On Business Cycles and Countercyclical Policies

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Over the last ten years, the U.S. economy experienced one of the longest economic expansions in its history. However, since the third quarter of 2000, its real gross domestic product (GDP) has experienced significantly lower rates of growth, on an annualized basis, than those observed between 1996 and mid-2000.

Economists are still trying to assess the severity of this slowdown, and this assessment has clearly become more difficult since the events of September 11. It is worth emphasizing that this article is silent about the economic implications of wars and similar cataclysms and focuses instead on the analysis of "typical" business cycles. The slowdown that began prior to September 11 had already served as a reminder that the business cycle is still alive—that the U.S. economy is likely to continue to experience both expansions and contractions. This situation raises the following questions: What do we know about the driving forces behind the business cycle? What should policymakers do in the face of economic fluctuations?

Not surprisingly, there are a number of competing explanations for business cycles, and there is no shortage of policy recommendations. This article focuses on only two of these explanations: the animal spirits theory and the real business cycle theory. The former is closely connected with the Keynesian economic tradition and identifies market participants' mood swings as the key source of economic fluctuations. The second explanation is rooted in the classical economic tradition and views productivity shocks as the driving force behind economic fluctuations. These explanations are examined because they are some of the better-known and most widely quoted business cycle theories among academic economists. Both theories meet modern academic standards—one of them from its inception and the other after a significant reformulation. Modern academic standards explicitly acknowledge the dynamic nature of economic decisions—that macroeconomic variables interact with each other in such a way that the relevant economic relations must be considered simultaneously—and the importance of microeconomic theory as a sound foundation for macroeconomic theory.

In addition to reviewing these two theories, the article looks at what they suggest about countercyclical policies—policies aimed at trying to eliminate business cycle fluctuations or insulate market participants from the effects of these fluctuations.

This article first presents the "everyday" adaptation of the original animal spirits explanation for business cycles and then sketches the foundations of the real business cycle and the reformulated animal spirits explanations. The article next reviews the real business cycle and Neo-Keynesian views and, finally, discusses the policy implications of these two theories.

The Keynesian (Nonfundamentals) Approach

One popular explanation for the source of the business cycle is that fluctuations in private spending are induced by so-called animal spirits.[1] That is, economic fluctuations result from waves of overpessimism or overoptimism, affecting households and firms, that are not directly connected to economic fundamentals but may nevertheless become self-fulfilling.

A report on a popular Internet site earlier this year reflects this belief. "The latest economic reports confirm what people on Wall Street and Main Street already knew: the U.S. economy slowed sharply at the end of last year. Consumers are largely to blame. They reined in spending, which accounts for two-thirds of the U.S. economy; as their confidence fell to a four-year low, so did their spending" (www.cnn.com, January 2001).

According to the real business cycle theory, there is nothing the government can do to eliminate business cycle fluctuations. According to Farmer and Guo, in contrast, governments may be able to design policies to moderate economic fluctuations.

This statement suggests that a fall in consumer confidence, induced perhaps by animal spirits, has driven down personal consumption expenditures, in turn dragging down output. This logic is a faithful reproduction of the so-called spending hypothesis attributed to Keynes and found in many macroeconomics textbooks. In a review of the Great Depression, Mankiw (1992a) addresses the question that originally motivated Keynes: What caused the Great Depression? Mankiw describes what he calls the spending hypothesis of what caused the Depression. "The *spending hypothesis* . . . places primary blame for the Depression on an exogenous fall in spending on goods and services. Economists have attempted to explain this decline in spending in several ways. Some argue that a downward shift in the consumption function caused the contractionary shift. . . . The stock market crash of 1929 may have been partly responsible for this decline in consumption. By reducing wealth and *increasing uncertainty* about future prospects for the U.S. economy, the crash may have induced consumers to *save more of their income* [italics added]" (1992a, 284–85).

In fairness to Keynes, his conjecture was that a drop in consumption was part of the explanation behind business cycles. The second part of the explanation had to do with why the resources that became available following a drop in aggregate consumption did not find their way into the investment sector of the economy, thus preventing market participants' mood swings from becoming self-fulfilling. This question is a difficult one that many economists continue to struggle with, and therefore it is not always reported in textbooks. Because many commentators are exposed only to the first part of Keynes's explanation, it is referred to in this discussion as the everyday Keynesian explanation.

Of course, for this logic to apply, one would first have to show that a fall in consumer confidence drags down private consumption spending. Assuming for the moment that this statement is true, the question remains, Why would changes in private consumption cause fluctuations in output or GDP? The explanation according to the everyday Keynesian theory can be illustrated as follows. Suppose a shoemaker's customers suddenly, for whatever reason, become very pessimistic about their future income, inducing them to slash their consumption across the board. As a consequence, the shoemaker might see a significant drop in shoe sales, forcing him to reduce his production. Extrapolating from the shoemaker's actions, commentators might conclude that there is likely to be a drop in GDP if most producers of consumer goods and services experience a simultaneous decrease in sales.[2] It is clear, then, from this line of reasoning, that lower private consumption spending causes lower output.

Despite its intuitive appeal, this analysis has been the subject of criticism and qualifications by academic economists for a number of decades. More recently, these objections have stemmed from a theoretical reexamination of the way households and firms make their economic decisions at the microeconomic level and economists beliefs about how these decisions shape the evolution of the macroeconomy.

The next section presents a primer on the way modern academic economists describe the economic decisions of the two basic units that integrate the macroeconomy: households and firms. These ideas lay the foundations for the two business cycle theories this article examines.

The Economic Decisions of Households and Firms

Macroeconomists build theoretical models that are meant to provide a plausible representation of a number of features in the economy. Modern macroeconomists analyze models in which households make consumption, savings, and labor supply decisions over their lifetimes, which span a large number of years, and firms make their input choices so as to maximize their profits.

Households. For a given stream of projected income, a household's key economic decision, which takes place continuously and is based in part on a decision about how many hours to work, is how much to consume and how much to save. This decision is also based on the household's degree of frugality. For a given level of income, the more frugal a household is, the more it will save. Households also prefer to avoid sharp swings in their consumption patterns; for instance, most people would rather have a moderately priced meal most of the time than eat at La Tour d'Argent for a month and then starve for the rest of the year. Finally, household savings consist of increases in net acquisition of financial assets in financial institutions. These institutions lend most of their funds to the firms in the economy to help them acquire capital.

Firms. Every production process, from fast food restaurants to high-tech services, can be described as the result of combining two basic inputs: capital and labor. In most economic models, the goods that households consume are produced by firms that use labor and capital as inputs. The level of output depends on the amount of labor supplied by the households and on the amount of capital that has been accumulated over time.

The Interaction of Households and Firms in the Macroeconomy. The larger the number of hours worked and the higher the level of accumulated capital, the greater the output level in an economy. At the same time, capital enhances workers' productivity. In a competitive marketplace, higher productivity is normally associated with higher pay. Firms choose the right mix of labor hours and capital to maximize their profits.

The more frugal the households in an economy are—that is, the lower their contemporaneous consumption expenditures—the more the households will save and thus the more capital they will accumulate. The larger the amount of capital in an economy, the larger the amount of output produced, consumed, and invested. Hence, according to this sketch of how households and firms make economic decisions at the micro level, it is possible that lower consumption today will result in higher output levels tomorrow. Similarly, if animal spirits led households to slash their consumption, for a *given* level of income this reduced consumption would result in *higher* savings, additional capital accumulation, and higher output in the near future. Unlike the everyday Keynesian explanation described earlier, in which a decrease in consumption leads to a fall in output, in modern macroeconomic models a drop in consumption produces an increase in savings that will provide the necessary capital to fuel economic growth.

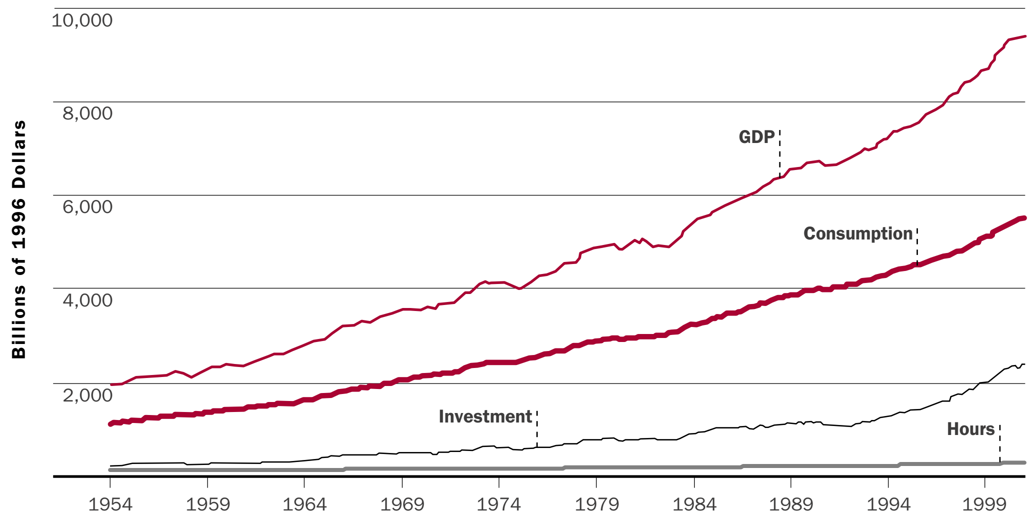
An example of this phenomenon is the boom Singapore experienced between 1960 and the mid-1980s. Singapore, one of the four "Asian tigers," saw a decrease in consumption in the late 1970s. This drop was caused by a marked increase in household frugality and was matched by a sharp increase in the savings rate, which facilitated an investment expansion and an output boom.[3] This example suggests that, as modern macroeconomic analysis predicts, lower consumption can cause higher GDP.

In sum, the everyday Keynesian analysis predicts that lower private consumption will always lead to lower output. This prediction is inconsistent with the modern macroeconomic analyses described above and with the sequence of events that occurred in Singapore.

The factors that determine how much an economy produces, consumes, and invests are known as the economy's fundamentals. These fundamentals include the total number of hours worked and the amount of capital in the economy. Economists also recognize that there are additional fundamental factors that can help explain the ultimate level of GDP. These additional factors are included in so-called multifactor or total factor productivity (TFP).[4] Factors affecting TFP include a country's legal framework, its infrastructure, and its level of technological sophistication. For a given number of hours worked and a given level of capital in an economy, higher TFP means higher production capacity. Thus, TFP reflects the fact that output can be increased not only by working harder but also by working

1. Originally, the term *animal spirits* was coined in the context of explaining wild investment swings. In Keynes's words, "Most, probably, of our decisions to do something positive . . . can only be taken as a result of animal spirits—of a spontaneous urge to action rather than inaction. . . . If the animal spirits are dimmed and the spontaneous optimism falters . . . enterprise will fade and die" (Keynes 1973, 161–62).
2. According to the same logic, a wave of overoptimism would lead to a sharp increase in the sales of consumer goods, and one would expect a production boom.
3. As reported by Barro (1992), the ratio of real gross investment to real GDP in Singapore was about 13 percent in the early 1960s, reached 21 percent between 1965 and 1969, and then climbed to an average of 37 percent from 1970 to 1985. Per capita real GDP growth rates from 1960 to 1985 were around 5.8 percent, whereas for the 1960–85 period per capita real consumption grew by only 2.9 percent annually. Therefore, for the 1960–85 period, the relatively low growth in consumption was matched by a sharp increase in the savings rate, which resulted in an investment and output boom.
4. Solow (1957) was the first economist to develop this idea.

CHART 1
U.S. Output, Consumption, Investment, and Labor Hours, 1954:Q1–2001:Q1



Source: Computed by the authors from data from the Bureau of Economic Analysis and the Bureau of Labor Statistics.

smarter, that is, by combining the same amounts of inputs in a more efficient fashion.

