated relationships between those found for the period 1960–79 and those for the period 1960–84.

We also examine the forecasting ability of the two models. To do this, the equations are estimated over the 1960–79 sample and are used to generate quarterly forecasts for the 1980–84 period. By observing the forecast errors in conjunction with the stability test results, we can better assess the validity of the recent arguments against monetary targeting.

## ESTIMATING SHORT-RUN MONEY DEMAND

An extensive literature exists on the appropriate

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<sup>1</sup>For example, Higgins and Faust (1981), p. 17, note that financial innovations create an atmosphere in which "it may be necessary to reevaluate the desirability of using monetary targets to achieve ultimate policy objectives." In this vein, Davis (1981), p. 24, suggests that "perhaps more subtle and pervasive questions about the desirability of pursuing rigorously monetary growth targets are raised by questions about the stability of the 'demand for money'."

form of the short-run money demand function.<sup>2</sup> To investigate the issue of money demand stability, we have chosen two common specifications. These are

$$(1) \ln(M/P)_t = \alpha_0 + \alpha_1 \ln y_t + \alpha_2 \ln R_t + \alpha_3 \ln(M/P)_{t-1} + \varepsilon_t,$$

and

$$(2) \ln(M/P)_t = \alpha'_0 + \alpha'_1 \ln y_t + \alpha'_2 \ln R_t + \alpha'_3 \ln(M_t/P_t) + \varepsilon'_t,$$

where  $M$  = nominal M1,

$P$  = the price level measured by the GNP deflator (1972 = 100),

$y$  = a scale variable represented by real GNP (\$1972),

$R$  = a nominal market rate of interest, measured by the commercial paper rate, and

$\varepsilon$  = a random error term.

Equations 1 and 2 are the so-called real and nominal adjustment specifications, respectively. These two equations differ in that the real adjustment specification assumes that individuals adjust their actual real money balances to their desired level. The nominal adjustment specification, on the other hand, assumes that individuals adjust their nominal money balances to their desired level. Although the two equations appear equivalent except for the adjustment variable, the dependent variable in equation 2 actually is the logarithm of nominal money.<sup>3</sup> Because there is no consensus on which of these two specifications is correct, both are used.

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<sup>2</sup>For a survey of the literature, see Laidler (1977).

<sup>3</sup>Thornton (1985) discusses this point and provides a more complete discussion of the derivation of the two money demand specifications.



Table 1  
Money Demand Estimates

Variables	I/1960–IV/1979		I/1960–IV/1984	
	Real	Nominal	Real	Nominal
$\Delta \ln y_t$	0.168 (3.10)	0.151 (3.20)	0.239 (3.32)	0.187 (2.82)
$\Delta \ln R_t$	-0.015 (2.60)	-0.015 (3.06)	-0.013 (1.77)	-0.014 (2.22)
$\Delta \ln (M/P)_{t-1}$	0.533 (5.37)	—	0.309 (3.04)	—
$\Delta \ln (M_{t-1}/P_t)$	—	0.679 (7.70)	—	0.526 (5.27)
$\bar{R}^2$	0.432	0.559	0.241	0.353
SE	2.219	1.956	3.318	3.063
Dh	-0.30	-0.70	N.A. <sup>1</sup>	N.A. <sup>1</sup>

NOTE:  $\bar{R}^2$  is the coefficient of determination adjusted for degrees of freedom; SE is the regression standard error; and Dh is the Durbin h-statistic for autocorrelation.

<sup>1</sup>The h-statistic could not be calculated. The relevant Durbin-Watson statistics are 2.15 for the real adjustment specification and 2.43 for the nominal.

A number of studies have found that the estimated coefficients in equations 1 and 2 are statistically unstable when estimated across the mid-1970s. This instability has been ascribed to a variety of causes, including large changes in the price level, a wealth loss due to OPEC oil shocks, changes in financial management techniques and more.<sup>4</sup> It has been shown, however, that this instability of the *level* version is reduced greatly when the equation is estimated in first-difference form, at least up to 1980.<sup>5</sup> The general use of differencing has been suggested by Granger and Newbold (1974) and Plosser and Schwert (1978) to achieve stationarity and to reduce the possibility of a spurious regression result. On this point, a recent study by Layson and Seaks (1984) presents evidence indicating that the first-difference version of the money demand specification is statistically preferable to its level form.

Based on these findings, therefore, we use the first-difference versions of equations 1 and 2 in this study. Thus, the equations estimated and analyzed in this article are:

$$(3) \Delta \ln (M/P)_t = \beta_1 \Delta \ln y_t + \beta_2 \Delta \ln R_t + \beta_3 \Delta \ln (M/P)_{t-1} + \phi_t$$

$$(4) \Delta \ln (M/P)_t = \beta'_1 \Delta \ln y_t + \beta'_2 \Delta \ln R_t + \beta'_3 \Delta \ln (M_{t-1}/P_t) + \phi'_t$$

### Estimation Results

Equations 3 and 4 are estimated for two sample periods: I/1960–IV/1979 and I/1960–IV/1984. The split at 1980 is used to determine the stability of the model during the past five years, a period of substantial financial market change. The question addressed is whether the results from the earlier period are statistically different from those of the latter.<sup>7</sup>

The results of estimating equations 3 and 4 are presented in table 1. Looking at the 1960–79 results, the estimated short-run income and interest rate elasticities are similar across specifications. The estimated coefficient on lagged money balances in equation 3 is

<sup>6</sup>Note that the constant term does not appear in the first-difference equations. This is due to the algebraic manipulation of the level equation to generate the first-difference model. It should be noted, however, that incorporating a constant term into the first-difference equation represents a time trend variable from the level equation. Estimating the first-difference equations with the constant term found it to be insignificantly different from zero.

<sup>7</sup>The estimation properties of the (real) equation for the 1960–79 period are presented in Hafer and Hein (1982).

<sup>4</sup>A survey of the relevant literature is presented in Judd and Scadding (1982) and Roley (1985).

<sup>5</sup>This finding initially was reported in Hafer and Hein (1982).



**Table 2**  
**Stability Test Results**

Specification	Test statistics for:	
	Coefficient stability	Homoskedasticity
Real adjustment	4.18	37.72
Nominal adjustment	2.68	45.86

NOTE: The test statistic is distributed as a  $\chi^2$  with three degrees of freedom. The 5 percent critical value for these tests is 7.82.

0.533, implying an adjustment speed of 47 percent per quarter. For the nominal adjustment model, the estimated coefficient is 0.679, which yields an adjustment coefficient of 32 percent per quarter.<sup>8</sup>

The differences in the estimated adjustment speeds produce different long-run income and interest rate elasticities. The long-run income elasticity from the real specification is 0.36; from the nominal model it is 0.47. Each estimate is slightly less than values reported in previous studies.<sup>9</sup> The differences are especially noticeable in the long-run interest elasticities: the long-run interest elasticity from the real model is  $-0.032$ , while that from the nominal model is  $-0.047$ .

When the equations are estimated for the full 1960–84 period, some notable changes occur in the coefficient estimates. In each equation, the estimated short-run income elasticity increases in value, while the estimated coefficient on the lag term declines. Interestingly, the estimated short-run interest elasticities are little changed by the increased sample data.

## ARE THE MODELS STABLE?

Comparing the two equations across the two sample periods indicates a substantial increase in the regression standard error. This increase suggests that the equations may not be statistically stable; that is, the estimated statistical relationship may have changed significantly across the sample.

To examine this issue, each equation was tested for stability of the estimated coefficients and for stability of the error structure. This dichotomy is important,

because tests for coefficient stability in the presence of heteroskedasticity can be misleading.<sup>10</sup> Consequently, two test statistics are reported for each specification. One tests for coefficient stability, allowing the variance to change; the other tests for constant variance, with the coefficients allowed to change. The relevant test statistics are reported in table 2.

The results for each specification indicate that we cannot reject the hypothesis that the estimated coefficients are statistically constant across the 1979 break. Each of the calculated chi-squared statistics is well below the 5 percent critical value. The results of testing for homoskedastic errors indicates, however, that we can easily reject the hypothesis of constant variance over the two periods. This outcome suggests that the exogenous influences affecting the error term have changed between the two periods.

The stability evidence indicates that, contrary to some recent findings, the estimated coefficients of the real and nominal adjustment models of money demand have not changed significantly during the past five years when compared with those from the 1960–79 sample.<sup>11</sup> The question to which we now turn is, why has the variance of the estimate relationships changed? To do this, we examine the models' forecast errors for the post-1979 period.

<sup>10</sup>See Thornton for a related discussion on this point and the likelihood ratio tests used here.

<sup>11</sup>Thornton recently has reported that there is some evidence of instability for the real and nominal adjustment models. It should be noted, however, that his tests are based on the level specification. Also, his estimated equations include the passbook savings rate as an additional explanatory variable. Even with these differences, however, his parameter stability test results for the nominal adjustment model without the passbook rate estimated over the 1962–84 period indicate that stability cannot be rejected at the 5 percent level of significance.

Gordon (1984), on the other hand, reports the first-difference model to be unstable, based on a simple F-test. The reported test results examine the overall fit of the model. It is possible to test the stability of each coefficient over the 1979 break through the use of dummy variables. Let  $D1 = 1$  for I/1960–IV/1979 and zero elsewhere, and  $D2 = 1$  for I/1980–IV/1984 and zero elsewhere. Forming interaction terms with the right-hand-side variables, we may test the difference between coefficients estimated for each subsample. Testing the null hypothesis of coefficient equality, the absolute value of the calculated t-statistics for the real adjustment model variables are: income — 1.50; commercial paper rate — 0.14; and lagged term — 2.22. The t-statistics from the nominal adjustment model are: income — 0.92; commercial paper rate — 0.02; and lagged term — 1.68.

This evidence suggests that the lagged term in the real-adjustment model has changed. In contrast, none of the coefficients in the nominal adjustment model have changed, providing some basis for the preference of this version. It should be noted, however, that this test procedure does not account for changes in the error variance.

<sup>8</sup>For a critical interpretation of such results, see Goodfriend (1985).

<sup>9</sup>For a comparison with previous results, see Judd and Scadding (1982).



## FORECASTING MONEY DEMAND: 1980-84

A computationally convenient procedure to examine the post-1979 forecast results for each specification is suggested by Dufour (1980, 1982). This technique uses separate (0, 1) dummy variables entered for each individual observation beyond a selected break point. In the present example, a dummy variable D1 was entered as 1.0 for I/1980 and zero elsewhere; D2 was entered as 1.0 for II/1980 and zero elsewhere; and so on through IV/1984. When added to equations 3 and 4 and estimated over the full 1960-84 sample period, the estimated coefficients on the dummy variables represent post-sample static forecast errors. Moreover, the t-statistic for each dummy variable provides information about which forecast error significantly departs from the 1960-79 regression model. Thus, by examining the estimated coefficients on the dummy variables for the I/1980-IV/1984 period, we can determine the magnitude of the forecast error and determine the sign pattern of the errors.<sup>12</sup>

On this last point, we especially are interested in whether there are transitory errors — errors that alternate in sign — or whether the errors are generally one-sided. Significant transitory errors suggest that the model is subject to random shocks that are larger during the forecast period than the average squared error experienced during the estimation sample. A forecast error pattern that has consistently significant, one-sided errors, however, suggests that the relationship embodied in the estimated model has changed from that in the estimation period.

To statistically investigate the nature of the forecast errors, it is informative to test whether the sum value of the forecast errors is statistically different from zero. If this hypothesis is rejected, the evidence would indicate that the forecast errors are offsetting in sign and magnitude.