In a market economy, individuals are rewarded according to the amount of goods and services they help produce. A higher level of capital per worker allows workers to generate more goods and services per unit of labor input and thus helps raise workers' compensation. However, efficiency changes (changes in TFP) can also help explain changes in workers' compensation. Other things being equal, above-average rates of TFP growth (possibly the result of technological innovation) generate higher rates of growth in real (inflation-adjusted) wages because workers are compensated for helping produce more goods and services. Higher wages, in turn, result in increases in household income, leading to higher consumption and saving. Similarly, below-average rates of TFP growth reduce the rate of growth in real wages. Lower wages result in decreases in household income, leading to lower consumption and saving. In sum, random shifts in TFP could cause fluctuations in the total output of an economy. The view that total factor productivity has an important role in economic fluctuations has slowly made its way into business economics and policy-making circles. For example, in recent testimony (February 2001), Federal Reserve Chairman Alan Greenspan stated that "crucial to the assessment of the outlook . . . is the role of technological change . . . in shaping cyclical forces."

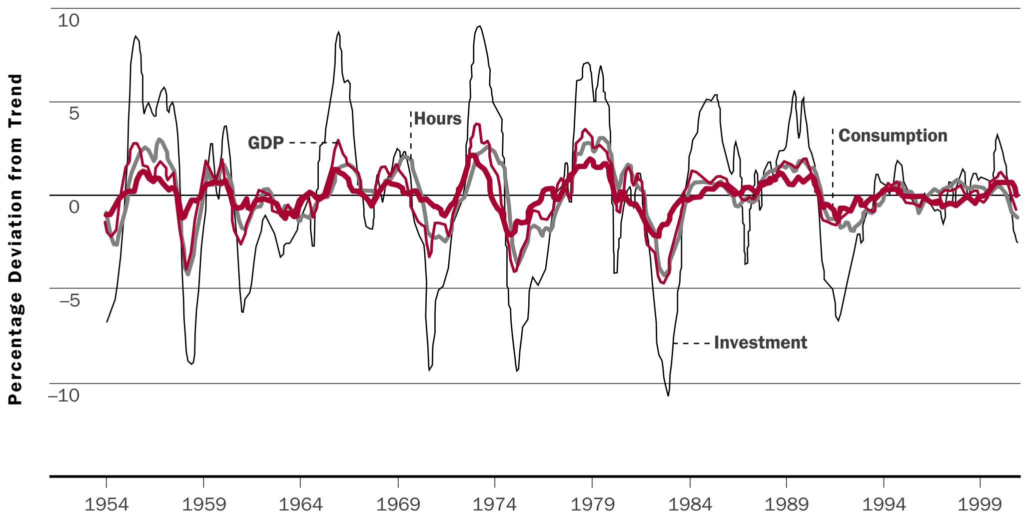
The next section reviews the findings of a well-known explanation for economic fluctuations: the real business cycle (RBC) or fundamentals theory. This theory relies on the foregoing analysis of the two basic units that make up the macroeconomy—households and firms.

Real Business Cycle Theory: The Fundamentals Approach

Kydland and Prescott (1982) and Long and Plosser (1983) were the first economists to recognize the possibility that business cycles could be caused by random shocks to TFP (technology shocks).[5] They started with the observation that in the post–Korean War U.S. economy, output, consumption, investment, and labor hours are positively correlated but differ in terms of their volatility over the business cycle.

To illustrate this empirical fact, Chart 1 plots output, consumption, investment, and labor hours in the United States from the first quarter of 1954 to the first quarter of 2001.[6] These time series can be thought of as consisting of two components: the trend or low-frequency component, which changes slowly over time, and the cyclical or high-frequency component—the deviation of the series from its trend—which moves up and down over the business cycle. The statistical mathematical procedure that decomposes a time series into these two components is called *detrending*. The cyclical component obtained after detrending is the object of business cycle analysis. Chart 2 shows the cyclical components (percentage deviations from trend) of some actual U.S. time series.[7] They represents the yardstick against which to measure alternative business cycle theories' predictions.

CHART 2
Cyclical Components of U.S. Output, Consumption, Investment, and Labor Hours, 1954:Q1–2001:Q1



Source: Computed by the authors from data from the Bureau of Economic Analysis and the Bureau of Labor Statistics.

Chart 2 shows that consumption, investment, and hours worked are all procyclical; that is, they all move in the same direction as output over the business cycle. Moreover, consumption displays a smoother pattern than output, labor is about as volatile as output, and investment is more volatile than output over the business cycle. Table 1 shows summary statistics on relative volatility and contemporaneous correlation with output for key U.S. aggregates during the sample period.[8]

Kydland and Prescott (1982) construct a model that builds on the assumptions about the behavior of households and firms that were sketched in the preceding section. They assume that the prices of different goods and services adjust readily in response to changes in the economy's fundamentals. Furthermore, economywide production of goods and services is assumed to yield constant returns to scale—that is, a proportional increase in the quantity of capital and labor inputs is expected to increase output by the same proportion.

Chart 3 reproduces Chart 2 along with the cyclical responses of output, consumption, investment, and labor hours to technology shocks in a single simulation experiment conducted within an RBC model. Although the model does a good job of matching the relative volatility of the macroeconomic aggregates, it does not capture the exact timing of the business cycle. However, given the relative simplicity of the model, it is remarkably successful in replicating the cyclical behavior of key U.S. macroeconomic aggregates revealed in Chart 2.[9]

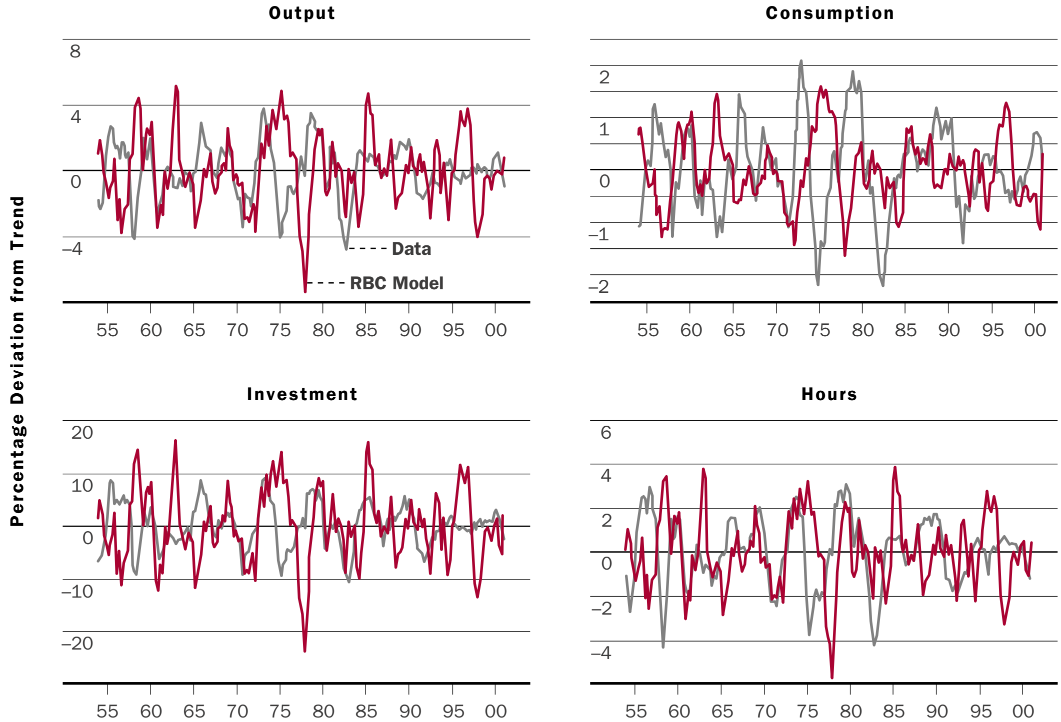
Another way of assessing the performance of the RBC model is to contrast Table 1 with Table 2, which presents sample means of relative volatility and contemporaneous correlation with output computed for

TABLE 1
The U.S. Economy, 1954:Q1–2001:Q1

Variable	Relative Volatility	Correlation with Output
Output	1.00	1.00
Consumption	0.50	0.83
Investment	2.57	0.91
Labor Hours	0.95	0.87

5. For a very informative tour of the genesis of the shock-based business cycle theory, see Chatterjee (2000).
6. Output is defined as GDP, consumption is defined as private consumption of nondurables plus services, and investment is defined as nonresidential fixed investment plus consumer durables. All these variables are measured in billions of 1996 dollars. In addition, labor hours are defined as total manhours of the employed labor force in all industries from the household survey, measured in billions of hours.
7. The detrending method used in Charts 2–4 is the Hodrick-Prescott filter, which fits a flexible trend through the time series. The flexible trend reflects the assumption that each of the relevant variables exhibits a slowly changing growth rate over time.
8. Relative volatility is defined as the standard deviation of a variable divided by the standard deviation of output.
9. Subsequent extensions of the real business cycle approach, as labeled by Long and Plosser (1983), have improved the U.S. data fit (see King and Rebelo 1999 for a survey and the references therein).

CHART 3
The Real Business Cycle Model



Source: Computed by the authors from data from the Bureau of Economic Analysis and the Bureau of Labor Statistics.

fifty simulations of an RBC model. Each simulation consists of 189 periods, the same number as the U.S. data sample.

In the RBC artificial economy, the patterns of relative volatility are consistent with the U.S. data reported in Table 1; that is, investment is the most volatile, followed by output, labor hours, and then consumption over the business cycle. Based on this result, one can conclude that changes in total factor productivity are a possible cause of fluctuations in GDP, consumption, investment, and labor hours. Moreover, all model-generated time series are procyclical in an RBC economy. In particular, output and consumption are positively correlated over the business cycle. As discussed earlier, a positive technology shock (or above-average TFP growth) leads to higher labor hours and higher real wages; therefore, more output is produced, and households raise their consumption expenditure accordingly. However, from the RBC point of view, it would make no sense to blame consumers for an economic slowdown, as the everyday version of the animal spirits explanation for business cycles would suggest. According to the RBC explanation, changes in households' incomes brought about by an unanticipated change in total factor productivity will induce changes in both savings and consumption so that the causality does not run from consumption to output but the other way around.

So far, this article has identified some inconsistencies between the predictions of the everyday adaptation of the original animal spirits theory and predictions of modern macroeconomic models. It has also presented an example that seems to support the predictions of modern macroeconomic theories. Finally, it has noted the success of the RBC theory in matching the fluctuations of U.S. data. Under these circumstances, one might wonder whether the nonfundamental or animal spirits explanation of the business cycle should be considered obsolete.

According to a new generation of Keynesian economists, the answer to this question is no. These economists study the cyclical implications of the presence of animal spirits in models that meet the modern academic standards sketched out in the last two sections. The next section presents a reformulation of the nonfundamentals explanation that has been put forward by some Neo-Keynesian economists.

The Neo-Keynesian (Nonfundamentals) Theory

According to Mankiw (1992b), a prominent Keynesian economist, at least some new or Neo-Keynesians agree with the RBC theorists that it is important for business cycle theory to

TABLE 2
The Real Business Cycle Model of the U.S. Economy, 1954:Q1–2001:Q1

Variable	Relative Volatility	Correlation with Output
Output	1.00	1.00
Consumption	0.29	0.87
Investment	3.18	0.99
Labor Hours	0.76	0.98

be consistent with the micro foundations of the macroeconomy. Mankiw states that "Keynesian economics has been reincarnated into a body with firm microeconomic muscle. . . . Beyond the broad principles . . . old and new Keynesians differ substantially. . . . To some old Keynesians, new Keynesian economics may be hard to recognize as Keynesian at all. Indeed, new Keynesian economics may appear more similar to the classical economics of David Hume" (1992b, 560).

Mankiw makes it clear that he is not the spokesperson for all Neo-Keynesian economists. However, it is fair to say that he speaks for a large body of academic economists who see the business cycle as a type of economywide market failure, as Keynes did, but who seek explanations that are firmly anchored in the analysis of the behavior of households and firms.

Rather than surveying all Neo-Keynesian studies of the business cycle, this discussion focuses on a recent Neo-Keynesian analysis by Farmer and Guo (1994). This particular study was chosen because it is consistent with the RBC and Mankiw's view that macro predictions should be the consequences of assumptions made at the micro level.[10] However, Farmer and Guo's analysis is also faithful to the Keynesian tradition. They pursue a market failure explanation for the business cycle, and they study the possibility that animal spirits or nonfundamental factors could be the driving force behind business cycle fluctuations. In addition, they were the first authors to conduct empirical tests of their theoretical arguments along the lines of the RBC approach, thereby permitting a straightforward comparison of their explanation and the RBC explanation.[11]

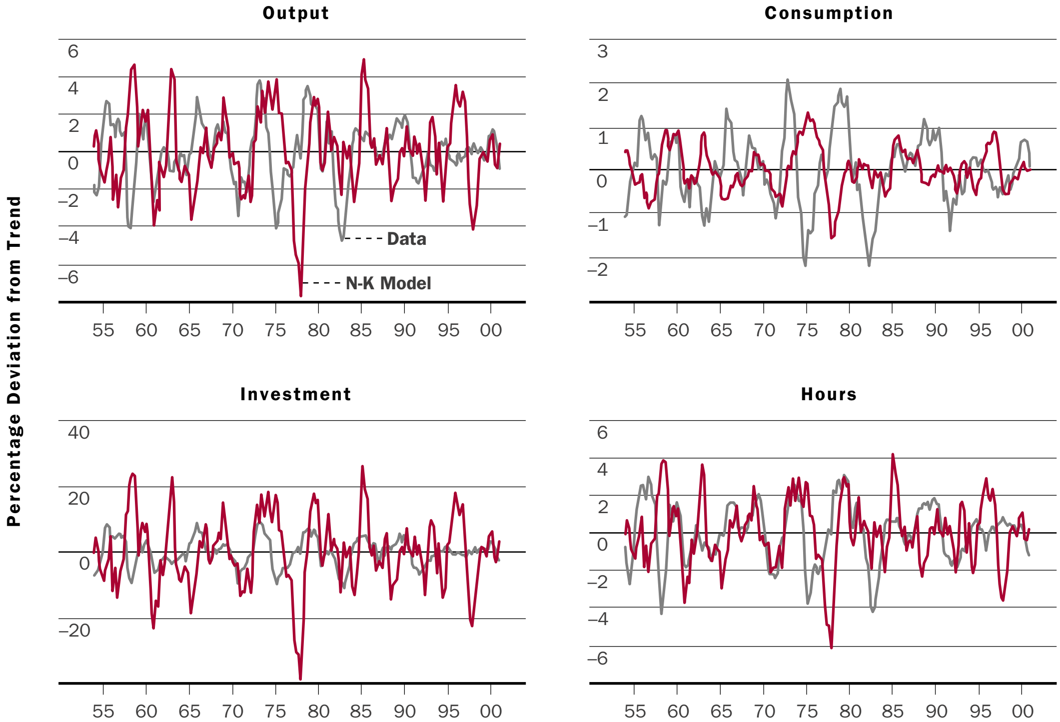
Farmer and Guo's analysis features an important departure from the RBC paradigm. Specifically, they postulate constant returns to scale at the firm level but economywide increasing returns to scale in production. The assumption of increasing returns to scale means that a proportional change in labor and capital inputs generates a more-than-proportional change in output.[12] To say that an economy experiences economywide increasing returns to scale means that, although individual firms see themselves as facing constant returns to scale, all of the firms taken together experience increasing returns to scale. Hence, Farmer and Guo assume that proportional additions of labor and capital by all individual firms result in a more-than-proportional increase in GDP. This possibility is also known as positive externalities in the aggregate production process.[13]

An example of positive externalities is the development and widespread use of the Internet. As individual firms continue to increase their use of the Internet, they induce improvements in the distribution, utilization, and management of information at the economywide level. Farmer and Guo believe that the assumption that there are externalities in the aggregate production process provides a better description of the production technology in the U.S. economy than the constant-return assumption favored by RBC theorists.

Armed with modern analytical tools, some of which were outlined earlier, Farmer and Guo envision an alternative sequence of events leading to economic fluctuations that have nothing to do with changes in TFP. Suppose, for whatever reason—say, an unexpected increase in the ratio of total business inventory to sales—households become pessimistic about the future of the economy. Fearing that the investment financed by their savings is not going to pan out, households lower their savings today. For a given level of income, this move would result in higher consumption. But since households are happy

10. Of course, Farmer and Guo (1994) is not the only Neo-Keynesian work on business cycles. It is, however, one that incorporates most of the elements that academic economists have come to accept as standard in modern macroeconomic models. For example, Mankiw (1985) presents a static, partial equilibrium analysis with no quantitative analysis of the U.S. business cycle. On the other hand, Blanchard and Kiyotaki (1987) and Ball and Romer (1990) both examine general equilibrium models, but these models are static and contain no quantitative business cycle analysis.
11. An alternative Neo-Keynesian analysis that emphasizes animal spirits as the source of business cycles is that of Gali (1994). His analysis begins with a different source of economywide market failure: monopolistic competition. This characteristic would make Gali's model also an ideal Neo-Keynesian study to contrast against the RBC theory. Farmer and Guo's model was chosen instead because its theoretical setup and empirical methodology makes it a more transparent alternative to contrast against the RBC approach.
12. See, for example, Farmer and Guo (1994) for a careful justification of this assumption.
13. See, for example, Caballero and Lyons (1992) for empirical support of positive externalities in the U.S. economy.

CHART 4
The Neo-Keynesian Model



Source: Computed by the authors from data from the Bureau of Economic Analysis and the Bureau of Labor Statistics.

with their initial choices of consumption (assuming that households favor smooth consumption patterns), they will reduce their supply of labor just to the point where they can earn enough to consume what they were consuming prior to the outbreak of pessimism. Therefore, employment will be predicted to fall at this stage.

Since aggregate production in the Farmer-Guo framework is subject to increasing returns, a decrease in labor supply may reduce labor productivity. If so, this decline leads to a drop in the demand for labor at every level of wages, in turn leading to a downward shift of the labor demand curve. Hence, the above outcome of lower employment in the economy is reinforced. The fall in employment reduces households' projected income streams, thus decreasing their ability to consume and save. In the end, households' pessimism becomes a self-fulfilling prophecy that causes output, investment, employment, consumption, and labor productivity all to go down.

Notice that, as in the RBC theory, Farmer and Guo's theory predicts that the cause of cyclical declines in output is not lower consumption. Lower consumption results from a decrease in investment and output caused by something else—in this case, a sudden burst of pessimism about investment prospects.

The natural question at this point is, How well do the simulated data generated by this model match the actual data featured in Chart 2? Chart 4 shows that, like the RBC model, the Farmer-Guo model is able to reproduce the relative variances of U.S. output, consumption, investment, and labor hours over the business cycle. Similarly, Table 3 shows that, like the RBC model, the Farmer-Guo model provides a plausible quantitative description of the cyclical behavior of key post–Korean War U.S. macroeconomic aggregates in terms of relative volatility and contemporaneous correlation with output.[14]

To sum up, the last two sections have described the driving forces behind business cycles according to two well-known theories: the real business cycle theory and the Neo-Keynesian Farmer-Guo theory. Neither theory supports the notion that fluctuations in consumption cause the business cycle. Instead, the theories predict that either random shocks to total factor productivity or investors' mood swings can lead to fluctuations in GDP, consumption, investment, and labor hours.

Policy Implications

As this article has just reported, proponents of these two explanations for the business cycle have conducted empirical tests of their theo-

TABLE 3
The Neo-Keynesian Model of the U.S. Economy, 1954:Q1–2001:Q1

Variable	Relative Volatility	Correlation with Output
Output	1.00	1.00
Consumption	0.24	0.78
Investment	5.14	0.99
Labor Hours	0.83	0.98

retical arguments. Both theories seem to achieve a reasonable fit to U.S. data. Since neither theory can be written off on empirical grounds, it is interesting to ask the following questions. What kind of economic policies according to these theories might moderate the business cycle, or insulate households and firms from aggregate fluctuations, and how desirable are such policies?

Policy Prescriptions from the RBC Camp. Imagine, as proponents of the RBC theory claim, that there really are random and perhaps persistent changes in total factor productivity. As discussed earlier, these changes will induce fluctuations in output, consumption, investment, and so on. Total factor productivity movements will also induce changes in the relative scarcity of resources. Under the assumptions of the RBC theory, inflation-adjusted wages and interest rates will adjust quickly to reflect these scarcity changes. Households and firms will modify their behavior so that they continue to maximize their well-being and profits, respectively, through time.

According to the RBC theory, business cycle fluctuations are the optimal responses of households and firms to random shocks to TFP and hence are "efficient" outcomes. In this scenario, Adam Smith's "invisible hand" will work in the sense that decisions and actions of the private sector will achieve the best possible economic outcomes. Accordingly, under RBC assumptions there is no reason for the government to implement any kind of "leaning against the wind" policy—that is, there is no reason for it to design policies that try to stimulate economic activity during a downturn or slow it down during a boom. The marketplace of households and firms will engineer adjustments in the opportunity cost of investment, leisure, and so forth that induce the optimal responses by its participants.

Consider the following simple example of cyclical economic behavior in the U.S. economy: the construction industry. Construction booms in the summer and slows down in the winter. Is there a case for taking policy actions such as raising interest rates during the summer and lowering them during the winter to stimulate borrowing and construction during winter (and vice versa) so as to even out the level of construction throughout the year? Probably not. No government policies can get rid of summers or winters. There is a reason for the building booms of the summer: building in the sun is a lot easier than building under layers of snow. Why then distort the market allocation of resources if it produces an efficient outcome?

Critics of the RBC approach argue that its predictions cannot be fully tested because relatively few observations of business cycles are available. They also argue that the TFP-shock story is contrived in that it does not admit any market failures and that its explanation for unemployment as a natural market response is hard to swallow. These critics also point out that the RBC theory makes a number of assumptions that are at odds with reality. Some prices, for example, do not adjust immediately to economic conditions. And what if the U.S. economy experiences aggregate production externalities of the type described in the Neo-Keynesian discussion? These concerns raise some questions: How seriously should one take the RBC theory's claim about the uselessness of countercyclical policies? Is there room for stabilization policies according to the competing animal spirits explanation of business cycles? And how desirable are these policies?

Policy Prescriptions from the Animal Spirits Camp. According to everyday Keynesian economics, policies that boost private consumption can help speed up a country's recovery from an economic slowdown. As noted earlier, however, this prescription is based on analytical methods that do not enjoy widespread support among academic economists.

The Farmer-Guo model from the preceding section meets modern academic standards, but, unlike the RBC theory, it assumes positive externalities in the aggregate production process. From this perspective, if firms recognized that their individual actions affected all the firms in the economy and if they could coordinate their actions, then all could reap the productivity benefits of increasing returns to scale. However, by design, economic decisions in a market economy take place in a decentralized way and thus make this kind of coordination difficult. As a result, it is possible for the decentralized decisions of households and firms to be "inefficient" in the sense that a central coordinating arrangement

14. As in Table 2, the statistics reported in Table 3 are sample means computed for fifty simulations, each of which consists of 189 periods.

would produce a better economic outcome than Adam Smith's invisible hand.

The potential inefficiency of the free-market outcome creates an opportunity for stabilization policies designed to suppress fluctuations driven by animal spirits to increase public welfare. For example, Guo and Lansing (1998) show that in a Neo-Keynesian model with aggregate increasing returns, a progressive income tax can prevent households from reacting to bursts of optimism or pessimism. When households experience a burst of optimism and decide to work harder and invest more, they are subject to a higher tax rate, preventing their optimism from becoming self-fulfilling. Conversely, when households experience a burst of pessimism and decide to work and invest less, they are subject to a lower tax rate, preventing their pessimism from becoming self-fulfilling.

But is it necessarily a good idea to eliminate economic fluctuations that are caused by animal spirits? Suppose Farmer and Guo are right and the aggregate production process in the United States does display positive externalities. In this case, if all the firms in the economy cooperated, they could obtain more-than-proportional increases in output by increasing their inputs simultaneously. However, since there is no central coordinating mechanism in a decentralized market economy, firms cannot take advantage of this situation under normal circumstances. One can think of waves of overoptimism as an unintentional coordinating mechanism. For example, if most firms believe that the "bad" times are over and decide to produce more, more-than-proportional increases in output may be observed. This possibility suggests that animal spirits–induced fluctuations may be a good thing for the economy. Thus, it is possible that even if the government can eliminate bursts of overoptimism, it may not want to.