The estimated dummy variable coefficients and t-statistics for both the real and nominal adjustment models are reported in table 3.<sup>13</sup> The evidence for the real adjustment model indicates that there have been

several statistically significant departures from the regression model during the past five years. The first two are in II/1980 and III/1980, when special credit controls were initiated by the Carter administration. These errors are by far the largest; more important, however, is the fact that they are offsetting in sign and magnitude. This result is consistent with the notion that the credit control program had only a temporary effect on the money demand forecast errors.<sup>14</sup>

The remaining significant forecast errors are found mostly in 1981 and 1982. The errors in 1981 occur during the first three quarters, a period associated with the nationwide legalization of NOW accounts. More important is the result that the errors alternate in sign and are of approximately equal magnitudes. This also holds true for the errors found in the first two quarters of 1982. The forecast errors found in 1981 and 1982 corroborate previous findings about the increased variability of velocity growth during this period. The evidence here suggests that these errors were transitory.<sup>15</sup>

The forecast errors from the nominal adjustment specification follow a pattern similar to those from the real adjustment model. The sign pattern generally holds between the two error series, and the significant errors are located in the same periods, except for II/1983. In that quarter, the nominal adjustment model's forecast error (2.357), unlike that of the real adjustment model, is not statistically significant at the 5 percent level.

The F-statistic reported below each forecast series tests the hypothesis that the sum of the forecast errors is zero. The reported F-statistics are quite low and, as indicated by the significance levels reported in parentheses, do not permit rejection of the null hypothesis at any reasonable level of significance. Thus, finding that the sum of the money demand forecast errors from the real and nominal adjustment specifications are not different from zero corroborates the previous

<sup>12</sup>This procedure also is used by Hafer (1985) to investigate the stability of money demand during the 1920-39 period.

<sup>13</sup>The estimated coefficients on the other variables are not reported since, by construction of the test, they are identical to the 1960-79 estimates found in table 1.

<sup>14</sup>For relevant discussions of this finding, see Judd and Scadding (1981) and Hein (1982). Indeed, our evidence suggests that large fluctuations in the nominal money stock, such as those associated with the credit control period, may explain observed errors in the money demand model. Such a theory is suggested by Carr and Darby (1981).

<sup>15</sup>See Tatom (1983), Judd and Motley (1984), Hafer (1984a, b) and Gordon (1984) for discussions of this period. Interestingly, the signs of the forecast errors during this period do not conform with those predicted by some financial innovation arguments.

For a discussion of how financial innovations have influenced money demand estimates in Japan, see Suzuki (1984).



Table 3  
Estimates of Post-1979 Forecast Errors

Variables	Real		Nominal	
	Estimates	t-statistic	Estimates	t-statistic
I/1980	-1.532	-0.68	0.357	0.18
II	-12.314	-5.31*	-11.211	-5.49*
III	13.613	5.25*	14.358	6.48*
IV	-1.520	-0.62	-0.923	-0.43
I/1981	-8.922	-3.92*	-8.991	-4.49*
II	6.657	2.84*	4.924	2.48*
III	-8.013	-3.60*	-6.098	-3.10*
IV	0.055	0.02	-0.185	-0.09
I/1982	6.908	3.07*	4.891	2.48*
II	-4.678	-2.07*	-4.684	-2.36*
III	2.915	1.29	1.857	0.93
IV	9.689	4.16*	9.251	4.51*
I/1983	-1.358	-0.53	-2.072	-0.95
II	4.696	2.04*	2.357	1.14
III	1.482	0.63	0.558	0.27
IV	-2.883	-1.24	-2.983	-1.48
I/1984	-0.617	-0.27	-0.704	-0.35
II	1.751	0.78	0.908	0.46
III	-1.112	-0.50	-1.137	-0.58
IV	-1.658	-0.73	-2.487	-1.23
F	0.094 (0.76)		0.048 (0.83)	

\*Denotes significance at 5 percent level.

result of stable coefficient estimates.<sup>16</sup>

## POLICY IMPLICATIONS

The empirical evidence suggests that the relationship between the growth of money balances and its economic determinants is more stable than some have argued. Although there is evidence of large post-

<sup>16</sup>In determining the significance of the individual dummy variables, it should be noted that they are being compared with the regression model estimated through IV/1979. In this way, the large forecast errors do not influence the two-standard-error interval used to locate the significant forecast errors.

It may be argued that the evidence on the sum of the forecast errors holds only over the long period forecasted and that the use of selected subperiods would show the average error not to be zero. This argument misses the point: because there always are short-term forecast errors, some of which can be "large," policies that attempt to exploit such quarterly deviations from forecasts may fail to achieve desired longer-term monetary policy goals. Because the longer-term results indicate that the errors average to zero over time, a longer-view policy may better achieve desired longer-term goals, such as price stability and income growth.

1979 forecast errors, these errors are transitory and the sum of the forecast errors is not statistically different from zero. This evidence suggests that monetary policies relying on quarter-to-quarter forecasts of money demand growth may not fare well because of the random, unpredictable component inherent in the estimated relationship. It also suggests, however, that the secular relationships embodied in the money demand function may be exploited successfully by emphasizing long-run money growth and GNP growth objectives.<sup>17</sup>

<sup>17</sup>This conclusion also is reached by Hein and Veugelers (1983) in their study of velocity. In that article, the predictability of the quarter-to-quarter growth of M1 velocity was examined. Their evidence indicated that, on a quarterly basis, velocity growth fluctuated randomly about a fixed mean. As the forecast horizon was extended, the accuracy of the forecasts improved. Thus, in the context of a simple quantity theory model, given some desired growth for nominal income, determining the correct growth for money based on a forecast of velocity (or money demand) will be successful only for horizons longer than one or two quarters.



## CONCLUSION

In this article, we have presented evidence indicating that the estimated coefficients from two common short-run money demand specifications are statistically stable across the 1960–84 period. Using IV/1979 as the hypothesized break point, we could not reject the hypothesis of stable coefficients. We also presented evidence showing that the estimated residuals have not remained constant over this time period. Further testing indicated that the reason for this heteroskedasticity stems from the large errors experienced by each equation primarily during the turbulent 1980–82 period.