What is the potential advantage of moderating economic fluctuations? First, if overoptimism alternates with overpessimism, then the average level of output might fall more than proportionally to the decreases in the amount of inputs, leading to undesirably low levels of consumption and investment. Second, even if fluctuations caused by animal spirits do not reduce the average level of output, they definitely increase the variability of consumption. Since the economic theory outlined earlier predicts that households prefer their consumption to be smooth rather than variable, swings in consumption tend to reduce public welfare.

As Christiano and Harrison (1999) point out, the case for stabilizing the economy against fluctuations driven by nonfundamental forces depends on the relative magnitude of two opposing factors. On the one hand, households prefer smooth consumption, so fluctuations in consumption reduce their well-being. On the other hand, increasing returns in production may allow nonfundamental fluctuations to increase the average level of consumption. As a result, it cannot be determined a priori whether stabilization policies will improve the well-being of the economy.

According to the RBC theory, there is nothing the government can do to eliminate business cycle fluctuations. According to Farmer and Guo, in contrast, governments may be able to design policies to moderate economic fluctuations. However, Farmer and Guo cannot recommend countercyclical intervention unambiguously because it is possible for cyclical fluctuations to be a net benefit for the economy.

Conclusion

This article has outlined two alternative explanations for business cycles: the real business cycle theory and Keynesian theory. Although neither theory is without detractors, each is worthy of review because it exerts significant influence on opinions about the business cycle inside the academic economic community.

This article has pointed out that the everyday version of Keynesian theory predicted that fluctuations in output might be caused by fluctuations in consumer spending. As a result, one of the reasons economic commentators follow consumer confidence and spending so closely is that these behaviors are viewed as leading indicators of economic fluctuations. Commentators think that identifying leading indicators is important in alerting government about the stage of the business cycle the economy is in so that the appropriate countercyclical policy can be implemented.

This article also reviewed the RBC theory's assumption that changes in total factor productivity are the cause of economic fluctuations. One modern version of Keynesian theory, on the other hand, suggests that animal spirits are the cause of economic fluctuations. However, this article makes two points. First, the existence of a causal relationship that runs from consumption spending to output is far from well established. In two prominent business cycle theories, the real business cycle theory and the Neo-Keynesian Farmer-Guo theory, causality runs from output to consumption. Second, although these theories differ diametrically in some key assumptions regarding the functioning of the economy, both theories meet modern academic standards and do a reasonably good job of matching key features of U.S. post–Korean War data. However, neither theory makes an unambiguous case for countercyclical policies.

Should readers conclude from this discussion that countercyclical policies are clearly a bad idea? Not necessarily. This review has covered only a small subset of the Keynesian literature, and it is possible that other modern Keynesian analyses of the business cycle may justify countercyclical policies more forcefully. Moreover, recent work using the RBC approach, such as Cho and Cooley (2000), suggests that it may permit more room for countercyclical policy than RBC theorists have previously believed.

This article makes clear, however, that two well-known and widely cited business cycle theories indicate that there may be no need for countercyclical government policies. This conclusion, no doubt, will come as a surprise to a number of government and business economists who have an ingrained belief in the benefits of such policies. It is important to remember, however, that attempts to understand business cycles and the effects and desirability of government policies that may (or may not) moderate them are still at a very early stage.

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What Remains of Monetarism?

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> In economics as in other developing sciences, change erodes the value of popular terminology. Monetarism is a name that has been given to a particular set of propositions at a particular point of time. Like Keynesianism, fiscalism, or the "Treasury view," the particular set of propositions called monetarism does not fully describe the body of thought accepted by a loosely knit group of practicing economists any more than terms like Chicago, Cambridge or Austrian School describe the thought of all to whom the terms are applied.
>
> —Allan Meltzer, *The Structure of Monetarism*

MOST CENTRAL BANKS CONDUCT MONETARY POLICY BY MANIPULATING SHORT-TERM INTEREST RATES TO ACHIEVE CERTAIN POLICY OBJECTIVES, SUCH AS ECONOMIC GROWTH AND LOW INFLATION. BY MOST ACCOUNTS THE FEDERAL RESERVE HAS BEEN REMARKABLY SUCCESSFUL DURING THE PAST TWO DECADES AT ACHIEVING THESE GOALS. THE LENGTH OF the economic expansion from 1982 to 1990 and from 1991 to 2001 is unprecedented in U.S. history. In addition, inflation has fallen sharply since the 1970s, averaging less than 3 percent during the past decade. Looking back over this period, Taylor (1998) calls it the "Great Boom" in U.S. economic history.

The Fed's approach to policy was not always as successful as recent experience suggests, however. It was the Fed's policy of controlling short-term interest rates—more specifically, the federal funds rate—that gave rise to the sustained inflation that began in the early 1960s and ran through the early 1980s.[1] Indeed, this dismal track record increased interest in an alternative policy, one that focused more on the growth rate of the money supply. The basic idea behind this alternative policy, usually put under the umbrella name of "monetarism," was that, by controlling the growth of the money supply and not interest rates, the Fed could better control inflation and foster stable economic growth.

The power of monetarist arguments and the building empirical evidence supporting them were key factors leading up to the Fed's October 1979 announcement that it would place more weight on the monetary aggregates in policy deliberations. The Fed's apparent romance with an aggregates-based policy was short-lived, however. Citing the unusual behavior of money growth, in October 1982 the Fed abandoned monetary targets as operating guides and returned to targeting the federal funds rate. Indeed, today monetary growth targets play no official role in the setting of U.S. monetary policy. The fact that money plays no role is not new in the history of U.S. policymaking.[2] The question is whether such disregard is justified by the data any more today than it was in the past.

This article addresses that question by discussing the development and apparent failure of monetarism as a guide to policy. This overview is useful because it puts today's disregard of monetary aggregates as policy tools into a historical perspective. The article also presents some empirical analysis using a sample of fifteen countries to explore whether the basic monetarist propositions still hold true. Before delving into these discussions and analysis, the article first provides a working definition of monetarism.

What Is Monetarism?

In its most generic form, *monetarism* is the term often used to describe a view or a body of work in which changes in the growth rates of the monetary aggregates play a central role in explaining economic activity, including changes in income (nominal and real) and prices. This view is directly linked to the quantity theory of money. To see this link, let

$$(1) \qquad M = kY,$$

where M represents the nominal money stock, k is the public's desired ratio of money holdings to nominal income, and Y is nominal income. The so-called k-ratio is key to understanding the behavioral relationship between the money stock, income, and prices. If this ratio is constant, then M and Y move proportionally. If M is viewed as the nominal stock of money balances demanded by the public, equation (1) is a simple money demand function, where money demand depends largely on income.

The usefulness of equation (1) is demonstrated by a scenario in which the economy is in equilibrium, defined as a condition in which the quantity of money balances demanded is equal to the quantity supplied. If this condition holds, then any increase in the nominal stock of money (M) leads to an increase in either k or Y. If individuals do not initially alter their desired money-to-income ratio (k), an increase in the money stock leads directly to an increase in nominal income. Writing equation (1) in growth rate terms leads one to the following proposition: increasing the growth rate of the money stock leads to an increase in the growth rate of nominal income.

This proposition is important to understanding the nature of monetarism. First, the proposition suggests that movements in the money stock lead to similar movements in nominal income. If the money stock is by and large influenced by the actions of the monetary authority—the Federal Reserve System in the United States or the European Central Bank in Europe—then policy actions have predictable effects on the economy. Of course, how closely money and nominal income move together is the subject of much ongoing debate and empirical testing.

Second, equation (1) also suggests, as a matter of arithmetic, that changes in money can affect both real income and prices differently; nominal income (Y) is the product of real income (y) and prices (P). So equation (1) can be rewritten in the form

$$(2) \qquad M = k(yP),$$

where $yP = Y$. If changes in the nominal money stock are not associated with permanent changes in real income and the k-ratio is stable, increases in inflation are linked directly to increases in money growth.

This age-old proposition recognizes the fact that increased money growth by itself cannot lead to an increase in the production of real goods. This fact can be illustrated by an example in which the money stock doubles, making Jane's checking account today twice as big as it was yesterday. What does Jane do? Of course, she might spend all the money, save it all, or spend and save it in varying proportions. The impact of these events on the overall economy is that demands for different goods are likely to change. For goods for which demand has increased, more of those goods are needed, so production increases. Real output (income) rises as more goods are produced. However, there is an upper limit to this production surge, a limit placed by existing plants, equipment, production technologies, and the current labor force. As demands for goods rise and the ability to produce more is constrained, profit-maximizing firms raise prices to ration the scarce goods. Over time, increasing the growth rate of the money supply is likely to be evidenced in rising inflation rates and not in increased rates at which goods and services are produced. This is the story that monetarists reinvigorated in the 1960s, which reappeared as the New Keynesian story of the 1980s and 1990s.[3]

This story provides a substantial foundation for understanding what monetarism is. Of course, exactly what constitutes monetarism varies as much as the number of individuals attempting to define it.[4] For the purposes of this article, the definition of monetarism comprises three facets. First, it refers to a set of testable propositions from which policy prescriptions are determined. For example, Milton Friedman's famous X percent rule for monetary policy is an example of a policy prescription derived from empirical findings.[5] Second, movements in the money supply are considered to be a major factor explaining observed changes in income, prices, and, in the short run, real output. This view suggests that money and nominal income should be positively related, just as money growth and inflation should be. While monetary impulses may have an impact on real economic activity in the short run, money and real output are not likely to be related over time. Finally, the monetary authority is believed to be accountable, over time, for movements in the money stock. Even though most central banks use short-term interest rates as the policy tool, manipulating interest rates still requires changes in the reserve structure of the banking system, and these changes produce changes in the money stock.

This article uses these propositions to address the question raised in the article's title. The discussion focuses on the first two points, leaving the issue of money stock control for another study. Before turning to the empirical evidence on these points, however, it is useful to examine a brief history of monetarism's rise and fall as a policy guide.

A Brief History of Monetarism

Money's role in the macroeconomic theories developed during the 1930–60 period was negligible.[6] Following the Great Depression and World War II, the dominant view was that governments could successfully manage economies to achieve full employment. The tool by which such "demand management" could be conducted was fiscal policy. Monetary policy was considered important only in the sense that it would keep interest rates at levels necessary to maintain economic growth. Inflation was of little concern in the early postwar period.[7]

Against this mainstream view, some economists emphasized the empirical relationship between movements in the money stock, nominal income, and inflation. The early studies of Warburton (1966) stand out in this regard. Warburton tested the link between money and inflation and money and income, providing empirical support for the notion that increases in the growth rate of the money stock lead to similar increase in the inflation rate. He also found that short-run fluctuations in real output are related to similar changes in money growth. Both of these empirical results became a hallmark of modern monetarism. Unfortunately, Warburton's evidence and scholarly work received scant attention and did little to alter mainstream perceptions regarding the importance of money.

Although the history of monetarism in the postwar period contains many important and interesting contributions, this article focuses on three: the early work done by Milton Friedman and his associates, the Andersen-Jordan model of income determination and the subsequent St. Louis model, and the velocity shift of the early 1980s.