Although the evidence reveals large quarterly forecast errors during the past five years, the results also show that these errors are offsetting in sign and magnitude. In fact, the sum of the forecast errors from each model is not statistically different from zero. This result substantiates previous findings from studies of velocity growth in which the forecast accuracy improved as the forecast horizon was lengthened. In this vein, arguments that monetary targeting to achieve the long-term goals of stable income growth and price stability has become useless because of purported money demand instability are not supported by the evidence.

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# Money, Income and Currency Substitution: Evidence from Three Countries

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A NUMBER of studies have demonstrated a relatively close empirical relationship between changes in a transaction-based measure of money and changes in nominal income. This relationship, found for a variety of economies, suggests that monetary policymakers can directly influence the path of nominal income over time by changing the growth of the domestic money stock.<sup>1</sup>

It has been argued recently, however, that the relationship between domestic money growth and economic activity may be affected by external factors.<sup>2</sup> If domestic residents consider domestic and foreign currencies (or other financial assets) as relatively close substitutes, for example, then changes in relative preferences for domestic and foreign assets will motivate them to reallocate their portfolios. This portfolio adjustment will affect the domestic demand for all assets, including domestic money.<sup>3</sup> This hypothesis, known as currency substitution, suggests that, if the demand for domestic money is dependent *inter alia* on external factors, domestic money growth may not affect domestic economic activity to the degree anticipated by policymakers.

This article tests whether currency substitution has affected the relationship between domestic money

and economic activity (income) in the United States, Germany and Japan within the framework of a simple reduced-form model. These countries were chosen primarily because they are the most influential in international financial markets; indeed, some have suggested that their monetary policy actions should be coordinated.<sup>4</sup> A reduced-form model is used, because it is a convenient form for testing the relative impact of specific variables on economic activity. A sufficient condition for currency substitution to be important is that some measure of foreign influence — money growth or exchange rate movements — have a significant impact on domestic income after accounting for the impact of domestic money growth.<sup>5</sup>

## THE CONSEQUENCES OF CURRENCY SUBSTITUTION

In a world of freely floating exchange rates, domestic monetary authorities theoretically are insulated from monetary shocks from abroad. Because monetary authorities have no obligation to maintain their currencies' foreign exchange value, an expansion or contraction of one country's money supply does not necessitate automatic policy reactions by other nations. Instead, exchange rates fluctuate in response to relative movements in money supplies. Thus, monetary actions in one country do not necessarily impinge on the policy actions of another; each country is able to pursue its own domestic policy program.

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*Dallas S. Batten and R. W. Hafer are research officers at the Federal Reserve Bank of St. Louis. Paul G. Christopher provided research assistance. The authors would like to thank Jeff Bergstrand for his comments.*

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<sup>4</sup>This policy coordination scheme is attributed to McKinnon (1984).

<sup>5</sup>This condition is only sufficient in that foreign influences may affect domestic activity within the structural econometric specification, but may not be identifiable in the reduced-form specification that we have employed.

<sup>1</sup>See, for example, Batten and Hafer (1983).

<sup>2</sup>See Miles (1978), Brittain (1981) and McKinnon (1982).

<sup>3</sup>Within this context, one of the initial approaches to the investigation of currency substitution was within a money demand framework. See Batten and Hafer (1984a) and the references contained therein.



Some analysts argue that this insular property of floating exchange rates breaks down when there is currency substitution. If domestic residents hold portfolios containing both foreign and domestic assets and reallocate these portfolios according to changes in the relative opportunity costs (domestic vs. foreign) of these assets, foreign monetary shocks will alter the relative costs of holding a given portfolio and induce residents to reallocate their portfolios between domestic and foreign assets. This behavior changes the demand for domestic money and, as a result, changes the impact of any specific domestic money growth rate on the domestic economy. As one advocate of the currency substitution hypothesis has noted,

... currency substitution destabilizes the demand for individual national monies so that one can't make much sense out of year-to-year changes in purely national monetary aggregates in explaining cycles in purely national rates of inflation.<sup>6</sup>

## TESTING FOR CURRENCY SUBSTITUTION

Although several approaches have been used for tests of currency substitution, this article focuses on the impact of external factors on the velocity of domestic money, that is, the relationship between domestic money growth and the growth of nominal income.<sup>7</sup> In previous research, Radcliffe, Warga and Willett (1984) and McKinnon (1984) have employed a reduced-form model of domestic income growth to test for currency substitution with conflicting results: Radcliffe, Warga and Willett find little empirical support for the currency substitution hypothesis, while McKinnon finds that external factors have a rather substantial impact on U.S. economic activity. Both analyses, however, were conducted using annual data over the relatively short floating exchange rate period, 1972–83. Such a limited sample (12 observations) de-

creases the power of the statistical tests and, therefore, the confidence one can place in the results.

The tests conducted here extend their analyses in several ways: First, we use quarterly data in our study, which expands the sample for the floating exchange rate period to about 50 observations. Second, we specify a more complete reduced-form model before testing for the influence of international factors. In a previous paper, Batten and Hafer (1983) demonstrated that variables other than domestic money growth alone explain some of the variation in income growth across countries. Consequently, in addition to money growth, we test for the importance of including a measure of government expenditures as well.<sup>8</sup>

## Some Caveats on Empirical Tests of Currency Substitution

There is no consensus on the appropriate variable with which to capture the foreign influence presumed in the hypothesis of currency substitution. McKinnon (1982) argues that, since the demand for world money cannot be affected by changing compositions of international portfolios, the world money supply (or, alternatively, the domestic money supply plus the rest-of-world money supply) is a better predictor of domestic economic activity than domestic money growth alone.<sup>9</sup> An obvious problem with employing the growth rate of "world money" as a proxy for foreign influences is that it may simply reflect world economic activity that already affects the domestic economy through the normal channels of international trade. Specifically, an increase in foreign money growth may stimulate foreign demand for all goods and services, including the exports of the domestic country. In other words, although changes in the world money supply may appear to affect the domestic economy statistically, this result does not necessarily reflect currency substitution.

<sup>6</sup>McKinnon (1982), p. 320.

<sup>7</sup>For example, Miles investigates this issue through a CES production function in which monetary services are "produced" by both domestic-currency and foreign-currency real balances. The degree of currency substitution was measured by the elasticity of substitution between these two balances.