Friedman and Associates. The 1950s witnessed an increase in scholarly work on monetary theory and policy. Notable in this regard is the work of Milton Friedman and his students at the University of Chicago. Friedman's research agenda at the National Bureau of Economic Research (NBER) in the early 1950s began to focus on monetary economics.[8] For example, an early analysis examined the effects of money on the economy during wartime (Friedman 1952). The mid-1950s saw the publication of *Studies in the Quantity Theory of Money* (1956), a collection of articles by Friedman and his students in the monetary workshop at the University of Chicago. His introductory essay, "The

1. See Mayer (1999), DeLong (1997), or Sargent (1999) for a discussion of what is referred to as the "Great Inflation."
2. See Hafer (1999) and Meigs (1976) for a discussion of the early debates over the use of monetary targets. A review of policy actions taken by the Federal Open Market Committee (FOMC) reveals that, during the period from 1950 through 1979 and since 1982, monetary aggregates have been ignored more often than they have contributed to policy decisions.
3. See Mayer and Minford (1995), DeLong (2000), or Woodford (forthcoming).
4. Mayer (1978), for example, suggests more than a dozen attributes of what makes up monetarism, including notions about governmental intervention.
5. The so-called Taylor rule, which relates changes in the federal funds rate to deviations in inflation and output from their desired rates, is a recent policy rule derived from empirical findings. Its long-term viability, like Friedman's rule, will be subject to the vagaries of the underlying data.
6. Portions of this discussion draw on Hafer and Wheelock (2001). Note that the discussion deals only with monetarism as it developed in the United States, not elsewhere.
7. The notion that monetary policy actions, defined as changes in the growth rate of the money stock, are unrelated to economic activity and should not be given much due is not an idea that remained the exclusive property of economists in the 1940s or 1950s. More recent evidence of such a view is found in B. Friedman (1984, 1997).
8. As Friedman recalls it, "In 1950, Arthur Burns, who had taken over from [Wesley Claire] Mitchell as director of research, asked me whether I would take responsibility for the part of the study dealing with the role of money in business cycles. Both his invitation and my acceptance of it demonstrates the interest that I had already developed in the role of money" (Friedman and Friedman 1998, 227–28).

Quantity Theory of Money—A Restatement," is considered by some as the defining article that established modern monetarism.

Friedman posits in this essay that nominal income is closely related to monetary developments: simply put, the theory of money demand is really just a theory of nominal income determination. Mayer and Minford (1995) suggest that Friedman's essay shifted the debate from money's long-run effects on prices to its shorter-term influence on the business cycle. As they state, "This meant that the quantity theory could now explain changes in output as well as in prices, and could no longer be dismissed as arbitrarily assuming full employment" (4). This view contrasted sharply with the Keynesian orthodoxy, one in which money had little or no role.[9] Friedman's own view is that the publication of this book in 1956 was "the first major step in a counterrevolution in monetary theory that succeeded in restoring the classical quantity theory to academic respectability under the unlovely label of 'monetarism'" (Friedman and Friedman 1998, 228).[10]

In October 1982 the Fed abandoned monetary targets as operating guides and returned to targeting the federal funds rate. Indeed, today monetary growth targets play no official role in the setting of U.S. monetary policy.

Friedman's work during the 1950s laid the foundation for later studies linking the behavior of the economy to monetary policy actions. His early work at the NBER with Anna J. Schwartz began to focus more on the business cycle effects of money and monetary policy.[11] His testimony to the Joint Economic Committee in 1958 provides a glimpse into this early counter-attack on Keynesian orthodoxy. At that time policymakers within the Federal Reserve System typically expressed little concern over money's cyclical effects. Minutes of the FOMC's policy meetings indicate that committee members largely rejected the notion that movements in the money supply could be controlled, much less that changes in money growth affected economic activity in any predictable manner. A few members of the FOMC warned that significant shifts in money growth could cause undesirable shifts in the real economy and that the secular increase in money growth would likely raise inflation rates. Unfortunately, these concerns went largely unheeded.[12]

A critical event in the early monetarist assault on Keynesian policies occurred with the 1963 publication of Friedman and Meiselman's "The Relative Stability of Monetary Velocity and the Investment Multiplier in the United States, 1897–1958." The key empirical finding reported in the article rejected a core component in the Keynesian macro model—namely, the relative stability of the expenditure multiplier. Instead, Friedman and Meiselman demonstrated that the velocity of money, considered by Keynesians to be highly erratic and thus obviating any reliable money-income link, is relatively stable over time.[13] They argued that changes in the money stock are more likely caused by changes in the money supply—stemming directly from monetary policy actions—than from changes in the public's demand for money. This finding supported an underlying tenet of the quantity theory and the emerging monetarist argument: changes in nominal income are largely determined by changes in the money supply. Since movements in the money supply are related directly to policy actions, fluctuations in economic activity logically are tied to the Fed's policy actions.

Friedman and Meiselman's evidence and methodology were attacked and dismissed by mainstream economists. The criticisms of Ando and Modigliani (1965) and DePrano and Mayer (1965) were published in the *American Economic Review* along with the Friedman-Meiselman article and the latter's rebuttal (1965). The debate reflected a fundamental difference in views on the importance of money and the role of monetary policy. Friedman and Meiselman's evidence came from simple, reduced-form relations reminiscent of the quantity theory. Their conclusions were based on observed long-run relations in the data. Keynesian policies and viewpoints, represented by the Ando-Modigliani and DePrano-Mayer papers, relied on the output of newly developed, large-scale macroeconometric models. These models focused more on short-run dynamics, not long-run implications. Ando-Modigliani argued, for example, that the Friedman-Meiselman analysis used methods that were "inadequate" given the advances in econometrics and evidenced in the construction of large-scale models. In later analysis, Blinder and Solow (1974) suggested that the reduced-form approach taken by Friedman-Meiselman was "far too primitive to represent *any* theory" (cited in McCallum 1986, 11). The conventional view was that while different approaches generate different results, only the more sophisticated approach produces a reliable outcome.[14]

Finding that velocity appeared more stable than commonly thought heightened the debate over the relative effectiveness of monetary and fiscal actions as countercyclical policies. Most economists continued to support the use of fiscal actions as the only effective policy tools available to manage real economic activity.[15]

The results of Friedman and Meiselman helped spur the development of a nascent monetarist research agenda. The publication in 1963 of Friedman and Schwartz's massive *A Monetary History of the United States: 1867–1960* provided even greater ammunition to the monetarist movement. In their study, Friedman and Schwartz documented the long-term, empirical relation between movements in the money supply, income, and prices. A major point established in their meticulous analysis of empirical relations and institutional detail was that movements in the money supply largely dictate observed changes in the economy. Indeed, a major contribution of the study was its description of policy blunders that led to the Great Depression. In the end, much of the blame was laid at the Fed's doorstep. While Friedman and Schwartz's *Monetary History* helped to establish a foundation for monetary policy emphasizing control of the monetary aggregates, the nature of the analysis was decidedly long-run.

Andersen-Jordan and the St. Louis Model. The heretofore long-run nature of the monetarist position changed dramatically with the 1968 publication of Andersen and Jordan's "Monetary and Fiscal Actions: A Test of Their Relative Importance." Their controversial results were based on testing the empirical relation between changes in nominal income and various measures of money and fiscal policy actions. The key equation can be written as

$$Y_t = \alpha + \sum_{i=0}^{3} \beta_i M_{t-i} + \sum_{j=0}^{3} \lambda_j E_{t-j} + e_t, \qquad (3)$$

where Y represents nominal GNP, M is the money stock (M1 or the monetary base), and E is one of several measures of fiscal policy actions.[16] The form of the equation explicitly recognizes the lagged effects of policy actions and allows a more precise estimation of the effects of changes in the policy variables. Andersen and Jordan, like Friedman and Meiselman, were interested in the role that money plays in explaining movements in nominal income.[17] But Andersen and Jordan extended the attack on the conventional wisdom by directly comparing the quantitative importance of the effect that monetary and fiscal impulses have on nominal income.

Money's role in explaining movements in nominal income was an important policy issue in 1968. Jordan recalls that "the 1966 credit crunch and subsequent 'mini recession' had demonstrated the potential for a restrictive monetary policy, measured in terms of a deceleration of monetary growth, to dominate an expansive fiscal impulse" (1986, 5).[18] The Andersen-Jordan results provided support for a key element in the monetarist position: namely, money is not only important in affecting nominal income but has a more direct and manageable impact on the economy than fiscal policy actions. In a significant way, the Andersen-Jordan results pushed the long-run monetarist propositions further into the short end of the policy horizon. Andersen and Jordan demonstrated that, by manipulating monetary aggregates, policymakers could achieve the kind of demand-management outcomes once thought possible only through fiscal policy actions.

Andersen and Jordan's results came under immediate criticism. A number of the criticisms

9. This view is debatable, as the exchange in Hafer (1986) between McCallum, Brunner, Blinder, and Gordon indicates.
10. Although Friedman is often considered the "father" of monetarism, it was Karl Brunner (1968) who coined the term.
11. This research would later be published in three volumes. See Friedman and Schwartz (1963, 1970, 1982).
12. Some members of the FOMC favored policies that placed more weight on the behavior of the money supply over financial market conditions. Of this small group, Delos Johns, president of the Federal Reserve Bank of St. Louis, and Malcolm Bryan, president of the Federal Reserve Bank of Atlanta, stand out. They based their policy recommendations on recent monetarist analyses. For a discussion of their contributions to the policy debate, see Meigs (1976) and Hafer (1999).
13. The velocity of money is simply the inverse of the k-ratio.
14. McCallum notes that "Most researchers in macroeconomics believed . . . that investigation of the issues under discussion could be adequately carried out in the context of a full specified, simultaneous-equation, econometric model"(1986, 11). Brunner rejected this notion, stating that "the use of a single equation with a single independent variable should now be clear. It was the appropriate choice for an assessment of the core class [of hypotheses]. It did not represent a single-equation *model* or a disposition to favor simple, as against sophistical, models" (1986, 41).
15. For a discussion of the issues surrounding the debate, see the articles in Hafer (1986).
16. Their analysis used three fiscal policy measures: the high-employment budget surplus, high-employment expenditures, and high-employment receipts.
17. Andersen-Jordan's intellectual link to earlier work by Karl Brunner is obvious. For example, Brunner and Balbach (1959) tested the relative role of money and fiscal policy actions and found that money played an important role.
18. The importance of the events surrounding the 1968 decline is revealed in Maisel's appraisal: "Monetarists' forecasts have had a fair record. The fact that they did well in 1968 when most others did poorly was a major cause of their initial popularity. . . . But I, at least, do not believe their record has been good enough to prove their simplified theory" (1973, 274).

were technical in nature.[19] It is interesting to note that some of the earliest and harshest criticisms came from within the Federal Reserve System itself. For example, DeLeeuw and Kalchbrenner (1969), both associated with the Board of Governors, argued that the monetary aggregate favored by Andersen and Jordan (the monetary base) was not exogenous with respect to movements in nominal income.[20] They also argued that Andersen and Jordan's results were inconsistent (and therefore suspect) with those generated by the Board of Governor's large-scale econometric model. Davis, an economist at the New York Fed, took up this argument, noting that the St. Louis equation "portrays a world [that is] in several respects sharply at variance with the expectations of most of us" (1968, 121). He suggested that monetarists build a structural model (like the FRB/MIT model) and reject the reduced-form approach that began with Friedman-Meiselman and was refined by Andersen and Jordan.[21]

The Andersen-Jordan results provided support for a key element in the monetarist position: namely, money is not only important in affecting nominal income but has a more direct and manageable impact on the economy than fiscal policy actions.

DeLong (2000) argues that the next significant development in the monetarist counter-revolution came with the 1970 publication of Andersen and Carlson's "A Monetarist Model for Economic Stabilization." Usually referred to as the St. Louis model, this study and subsequent refinement of the model put monetarism on similar footing with Keynesian models. The St. Louis model was "monetarist" in the sense that, even though money appears only in the total spending equation, its effects percolate throughout. For example, the effects from an increase in the growth rate of the money supply could be traced through its impact on nominal spending, changes in the price level, real output, long-term interest rates, and unemployment.[22] Since price level changes came about through a simple Phillips-curve relation embedded in the model, no claim was made that that relationship was being ignored. In fact, Andersen and Carlson explicitly state that their analysis was used "to estimate the response of output and prices to monetary and fiscal actions, not to test a hypothesized structure" (1970, 10–11).