A second approach, mentioned above (fn. 3), is to examine whether the domestic demand for money is a function of external and internal factors. A third approach is to ask whether the rate of domestic inflation is dependent upon external factors (see McKinnon (1982)). This approach has been criticized by Batten and Hafer (1984b) and Radcliffe, Warga and Willett (1984). In this article, we have chosen a fourth approach, which is to investigate the significance of external factors on the growth of domestic income using a simple reduced-form model.

<sup>8</sup>In Batten and Hafer (1983), a distributed lag of the growth rate of exports also was included. This measure is not included in this study, however, to ensure that all of the foreign influences are being captured by the variables proxying for currency substitution. This may bias the test, but it does so in favor of finding a significant impact of currency substitution. When a distributed lag of export growth is added to equation 1, no evidence of currency substitution can be found. Consequently, as discussed below, the variables that have been offered as proxies for currency substitution may also reflect the impact that international trade has on domestic economic activity.

<sup>9</sup>McKinnon (1982) provides a rationale for employing the world money supply in lieu of any particular domestic money supply. Goldstein and Haynes (1984) and Spinelli (1983) argue that the appropriate test must involve the separation of the world money supply into its domestic and rest-of-world components.



In response to this line of criticism, McKinnon (1984) claims that the effective exchange rate is a preferable measure in tests of currency substitution.<sup>10</sup> In particular, he employs changes in the foreign exchange value of a currency as an indicator of changes in domestic money demand prompted by currency substitution.

There are, however, at least two objections to using changes in the effective exchange rate as a proxy for foreign-generated disturbances to domestic money demand.<sup>11</sup> First, exchange rates move in response to changes in both the domestic demand for money and real economic conditions, such as a supply shock.<sup>12</sup> Such changes in real conditions motivate changes in the relative price of one country's output in terms of the output of other countries, that is, a change in the relative price of traded to nontraded goods. Second, movements in the exchange rate also reflect changes in (1) the foreign demand for foreign money and (2) the policies followed by foreign monetary authorities. Furthermore, exchange rate stability may be a policy goal for some monetary authorities. Consequently, exogenous exchange rate movements may cause domestic policymakers to react and, hence, may affect domestic money growth.<sup>13</sup>

In sum, exchange rate changes frequently are motivated by events quite apart from currency substitution's impact on domestic money demand. Moreover, it is impossible to distinguish exchange rate movements due to these events from those due to changes in the demand for domestic money. These reservations should be kept in mind when assessing the empirical impact of these variables on the relationship between domestic money and domestic economic activity.

## EMPIRICAL RESULTS

The empirical model suggested in the preceding section takes the general form

$$(1) \dot{Y}_t = \alpha + \sum_{i=0}^I \beta_i \dot{M}_{t-i} + \sum_{j=0}^J \lambda_j \dot{G}_{t-j} + \varepsilon_t,$$

where  $\dot{Y}$  represents the annualized quarterly growth of domestic nominal income,  $\dot{M}$  is the annualized quarterly growth of the narrowly defined domestic money stock ( $M1$ ), and  $\dot{G}$  is the annualized quarterly growth of government expenditures.<sup>14</sup> The terms  $\alpha$ ,  $\beta_i$ , and  $\lambda_j$  are parameters to be estimated, and  $\varepsilon_t$  is an error term with the usual properties assumed.

Equation 1 represents the domestic reduced-form equation to which the variables that measure foreign influences can be added to test for the impact of currency substitution. Before such a test is conducted, however, the appropriate lags,  $I$  and  $J$ , must be determined. To do so, we use Akaike's final prediction error (FPE) criterion.<sup>15</sup> This criterion is based on a mean square error prediction norm and, therefore, may select lag structures that are not statistically significant using conventional significance levels.

Equation 1 was estimated over the period II/1972–II/1984 (III/1972–IV/1983 for Japan) using the FPE-selected lag structures. The regression results for the United States, Germany and Japan are reported in table 1. The U.S. results for money growth are fairly similar to those found by other studies: the summed effect of a change in money growth is significant and is not different statistically from unity ( $t = 0.11$ ). Within the framework of this reduced-form specification, changes in the growth of government expenditures have no impact on economic activity in the United States: the FPE criterion selected no lag structure for this variable.

The results for Germany also show money growth to have a significant long-run effect on income growth: the reported sum coefficient is 0.522. It is interesting to note that while the FPE procedure selects a relatively long lag for government expenditures, its cumulative impact is not statistically significant at the 5 percent level. These results are broadly consistent with those reported in Batten and Hafer (1983).

Finally, for Japan, the FPE procedure selects six lags on money growth and three lags on government expenditure growth. The results in table 1 indicate that both the cumulative impact of money growth and

<sup>10</sup>The effective exchange rate is the International Monetary Fund's 17-country exchange rate index with the weights derived from the IMF's multilateral exchange rate model. For details on its construction, see Artus and McGuirk (1981).

<sup>11</sup>See, for example, Mussa (1981).

<sup>12</sup>While real shocks do affect the demand for money through their impact on real income, they also affect relative prices and, hence, have independent effects of their own on exchange rates. See Stockman (1980).

<sup>13</sup>On this point, see Batten and Ott (1984).

<sup>14</sup>To remove the impact of cyclical changes, cycle-adjusted government expenditures could be employed to measure fiscal actions in the estimation of equation 1 for the United States. Because comparable measures of government expenditures are not available for Germany and Japan, federal government expenditures *not* adjusted for cyclical changes are employed for each country. It should be noted, however, that the results for the United States were invariant to the government expenditures series used.

<sup>15</sup>See Batten and Thornton (1984) for a discussion and application of this criterion.