The St. Louis model strengthened monetarism's place in policy discussions in several ways. First, monetarist analysis moved into the realm of short-run policy dynamics. Second, the estimated relationships provided support for the theoretical findings of Friedman (1968) and Phelps (1967) that there does not exist a long-run, exploitable trade-off between inflation and unemployment, as many Keynesian economists believed. Estimates of the St. Louis model also demonstrated that expansionary monetary policy can produce a short-run increase in real economic growth (a reduction in the unemployment rate) but that it will vanish over time as inflation picks up and the economy returns to its potential rate of growth. Such actions, taken repeatedly, impart an inflationary bias to the economy.[23]

Third, the Andersen-Carlson results showed that monetary policy, not fiscal policy, is a more potent tool for economic stabilization. Now monetary policy was defined in concrete terms. Instead of terms like "money market pressure" or "tone and feel," a vocabulary that popularized monetary policy analysis in the 1950s and 1960s (and has resurfaced in recent times), changes in the growth of the monetary aggregates could be calculated and their effects analyzed. The St. Louis model helped push the monetarist agenda to the forefront of the short-run stabilization debate more forcefully than previous work had. Dewald argues that "monetarism was [now] widely interpreted as providing an alternative to short run Keynesian model forecasts" (1988, 6).

The Rise and Fall of Monetarism as a Policy Guide. As the success of monetarist predictions mounted, monetarists began to shift from testing rival policies to arguing for the use of monetary aggregates as a short-run stabilization tool. Ongoing development of the St. Louis model and its variants, along with its use for policy analysis, pushed monetarism away from its roots in the long-term relations embodied in the quantity theory. By the mid-1970s, monetarism had elbowed its way squarely into the arena of short-run stabilization issues.[24] Unlike the large-scale macroeconometric models that contained hundreds of variables and equations, the archetypal monetarist model allowed one to analyze stabilization issues using a handful of equations.[25]

The increase in inflation rates throughout the 1970s led many to reconsider monetarist calls for a policy of steady money growth. Even though the inflation spikes of the 1970s were related directly to oil price shocks, the rising trend rate of inflation since the mid-1960s shadowed a similar increase in the average rate of money growth.[26] The Fed began, reluctantly, to adopt parts of the monetarist platform. In the mid-1970s, monetary targets were being used in official policy analysis; there is substantial evidence, however, that these targets were more window-dressing than strict policy guidelines (Friedman 1982).

The most dramatic shift toward a monetarist-like policy occurred in October 1979. At that time the Fed announced that it would henceforth emphasize policy procedures aimed more at controlling nonborrowed reserves than at the federal funds rate.[27] This shift was made to reduce inflation rates, which were then running in double digits. The restrictive policies enacted served to help lower inflation (and inflationary expectations), but they also sent the economy into the deepest postwar recession on record.

Monetarist theory predicted the outcome: A swift, sharp reduction in money growth (and the attendant spike in interest rates) initially affected real economic activity and then, over time, lowered inflation. Although monetarists predicted the outcome, they neither favored the policy nor claimed credit for it.[28] While monetarists attempted to disassociate themselves from the Fed's policies and to provide alternative procedures to achieve the desired money growth,[29] public perception and professional opinion quickly rejected the so-called monetarist policies being followed by the Fed. Attacks on monetarism surged not only in academic journals but in the popular press as well.[30]

Whether the Fed truly embraced a monetarist policy agenda in 1979 remains debatable, but the Fed's policies dealt a severe blow to monetarism. In addition, sweeping deregulation associated with the Depository Institutions Deregulation and Monetary Control Act of 1980 gave rise to increased volatility in the empirical links between the existing monetary aggregates and the economy. The spread of interest-bearing checking accounts severely altered the relationship between narrow measures of money and income from their historical norms. The most visible effect was the unexpected and large shift in velocity in the early 1980s, which severely reduced the accuracy of monetarist model predictions of nominal income growth and inflation.[31] As the 1980s progressed, deregulation of the banking system, largely a response to the disintermediation that occurred in response to the inflation of the 1970s, and the quickened pace of financial innovations altered the historical empirical relationships between money, income, and prices.

19. For reference to previous studies, see Hafer and Wheelock (2001).
20. Deleeuw and Kalchbrenner (1969) decomposed the monetary base into what they argued were the most exogenous components: reserves less bank borrowings—the adjusted base—and the adjusted base less currency. With this change they found that when the adjusted base was paired with real high-employment receipts, the sum of the estimated coefficients on lagged money—a measure of the monetary multiplier—was less than that found by Andersen and Jordan. Even so, the results were striking enough to show that monetary policy appeared "to exert a powerful influence."
21. Brunner (1986) notes in his survey that this criticism confused competing economic theory with testing a core class of hypotheses that are derived from theory. Even so, the stigma attached to reduced-form results dogged the debate. Regardless of the amount of empirical support for the finding that money influenced nominal income, monetary policy continues to this day to focus on the behavior of interest rates as *the* mechanism by which policy actions are transmitted to the economy.
22. Output is determined as the difference between total spending and the price level. As Andersen and Carlson note, "This method of determining the change in total spending and its division between output change and price change differs from most econometric models. A standard practice in econometric model building is to determine output and prices separately, then combine them to determine total spending" (1970, 10).
23. For a discussion about the role of monetary policy in generating the spiraling inflation that began in the 1960s, see the interviews in Mayer (1999).
24. Hafer and Wheelock (2001) detail the difficulties that this focus placed on the popularity of monetarism in policy discussions. Tavlas (personal correspondence) suggests that the movement to a shorter-term focus occurred much earlier, evidenced by the publication of Friedman (1972).
25. The 1970 version of the St. Louis model, for example, contained eight equations and eleven economic variables.
26. Fed Governor Gramley is quoted in Grieder (1987) as saying, "When you look back over the past fifteen years, you find that inflation kept getting worse. It got worse for a whole variety of reasons, *but certainly one of them was that the course of monetary policy over this long period had permitted a rapid increase in money and credit*" (emphasis added) (1987, 94). For discussions of the "Great Inflation," see DeLong (1997), Mayer (1999), and Sargent (1999).
27. For a timely overview of the so-called monetarist experiment, see Brunner (1983).
28. See the debate between M. Friedman (1984) and B. Friedman (1984).
29. For example, a number of studies demonstrated that the money multiplier was easily forecast, thus allowing the Fed to achieve monetary growth targets. See, among others, Johannes and Rasche (1979) and Hafer and Hein (1984) for examples of such analyses. Of course, the vacuous argument made against such evidence was that, once the Fed began to target the money stock, the ability to forecast the multiplier would be impaired.
30. Batten and Stone (1983) provide a partial listing of the articles taking a negative view of the monetarist experiment. (The author's personal favorite is Kaldor 1982.)
31. A key ingredient of the earlier success of short-run, empirical monetarist models had been the relative stability of velocity over much of the postwar period, even though this point was recognized early in the debate. See, among others, Rasche (1972).

In light of these events, policymakers quickly rejected monetary aggregates as a policy tool. In lieu of money, they once again returned to the manipulation of the federal funds rate to achieve policy objectives. Since the early 1980s, monetary aggregates have played a minimal role in the conduct of U.S. monetary policy. In the early 1990s, Taylor (1993) showed that U.S. monetary policy could be described accurately by relating movements in the federal funds rate to deviations in inflation from a posited target rate and deviations in real output growth from potential growth. The so-called Taylor rule has dominated much of the research on monetary policy during the past decade, both as a model of Fed behavior and as a model to guide policy decisions.[32] What is notable in this monetary policy rule is that money does not appear.

Unlike the large-scale macroeconometric models that contained hundreds of variables and equations, the archetypal monetarist model allowed one to analyze stabilization issues using a handful of equations.

The failure of monetarism to survive as a policy guide has been noted by Fed Governor Meyer (2001), who stated, "Monetarism is about money, but money plays no explicit role in today's consensus macro model, and it plays virtually no role in the conduct of monetary policy, at least in the United States."[33] The consensus macro model to which Meyer refers is described in McCallum (1999) and Rudebusch and Svensson (2000), among others. In this model, money's purpose is only to assist the central bank in determining the interest rate. The consensus macro model determines the inflation rate, the level of output, and the interest rate without any direct reference to the behavior of the money stock. As McCallum notes, "This is the basic point that has led many researchers to ignore money and, indeed, that has led the staff of the Fed's Board of Governors to construct a large, sophisticated, and expensive new macroeconometric model that does not recognize money in any capacity" (1999, 7). Meltzer echoes this in his observation that "Most working economists, most central bank staffs, and market practitioners do not use money growth to predict inflation" (1999, 25).

It would be incorrect, however, to conclude that monetarism failed. In fact, several of its key tenets have become characteristics of current economic thinking. DeLong (2000) and Woodford (forthcoming), for example, argue that the general acceptance of policy rules is a direct descendant of the monetarist agenda. In addition, the very fact that monetary policy, not fiscal policy, is considered the major weapon to combat economic fluctuation is a clear victory for the monetarist view. Still, interest rate manipulation once again dominates controlling growth in the monetary aggregates as a means of achieving stable economic growth and low inflation. The policy role of money is back to where it was almost forty years ago, and policy discussion today is similar to that found in the FOMC minutes from the 1960s.[34]

Monetarism is based on an empirical relation between movements in the money supply and income and prices. Thus, is there any informational content in the monetary aggregates that could help determine the direction and thrust of policy actions? Answering this question occupies the remainder of this article.

Empirical Evidence

This section provides some empirical evidence aimed at answering the question raised in the article's title as well as Meyer's (2001) corollary question: Does money matter? The analysis approaches this task in three interrelated parts. First, data from a sample of diverse countries is examined to determine whether money growth and nominal income growth are positively and significantly related. Next, the link between money and inflation is investigated. Finally, the effect of money on short-term fluctuations in real output is tested. Overall, the evidence indicates that movements in the money supply still help explain movements in nominal income, prices, and real output.

Data. The analysis uses annual post–World War II data from a diverse sample of countries. The data include two measures of money (M1 and M2), the price level (measured using the consumer price index [CPI]), nominal income (gross domestic product [GDP]), and real income (real GDP). The choice of countries is based on no specific criteria beyond data availability, attempting to provide a wide range in economic experience, and keeping the discussion tractable. The attempt is not to achieve total coverage but to test the general applicability of several key monetarist propositions. The sample of countries, the period covered, and summary statistics are provided in Table 1.[35]

Fifteen countries, including developed and developing countries, make up the sample. This sample covers a wide variety of economic experiences. For example, the average annual inflation rate averages a little over 9 percent, ranging from Malta's 3.3 percent to Indonesia's 23.3 percent. Similarly, average annual nominal GDP growth spreads across a wide

TABLE 1
Summary Statistics

Country	Sample	Average Rates of Growth (Percent) M1	M2	Price Level	Nominal GDP	Real GDP
Canada	1950–99	7.9	8.7	3.5	8.0	3.8
Chile	1960–99	23.7	26.4	16.5	21.7	5.2
Colombia	1955–99	20.0	22.9	16.6	21.2	4.6
Denmark	1950–99	8.3	8.2	5.3	8.2	3.0
Egypt	1952–99	10.8	13.5	7.6	12.4	4.9
Iceland	1951–98	20.5	21.4	16.1	21.4	5.3
Indonesia	1965–99	31.4	36.4	23.3	31.5	8.2
Japan	1953–99	10.5	11.0	4.0	9.2	5.3
Korea	1966–99	19.0	23.2	9.2	18.7	9.4
Malta	1957–99	7.8	9.6	3.3	8.7	5.4
Pakistan	1956–99	11.8	12.8	7.4	12.3	5.0
Philippines	1950–99	11.9	14.6	8.1	12.4	4.3
South Africa	1965–99	15.2	13.4	9.8	13.7	3.8
Thailand	1953–99	10.5	14.5	4.7	10.7	5.9
United States	1959–99	5.6	6.9	4.4	7.3	2.9
Averages		14.5	16.2	9.3	14.5	5.1

Source: International Monetary Fund, International Financial Statistics CD, December 2000.

range, from 7.3 percent in the United States to 31.5 percent in Indonesia. One aspect worth noting is that average nominal GDP growth across the sample is closer to money growth than is inflation or real GDP growth. As Table 1 shows, the average growth rate of the money supply—14.5 percent for M1 and 16.2 percent for M2—is closer to nominal GDP growth (14.5 percent) than to average inflation (9.3 percent). It should also be noted that average real GDP growth (5.1 percent) is noticeably less than money growth. Finally, the range of growth rates for real GDP—2.9 percent to 9.4 percent—is less than the range recorded for nominal GDP growth and inflation.[36] As a first approximation, these data suggest a closer relation between money and nominal income than between money and inflation or money and real output.