Table 1  
Regression Estimates of Equation 1

Country/Sample	Estimated Coefficients (lags) for <sup>1</sup>			Summary Statistics <sup>2</sup>		
	Constant	$\bar{M}_1$	$\bar{G}_1$	$\bar{R}^2$	SE	DW
United States (II/1972–II/1984)	3.17 (1.39)	0.965*(2) (3.14)	—	0.14	4.59	1.61
Germany (II/1972–II/1984)	0.35 (0.21)	0.523*(6) (3.53)	0.200(8) (1.33)	0.41	3.54	2.16
Japan (III/1972–IV/1983)	−0.10 (0.08)	0.602*(6) (6.70)	0.225*(3) (2.87)	0.74	3.48	1.85

\*Statistically significant at the 5 percent level.

<sup>1</sup>Only summed coefficients are reported. Absolute values of t-statistics shown below each coefficient.

<sup>2</sup> $\bar{R}^2$  is the coefficient of determination adjusted for degrees of freedom; SE is the regression standard error; and DW is the Durbin-Watson test statistic.

the cumulative effect of government expenditure growth are significant. Moreover, the distributed lags on these variables alone explain almost 75 percent of the variation of nominal income growth during this period. This is five times the explanatory power of the U.S. equation and 80 percent more than the German equation.

### Rest-of-World Money Growth

The first proxy used in our test for currency substitution is the rest-of-world money stock (ROWM). In tests of currency substitution, it is assumed that the demand for world money is stable and changes in ROWM reflect substitution from the domestic currency to foreign currencies. For example, an increase in the growth rate of ROWM reflects a shift from domestic to foreign money, signalling a decrease in the demand for domestic money or, equivalently, an increase in its velocity. That is, increases (decreases) in ROWM growth should increase (decrease) the rate of growth of domestic income, *ceteris paribus*.

Two approaches can be taken to measure ROWM, both of which require some aggregation assumptions. One procedure, suggested by McKinnon (1982, 1984), uses the money growth rate series for each country in the rest-of-world sample to calculate a weighted average growth rate. In calculating this series, the individual country's weights are determined using the country's share of world nominal GNP in some base year, where world GNP and each country's GNP are specified in U.S. dollars. By using this fixed-weight approach, complications arising from continually fluctuating exchange rates are avoided. In the discussion that follows, this series is referred to as ROWMF.

An alternative to the fixed-weight approach is to convert all foreign money supplies into the relevant domestic currency equivalents, sum the values for each country to form a rest-of-world monetary aggregate, then calculate the latter's growth rate. This approach, advocated by Spinelli (1983), allows the relative country weights to vary across the sample period as exchange rates fluctuate. This series is referred to as ROWMV.

The ROWM growth series were generated using the country sample of Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom and the United States. Obviously, the ROWM growth series for each country uses the summed money supplies of the other countries in the sample.

To test statistically for the importance of ROWM growth on domestic income growth in the United States, Germany and Japan, a distributed lag of ROWM growth for each country has been added to equation 1. The FPE criterion then was applied to select the appropriate lags of each of the three variables ( $\bar{M}_1$ ,  $\bar{G}$  and ROWM) simultaneously. The results using ROWMF growth are reported in table 2.<sup>16</sup>

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<sup>16</sup>The regression results using ROWMF and ROWMV for the United States and Germany are based on slightly different sample periods than those used in table 1. Because of data restrictions in generating the ROWM measures, the sample period used for the United States and Germany is II/1972–IV/1983. The analysis for Japan uses the sample period reported in table 1.



Table 2  
Testing the Significance of ROWM Growth:  
Fixed-Weight Version

Variable	Estimated Coefficients (lags) for		
	United States	Germany	Japan
Constant	1.588 (0.58)	-2.655 (1.21)	-0.550 (0.15)
$\Sigma \dot{M}$	0.925*(2) (3.01)	0.322*(6) (2.02)	0.579*(6) (5.92)
$\Sigma \dot{G}$	—	0.158(8) (1.20)	0.220*(3) (2.71)
ROWMF <sub>t</sub>	0.182 (1.10)	0.235 (1.23)	0.085 (0.43)
ROWMF <sub>t-1</sub>		0.378* (2.03)	-0.199 (1.01)
ROWMF <sub>t-2</sub>			0.304 (1.54)
ROWMF <sub>t-3</sub>			-0.570* (2.76)
ROWMF <sub>t-4</sub>			0.077 (0.31)
ROWMF <sub>t-5</sub>			0.414 (1.74)
Joint F (ROWMF)	—	2.65	2.03
<b>Summary statistics</b>			
$\bar{R}^2$	0.15	0.54	0.78
SE	4.62	2.87	3.20
DW	1.74	2.71	1.57

\*Statistically significant at the 5 percent level.

NOTE: The sample periods are II/1972–IV/1983 for the United States and Germany; III/1972–IV/1983 for Japan. Absolute value of t-statistics shown below each coefficient.

It is interesting to note that, when ROWMF growth was added to equation 1, the FPE procedure selected the same lag structures for domestic money and government expenditures for each country as those in table 1. It chose a lag length for ROWMF growth that was substantially different across the three countries, however. Even though these lag structures differ, the F-statistics (the t-statistic for the United States) for testing the hypothesis that all of the estimated coefficients of ROWMF growth are zero indicate that this

hypothesis cannot be rejected at the 5 percent significance level in any country examined.<sup>17</sup> That is, ROWMF growth has no statistically significant impact on the growth of domestic income given the initial set of explanatory variables in equation 1. Moreover, the addition of ROWMF growth generally has little impact on the estimated coefficients of money growth and government expenditure growth. The one exception is money growth in Germany: when ROWMF growth is added to this equation — even though ROWMF growth is not statistically significant — the cumulative impact of domestic money growth declines by about 60 percent.<sup>18</sup>

The substitution of the variable-weight calculation of ROWM growth for the fixed-weight version does little to alter the general results. These results, presented in table 3, indicate that the distributed lag of ROWMV growth is not statistically significant at the 5 percent level in any of the three countries.<sup>19</sup> Furthermore, the addition of ROWMV growth has little impact on the estimated sum coefficients of money and government expenditure growth. Thus, the results using ROWMV growth measure are consistent with those using ROWMF: there is little empirical support for the notion that foreign influences, measured by

<sup>17</sup>Omitting lags t-4 and t-5 on ROWMF for Japan had no impact on the conclusions. Also, when the contemporaneous ROWMF term for Germany was excluded, the coefficient on the t-1 term was no longer statistically significant at the 5 percent level.

<sup>18</sup>This result may indicate that ROWMF is actually proxying for the impact of economic activity in the rest of the world on German exports as discussed above. Indeed, when ROWMF is added to equation 1 augmented with a distributed lag of export growth, export growth is statistically significant, ROWM growth is not at any conventional level, and the summed effect of German money growth is little affected.

<sup>19</sup>It should be noted that when ROWMV was added to equation 1 for the United States, the FPE criterion indicated a contemporaneous term for government expenditures. Because of this change, the F-statistic reported in table 3 for the United States compares the fit of the equation with  $\dot{M}_1$ ,  $\dot{G}$  and ROWMV to one that includes only contemporaneous and two lags on  $\dot{M}_1$  and a contemporaneous term for  $\dot{G}$ . When lags t and t-1 on ROWMV for the United States are excluded, the coefficient of the t-2 lag remains statistically significant at the 5 percent level. Even though this may indicate that changes in ROWMV growth have some impact on U.S. economic activity, the inclusion of ROWMV has no impact on the influence of U.S. money growth. (Its summed effect remains essentially one.) Furthermore, the estimated coefficient on ROWMV<sub>t-2</sub> (.095) indicates that a 1 percentage-point change in ROWM growth has about one-tenth the impact on U.S. economic activity of a 1 percentage-point change in U.S. money growth. Also, when ROWMV is added to equation 1 augmented with a distributed lag of export growth, export growth is statistically significant, while ROWMV is not at conventional significance levels. Consequently, the conclusions drawn in footnote 18 for Germany appear to be applicable for the United States as well.



changes in foreign money supply measures, significantly impinge on (or even add to) the relationship between domestic money growth and income growth.

### Exchange Rate Changes

Changes in either measure of ROWM growth may reflect phenomena other than those associated with currency substitution. Consequently, exchange rate (the foreign currency price of domestic currency) changes also have been employed as a proxy for currency substitution. In particular, a fall (rise) in the exchange rate could indicate an increase (decrease) in the demand for foreign money relative to the demand for domestic money, that is, currency substitution. While exchange rates may change for other reasons, if currency substitution is the dominant force behind them, then observed exchange rate changes should be associated with opposite changes in the velocity of domestic money. A fall (rise) in the exchange rate, *ceteris paribus*, should cause the velocity of domestic money to rise (fall). Consequently, the same rate of domestic money growth should be associated with a higher rate of domestic income growth. If exchange rate movements are a proxy for currency substitution, these changes should have negative, statistically significant coefficients when added to equation 1.

To test this conjecture, a distributed lag of changes in the effective exchange rate is added to equation 1. The FPE criterion again is applied to select the lag structure for the three explanatory variables simultaneously. These results are presented in table 4. The addition of the distributed lag of exchange rate changes has little impact on the lag length or the estimated coefficients for money growth and government spending growth in Germany and Japan. For the United States, on the other hand, this procedure selected a lag length of four on government expenditures where none had been selected before. The sum coefficient of this distributed lag of government spending growth, however, is not statistically significant at the 5 percent level. Moreover, neither the lag length nor the estimated coefficients for money growth are affected significantly by the inclusion of exchange rate changes.

While the FPE procedure selected a relatively long lag of changes in the effective exchange rate for the United States, it selected only the contemporaneous term for Germany and Japan. The results for these two countries do not support the currency substitution hypothesis. The exchange rate coefficient is not statistically significant for Germany and, while significant

**Table 3**  
**Testing the Significance of ROWM Growth:**  
**Variable-Weight Version**

Variable	Estimated Coefficients (lags) for		
	United States	Germany	Japan
Constant	0.172 (0.06)	0.609 (0.39)	-0.587 (0.45)
$\Sigma \dot{M}$	0.982*(2) (3.23)	0.574*(6) (4.51)	0.651*(6) (7.45)
$\Sigma \dot{G}$	0.115(0) (1.55)	0.116(8) (0.85)	0.238*(3) (3.22)
ROWMV <sub>t</sub>	0.004 (0.10)	-0.004 (0.13)	-0.046 (1.17)
ROWMV <sub>t-1</sub>	0.027 (0.67)	0.050 (1.49)	-0.005 (0.12)
ROWMV <sub>t-2</sub>	0.085* (2.21)		-0.076 (1.78)
ROWMV <sub>t-3</sub>			0.064 (1.51)
ROWMV <sub>t-4</sub>			-0.022 (0.49)
ROWMV <sub>t-5</sub>			0.046 (1.15)
Joint F (ROWMV)	2.59	1.11	2.08
<b>Summary statistics</b>			
$\bar{R}^2$	0.23	0.49	0.78
SE	4.40	3.01	3.19
DW	1.74	2.40	2.17

\*Statistically significant at the 5 percent level.

NOTE: The sample periods are II/1972-IV/1983 for the United States and Germany; III/1972-IV/1983 for Japan. Absolute value of t-statistics shown below each coefficient.

for Japan, it does not have the theoretically predicted negative sign.

The coefficients on the distributed lag of exchange rate changes are statistically significant at the 5 percent level for the United States. Moreover, their sum (-0.247) has the predicted negative sign. These results indicate that a 1 percentage-point increase (decrease) in the rate of growth of the exchange rate leads to a 0.25 percentage-point decline (rise) in the growth of U.S. nominal income after six quarters. Thus, if exchange rate movements reflect primarily changes in demand for domestic money, it appears that eco-



Table 4

**Testing the Significance of Exchange Rate Changes**

Variable	Estimated Coefficients (lags) for		
	United States	Germany	Japan
Constant	0.376 (0.12)	0.337 (0.21)	-0.832 (0.72)
$\Sigma \dot{M}$	0.865*(2) (2.79)	0.497*(6) (3.30)	0.641*(6) (7.64)
$\Sigma \dot{G}$	0.340(4) (1.96)	0.213(8) (1.41)	0.227*(3) (3.15)
$EF_t$	-0.015 (0.25)	0.042 (1.02)	0.069* (2.68)
$EF_{t-1}$	-0.092 (1.44)		
$EF_{t-2}$	-0.091 (1.53)		
$EF_{t-3}$	0.038 (0.61)		
$EF_{t-4}$	-0.167* (2.49)		
$EF_{t-5}$	-0.095 (1.39)		
$EF_{t-6}$	0.175* (2.32)		
Joint F(EF)	2.53*	—	—
<b>Summary statistics</b>			
$\bar{R}^2$	0.26	0.42	0.78
SE	4.24	3.54	3.20
DW	2.10	2.18	2.11

\*Statistically significant at the 5 percent level.