Correlations. If money matters for policy, there should be a correlation between money growth, nominal income growth, and inflation. In addition, if money growth has little impact on real output in the long run, then a smaller correlation between money growth and real output growth should be found in the data. It is useful to compare correlations across three time horizons, using annual observations of each variable, to assess the link between money and

32. For a critical analysis of the Taylor rule and its applicability, see Hetzel (2000) and the works cited therein. Arguably, the Taylor rule suffers from the same problems as the monetarist rule—namely, reliance on short-term empirical relationships in the data to drive policy implications. As Hetzel demonstrates, policies derived from the rule change over time, thus yielding questionable guidance.
33. There is an inconsistency to recent discussions concerning the role of money in monetary policy and the ultimate policy objective of price stability. For instance, Meyer (2001) states that money "plays virtually no explicit role in the conduct of monetary policy" in the United States and that "money matters—indeed it is just about all that matters—for inflation in the long run." While price stability is widely acknowledged as the appropriate long-run objective of monetary policy, many economists argue that policymakers should respond to fluctuations in real output or employment as part of their strategy to achieve price stability and, ultimately, to support maximum sustainable economic growth. This position is taken in Mishkin (2000), for example.
34. Consider Estrella and Mishkin's argument that "the inability of monetary aggregates to perform well as straightforward information variables in recent periods has the implication that they cannot be used to signal the stance of monetary policy, an important requirement if money growth targets are to be used as part of a strategy to increase the transparency of monetary policy to the public and the markets" (1996, 29).
35. All data are from the December 2000 International Financial Statistics CD.
36. This correlation between money growth, income growth, and inflation using a cross-section of countries has been documented previously. For recent examples, see Dwyer and Hafer (1988, 1999) and the references cited therein.

the economy. The analysis uses rolling averages of growth rates over one- three- and five-year intervals. This approach, similar to that of Dewald (1998) and Dwyer (1998), smoothes short-run fluctuations in the series that may mask the underlying, long-term relationship.[37] The correlations are reported in Table 2.

The results based on annual observations indicate a wide range of correlation for the money-price link. The correlation between M1 growth and inflation for the United States is 0.21. Using M2, the annual correlation is zero. This finding seems to support the contention that there is little informational content in the money growth numbers that policymakers can exploit. Looking across countries, the range of the annual correlation is from –0.04 for the Philippines to 0.97 for Indonesia. Considering the money-inflation relationship across countries, the average correlation between M1 growth and inflation is about 0.25 percent. Using M2 growth, the average correlation increases slightly to 0.40 percent. In either case, these correlations suggest a fairly loose relationship at an annual horizon. Indeed, this evidence suggests that the money-inflation link is rather weak over a period as short as one year.

Policies that increase money growth are more likely, over time, to generate increased inflation, not faster growth in the production of goods and services.

When the growth rates are averaged over time, the correlation between money and inflation generally increases. In Thailand, for example, the M1-inflation correlation is essentially zero with annual data but increases to 0.27 using the three-year average data and to 0.42 for the five-year averaged data. If M2 is used, the five-year correlation jumps to 0.63. This increase is also found in most other countries for which the annual correlations are rather low. For instance, the M2-inflation correlation using annual data for the United States is 0.21 but is 0.56 using the five-year interval. In one instance—Canada—there is no noticeable increase in the correlation between M1 growth and inflation even as longer averages are used. However, the money-inflation correlation in Canada is noticeably larger using the broader M2 measure: the correlation increases from 0.57 percent with annual data to 0.74 percent using five-year averages.

The results in Table 2 indicate that the link between money and inflation improves as the time horizon increases. The cross-country average correlation between M1 growth and inflation is 0.25 at an annual frequency but 0.60 percent when five-year averages are used. Similarly, the correlation between M2 growth and inflation jumps from a sample average of 0.40 using annual data to 0.70 with five-year averages. These results are consistent with the proposition that money growth and inflation are related more closely in the long run.

Table 2 reveals, in all instances but one, a positive correlation between annual money growth and nominal GDP growth, and in most cases this correlation increases as the time interval expands. For example, for the United States the correlation between annual M2 and GDP growth rates is 0.49, increasing to 0.85 when the data are averaged over five years. A similar increase in correlation is reported for most other countries although the magnitude of the increase varies. As with inflation, comparing the averages across countries is useful. For instance, the sample average money-GDP correlation using annual data is 0.40 percent using M1 and 0.57 percent using M2. When five-year averages are used, the correlation increases to 0.65 and 0.83, respectively. This evidence indicates not only that there is a positive correlation between money growth and nominal income growth but that this correlation increases as the time interval increases. This outcome also is consistent with the proposition that income growth and money growth are positively related.

Finally, monetarists often claim that the correlation between money growth and real income growth weakens over time relative to money-inflation and money-nominal income. The results in Table 2 bear this out. The correlation between money growth and real GDP growth using the five-year averages is considerably smaller than the corresponding correlations between money growth, inflation, and nominal income growth. Even though there are instances in which the correlation appears relatively large (for example, Malta [0.84] and Japan [0.82]), on average the money-real income correlations are smaller. This general view again is supported by measuring the average correlations across countries. The average M1–real income correlation is 0.26 percent at an annual horizon and only 0.19 using the five-year averages. If M2 is used, the correlations are 0.27 and 0.17, respectively. This evidence suggests

37. Dwyer (1998, n. 3) notes that a drawback of using rolling averages is that it induces serial correlation. Because each observation uses overlapping data, the usual tests for zero correlation are invalid. Even so, such averaging does not preclude comparing correlations as the time interval changes.

TABLE 2
Correlations

Country	Pair[a]	M1 Time Interval 1-Year	M1 Time Interval 3-Year	M1 Time Interval 5-Year	M2 Time Interval 1-Year	M2 Time Interval 3-Year	M2 Time Interval 5-Year
Canada	M, P	.00	.05	.16	.57	.71	.74
	M, GDP	–.09	.14	.17	.61	.81	.81
	M, RGDP	–.10	.14	.03	.17	.24	.15
Chile	M, P	.66	.69	.75	.60	.86	.87
	M, GDP	.78	.77	.75	.51	.62	.72
	M, RGDP	.72	.57	.37	.14	–.12	–.21
Colombia	M, P	.40	.77	.87	.57	.84	.90
	M, GDP	.50	.53	.46	.70	.90	.93
	M, RGDP	.12	.06	–.12	.18	.06	–.10
Denmark	M, P	.21	.55	.62	.33	.50	.49
	M.GDP	.26	.41	.41	.38	.72	.74
	M, RGDP	.07	.11	.13	.08	.05	.07
Egypt	M, P	.44	.32	.28	.62	.71	.77
	M, GDP	.62	.76	.81	.76	.87	.92
	M, RGDP	.33	.50	.49	.29	.38	.33
Iceland	M, P	.78	.92	.95	.82	.93	.96
	M, GDP	.81	.93	.94	.82	.92	.94
	M, RGDP	–.02	–.06	–.17	–.08	–.12	–.20
Indonesia	M, P	.35	.74	.94	.57	.72	.95
	M, GDP	.56	.86	.97	.70	.79	.96
	M, RGDP	.38	.43	.58	.27	.30	.50
Japan	M, P	.30	.46	.52	.41	.49	.55
	M, GDP	.59	.77	.84	.78	.91	.96
	M, RGDP	.50	.62	.68	.65	.79	.82
Korea	M, P	.19	.58	.74	.44	.78	.77
	M, GDP	.55	.86	.92	.53	.82	.82
	M, RGDP	.50	.71	.75	.21	.35	.51
Malta	M, P	.37	.64	.70	.06	.36	.52
	M, GDP	.56	.79	.82	.59	.83	.89
	M, RGDP	.39	.54	.59	.70	.81	.84
Pakistan	M, P	.02	.31	.61	.04	.34	.61
	M, GDP	.16	.32	.64	.19	.40	.66
	M, RGDP	.25	.02	.06	.26	.11	.10
Philippines	M, P	–.04	.51	.70	.14	.47	.74
	M, GDP	.08	.59	.70	.30	.53	.66
	M, RGDP	.18	–.10	–.41	.17	–.11	–.58
South Africa	M, P	.04	.28	.45	.17	.33	.61
	M, GDP	.34	.40	.40	.57	.70	.73
	M, RGDP	.33	.13	–.27	.49	.42	–.13
Thailand	M, P	–.01	.27	.42	.40	.51	.63
	M, GDP	.17	.51	.63	.63	.77	.84
	M, RGDP	.21	.33	.34	.32	.39	.37
United States	M, P	.00	.14	.28	.21	.43	.56
	M, GDP	.10	.22	.25	.49	.77	.85
	M, RGDP	.11	.03	–.16	.21	.19	.13

[a] The variables are money growth (M); the inflation rate (P), measured using the CPI; nominal GDP growth (GDP); and real GDP growth (RGDP). All variables are measured as logarithmic first differences.

that, in the long run, changes in money growth are more likely to affect changes in nominal income and inflation than changes in real output.

Why should money be related more closely with changes in prices and nominal GDP than changes in real output? If real output growth is, over time, determined by real factors, such as population growth or technology, then changes in money growth should be reflected in prices and nominal income (see equation [2]). The correlations do not reject the notion that, in the long run, changes in the growth rates of money have less effect on the path of real economic activity than on nominal income growth and inflation.[38] This finding is in line with monetarist propositions and has an important policy implication: Policies that increase money growth are more likely, over time, to generate increased inflation, not faster growth in the production of goods and services.

It appears that changes in the real money stock may significantly affect short-term economic activity even after the impact of changes in the real rate of interest is accounted for.

Money and Nominal Income. Equation (1) suggests that changes in the stock of money are directly and positively associated with movements in nominal income, given the *k*-ratio. This hypothesized relationship is used to examine an important monetarist proposition—namely, that there exists a positive connection between changes in the stock of money and the level of nominal income. The correlations in Table 2 generally do not reject this notion. To further check whether money growth can serve as an indicator of nominal income growth, this analysis employs so-called Granger causality tests. The idea is to determine whether there is information in money growth that, once estimates have been conditioned on past income growth, significantly improves the prediction of income. Even though such test results should be viewed with some caution, they are instructive. Table 3 reports the outcome of these pairwise causality tests between money growth (M1 and M2) and nominal income growth.[39]

The first two columns of Table 3 report statistics associated with testing the hypothesis that M1 growth does not cause GDP growth. A statistically significant test statistic allows one to reject that hypothesis. The hypothesis is rejected in ten instances at a 10 percent level of significance (eleven if one permits the 12 percent significance level found for Pakistan). These results suggest that in two-thirds of the countries examined there is evidence that changes in money growth have a significant impact on nominal income growth. The second column tests the companion hypothesis, whether GDP growth does not cause M1 growth. The results of that test indicate that this hypothesis is rejected in five cases, again using a 10 percent level of significance. The results suggest that GDP growth does not cause money growth in nine out of fifteen instances.

The third and fourth columns of Table 3 report the results using the broader M2 measure of money. Overall, the results are comparable to those using M1. The hypothesis that M2 growth does not cause GDP growth is rejected in eight instances, and in seven cases the hypothesis that GDP growth does not cause M2 growth is rejected. These results suggest that the choice of the monetary aggregate has some effect on the test outcome. Overall, the results in Table 3 indicate that there is a causal link from money growth to nominal income in many countries.

An even more restrictive hypothesis can be tested: Does money have a *unidirectional* effect on nominal GDP? This hypothesis is important to establish the usefulness of monetary aggregates in conducting monetary policy. If changes in money do not stem from changes in income, money could serve as a useful measure of the thrust of policy actions.[40] The results for M1 found in Table 3 indicate that one would answer this question in the affirmative for seven countries: Canada, Colombia, Egypt, Japan, Malta, the Philippines, and Thailand. Unidirectional causation from M2 to income cannot be rejected for Canada, Colombia, Egypt, Korea, and the Philippines. Note that changing the definition of money affects the outcome for Malta, Korea, and Thailand. The array of economic experiences captured by this subsample of countries suggests that the money-income relation does not hold only for certain types of economies.