NOTE: The sample periods are II/1972–II/1984 for the United States and Germany; III/1972–IV/1983 for Japan. Absolute value of t-statistics shown below each coefficient.

conomic activity in the United States is affected significantly by currency substitution.

**How Robust Are the U.S. Results?**

It is puzzling that currency substitution could have a significant impact in the United States but not in the other two countries. After all, the currency substitution argument is symmetrical; that is, if the demand

for one currency falls, the demand for another must rise. Consequently, since the Deutsche mark and the yen are the most likely substitutes for the U.S. dollar, one would expect that, if currency substitution has a significant impact on U.S. velocity, it should affect the velocity in Germany or Japan as well. Given that no other evidence of currency substitution could be found examining the other two countries or using the other proxy variables, the U.S. result should be scrutinized more closely.

The approach taken here is to investigate this relationship over time. The experiment conducted was to estimate the U.S. equation found in table 4 over the period II/1972 to IV/1980, then add four quarters to the sample period until the original estimation period was reached.<sup>20</sup> The results are reported in table 5.<sup>21</sup> A comparison of the results over time is quite revealing. The distributed lag of exchange rate changes is statistically significant at the 5 percent level *only* when the four quarters ending in IV/1983 are included in the sample.<sup>22</sup> In fact, the summed coefficient is positive for the sample periods ending in IV/1980 and IV/1981 and becomes negative (the predicted sign) only when the four quarters ending in IV/1982 are added. These results support one of two possible scenarios: First, currency substitution has been important only during the past couple of years. Second, recent exchange rate changes have spuriously captured events other than currency substitution.

**CONCLUSIONS**

We have investigated the hypothesis that currency substitution affects the velocity of domestic monetary aggregates to the extent that anticipated policy outcomes may not be realized. Using three variables to

<sup>20</sup>This is the furthest back into the sample period that we could go and still obtain reliable estimates. There are only 19 degrees of freedom in the first subperiod.

<sup>21</sup>Glancing at table 5, one notices that the summed effect of money growth declines as the sample period is lengthened. While none of these summed effects is statistically different from one at the 5 percent level, this result probably indicates that the lag structure for money growth differs across estimation periods, while we have constrained the lag structure in each subperiod to be the one chosen for the entire period (II/1972–II/1984). For some corroborating evidence, see Batten and Thornton (1983).

<sup>22</sup>One may conjecture that exchange rate changes have always had a negative impact on economic activity, but were too small, until 1983 and 1984, to be statistically significant. The data do not support this view, however. For example, from IV/1980 to IV/1982, the effective exchange rate rose at about a 17 percent annual rate and actually rose less rapidly (at about a 10 percent rate) during 1983 and 1984.



Table 5

## Testing the Significance of Exchange Rate Changes in the United States

Estimated Coefficients for	Sample Period				
	II/1972–IV/1980	II/1972–IV/1981	II/1972–IV/1982	II/1972–IV/1983	II/1972–II/1984
Constant	-4.416 (0.90)	-4.650 (1.22)	-4.714 (1.19)	-1.625 (0.47)	0.376 (0.12)
$\Sigma \dot{M}$	1.734* (3.14)	1.672* (3.90)	1.425* (3.27)	0.949* (3.03)	0.865* (2.79)
$\Sigma \dot{G}$	0.309 (1.53)	0.346 (1.84)	0.448* (2.38)	0.445* (2.40)	0.340 (1.96)
$EF_t$	0.011 (0.14)	0.003 (0.05)	-0.027 (0.44)	-0.027 (0.46)	-0.015 (0.25)
$EF_{t-1}$	-0.020 (0.27)	-0.050 (0.74)	-0.062 (0.93)	-0.077 (1.20)	-0.092 (1.44)
$EF_{t-2}$	-0.032 (0.40)	-0.085 (1.15)	-0.101 (1.55)	-0.096 (1.60)	-0.091 (1.53)
$EF_{t-3}$	0.046 (0.60)	0.084 (1.11)	0.023 (0.35)	0.005 (0.08)	0.038* (2.49)
$EF_{t-4}$	-0.037 (0.44)	-0.077 (0.97)	-0.104 (1.40)	-0.149* (2.10)	-0.167* (2.49)
$EF_{t-5}$	-0.050 (0.62)	-0.016 (0.20)	-0.099 (1.31)	-0.078 (1.11)	-0.095 (1.39)
$EF_{t-6}$	0.180 (2.08)*	0.180 (2.00)	0.153 (1.85)	0.136 (1.70)	0.175* (2.32)
Joint F(EF)	0.66	0.81	1.52	2.41*	2.53*
<b>Summary statistics</b>					
$\bar{R}^2$	0.25	0.32	0.35	0.29	0.26
SE	3.85	4.01	4.22	4.22	4.24
DW	2.47	2.67	2.13	2.12	2.10

\*Statistically significant at the 5 percent level.

NOTE: Absolute value of t-statistics shown below each coefficient.

measure currency substitution, we could find no statistical support for the hypothesis in either Germany or Japan. We did find some support for the United States when exchange rate movements were used to proxy for currency substitution. When this result was subjected to a closer examination, however, the data indicated either that currency substitution is only a very recent phenomenon, or that recent exchange rate movements have captured effects other than those of currency substitution. Consequently, the variables offered in the literature and used here to estimate the extent of currency substitution provide no compelling statistical support for its existence.

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