Conversely, is evidence of unidirectional causation running from GDP growth to money growth? Such a finding is most damaging to the idea that monetary aggregates are useful in setting policy because it signals that money growth is not exogenous to changes in income growth. The hypothesis that GDP unidirectionally causes M1 is not rejected in only two countries—Iceland and Pakistan. In the remaining countries, there is evidence of bidirectional causation (Chile, Denmark, and Korea) or no discernable relation (Indonesia, South Africa, and the United States). Replacing M1 with M2 leads to the following outcomes: the hypothesis that GDP growth unidirectionally causes M2 is not rejected for Iceland, Malta, Pakistan, and South Africa at the 10 percent level. Bidirectional causation is not ruled out for Denmark,

TABLE 3
Pairwise Causality Tests

Country	F-statistics (Probability)							
	M1 Does Not Cause GDP		GDP Does Not Cause M1		M2 Does Not Cause GDP		GDP Does Not Cause M2	
Canada	2.45	(0.09)	0.33	(0.72)	3.21	(0.05)	1.22	(0.30)
Chile	3.41	(0.05)	5.68	(0.01)	0.51	(0.61)	1.88	(0.19)
Colombia	18.88	(0.00)	1.28	(0.29)	5.67	(0.01)	2.23	(0.12)
Denmark	4.43	(0.02)	7.07	(0.00)	2.94	(0.06)	6.32	(0.00)
Egypt	11.74	(0.00)	0.41	(0.67)	18.41	(0.00)	0.36	(0.70)
Iceland	0.78	(0.46)	9.24	(0.00)	1.49	(0.24)	9.92	(0.00)
Indonesia	0.88	(0.43)	0.32	(0.73)	0.41	(0.67)	0.52	(0.60)
Japan	5.06	(0.02)	1.76	(0.18)	7.78	(0.00)	2.89	(0.07)
Korea	5.05	(0.02)	3.73	(0.04)	3.66	(0.04)	1.79	(0.19)
Malta	4.16	(0.02)	1.58	(0.22)	1.36	(0.27)	8.54	(0.00)
Pakistan	2.26	(0.12)	3.06	(0.06)	1.23	(0.30)	5.18	(0.01)
Philippines	13.13	(0.00)	0.78	(0.46)	11.99	(0.00)	0.09	(0.91)
South Africa	0.40	(0.67)	0.61	(0.55)	2.02	(0.15)	2.57	(0.10)
Thailand	4.04	(0.02)	0.82	(0.45)	1.09	(0.35)	1.98	(0.15)
United States	0.68	(0.51)	1.16	(0.33)	8.18	(0.00)	3.18	(0.05)

Japan, and the United States. The remaining countries indicate no reliable statistical relation. The fact that the GDP-to-money causation is relatively weak across most countries suggests that money may possess potentially useful policy information.

Money and Inflation. The view often stated by policymakers is that the objective of monetary policy is to keep inflation at bay. Some central banks announce explicit inflation targets although Mishkin (2000) points out that the Federal Reserve has been reluctant to do so. As Meyer (2001) notes, "Given the widespread commitment to price stability, monetarists believe that central banks should therefore give appropriate attention to money growth in the conduct of monetary policy." Is there evidence to support this belief?

A number of recent studies find that movements in the nominal money stock and the price level are positively related. Two approaches are used in these studies. Dewald (1998), for example, averages money growth and inflation data over time, sometimes for periods as long as a decade. The other approach, used in Dwyer and Hafer (1988, 1999), for example, averages data over shorter time spans but across a large number of countries. The analysis in this article examines the temporal relationship between money and prices on a country-by-country basis to gauge the generality of the connection and to illustrate the idiosyncratic nature of the relationships.

To better illuminate the link between money and prices, equation (2) can be solved for the price level to yield

$$P = k^{-1}(M/y). \tag{4}$$

Equation (4) states that, given the k-ratio, changes in the ratio of money to real output are reflected in the price level. If the k-ratio is relatively stable over time,[41] the price level and money per unit of output should move together over time.

38. In a similar vein, Barro (1996) finds that there is no significant relation between inflation and economic growth for a large sample of countries. If inflation is, in the long run, determined by money growth, then Barro's results imply that money growth and real economic growth also are not related over time.
39. For each test, two regressions are estimated, one with nominal income growth as the dependent variable, another with money growth as the dependent variable. To conserve on degrees of freedom, the explanatory variables in each regression consist of two lags of money growth and nominal GDP growth. In essence, then, the causality tests conducted here simply ask whether there is any information in the variables that, after the estimates are conditioned with lags of the dependent variable, improve the explanatory power of the equation.
40. A classic treatment of the instrument-indicator issue is Brunner (1969).
41. This point has been the subject of intense and long-lasting debate, whether the issue revolved around the k-ratio or the demand for real money balances. Although there is evidence that the demand for money is somewhat volatile in the short run, there is compelling evidence to suggest that the economic relationship is stable over time. See, for example, Hoffman and Rasche (1996) and the articles cited therein for evidence on this point.

Real output (y) plays an important role in this story. The range of average output growth for the countries studied here is considerably less than the range for inflation and nominal income growth (see Table 1). This result suggests that real output growth may be determined less by nominal factors, such as money growth, and more by real factors, such as population growth, changes in technology, and changes in the capital stock. If one takes output in the long run as being determined exogenously to monetary policy, then the only impact of changes in the growth rate of money is on the price level. In other words, equation (4) shows that if the k-ratio is stable and real output is determined independently of money, there is a one-to-one connection between changes in money and the price level.

The data indicate that money growth is directly related to nominal income growth and inflation. Moreover, the evidence suggests a weaker relation between money growth and real output growth in the long run.

To investigate the link between money and prices within the context of equation (4), the ratio of money to real income is plotted along with the price level for each country. The resulting graphs are shown in the chart on page 27. The scale for each graph is logarithmic—that is, the slope of the money-output ratio and the price level lines represent rates of change. Similar slopes thus indicate that the growth rates of the underlying series are positively related.

The chart shows that for every country there is a positive, long-run relationship between the money and price series. It is informative that the recent deviation in the United States, which occurred during the early 1990s, is not unique. Such deviations occur, sometimes even frequently, but the two series persistently move together over time. Whether for a high-inflation country such as Indonesia or Chile or a low-inflation country like Japan, the plots in the chart indicate that increases in the growth of money, given output growth, are associated with higher rates of inflation.

Correlations between the two series (not reported) indicate that there is nearly a one-to-one relation between money and prices.[42] This evidence corroborates the results in Table 2, where the correlation between money growth alone and inflation increases over lengthening time intervals. The upshot is that an increase in the growth rate of money relative to real output is likely to impart upward pressure on the price level. Failure by central bankers to heed this signal may create inflationary increases that, as occurred in the past, necessitate restrictive measures.[43]

Money and Real Output. Current U.S. monetary policy, according to Meltzer (1998, 1999), McCallum (1999), and Meyer (2001), utilizes several economic models in which money generally plays no direct role. This view is based on a popular macroeconomic model in which movements in real output are a function solely of changes in the real rate of interest. In this model, monetary policy affects real economic activity only indirectly through its impact on the real rate of interest. Movements in the money supply, therefore, are viewed as having no independent effect on output.[44]

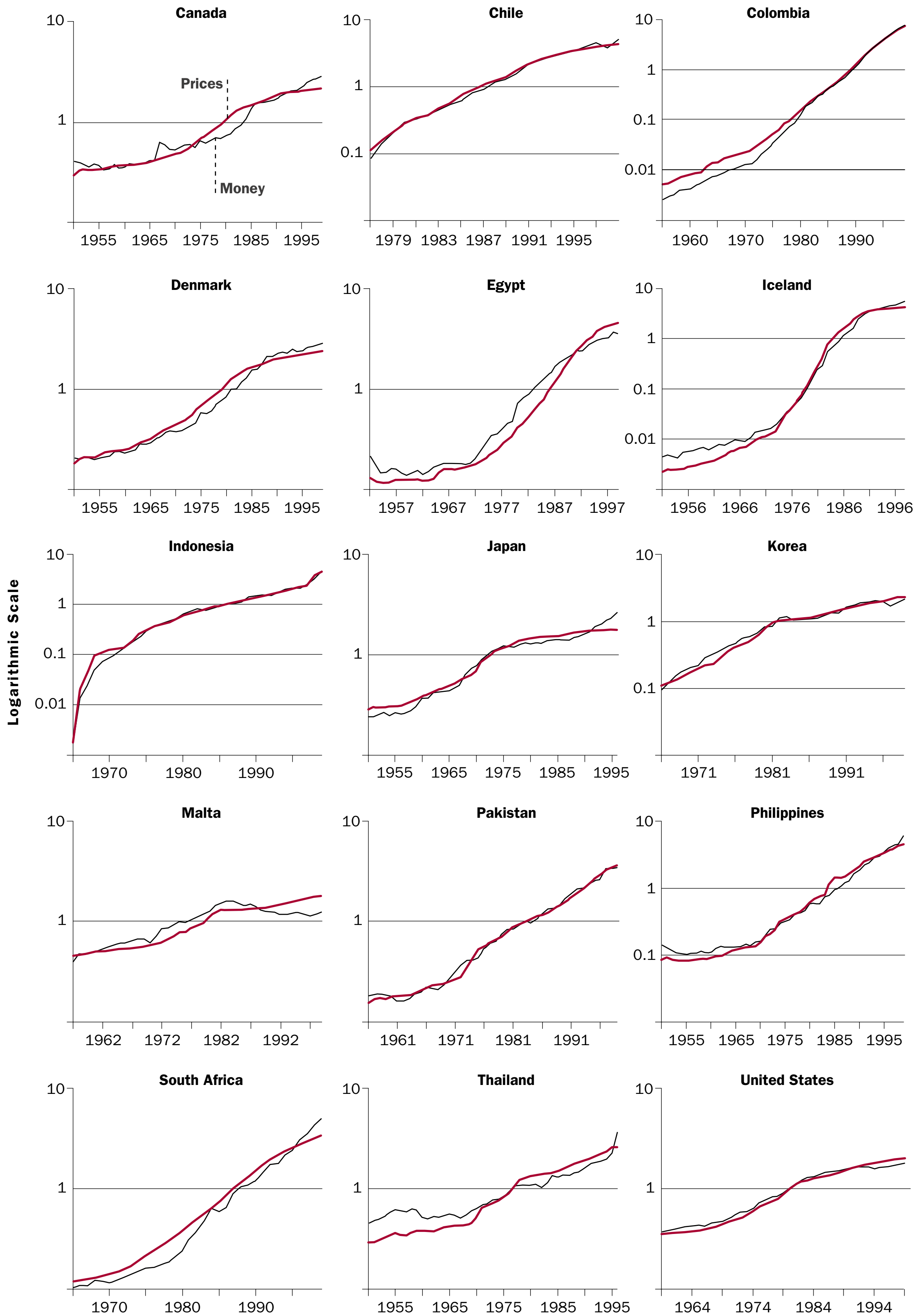
The policy implications of this so-called consensus model have been criticized by a number of economists, such as Meltzer (1999) and Nelson (2000). The popular view is that policy actions taken by a central bank first produce changes in a number of financial returns. The transmission mechanism—the route by which policy actions affect the real economy—thus works primarily through an interest rate channel. A change in policy—that is, a change in the target federal funds rate—leads to a series of changes in other interest rates that induce individuals to reallocate portfolios of financial and real assets, thus producing a change in economic activity. Taking such a narrow focus usually means that one considers only one real interest rate as reflective of policy actions—thus, the focus on the federal funds rate as the sole policy indicator.

This narrow view ignores the potential effects that arise through other avenues, such as changes in real long-term rates or in the return on real assets. Meltzer (1999) tests for the impact of monetary policy actions on aggregate demand by estimating a consumption function in which both short-term real interest rates and real money balances appear. Arguing that prices are relatively sticky in the short run, Meltzer finds that, even after accounting for the effect of the short-term real rate, movements in the real monetary base exert a statistically significant, independent effect on consumption.

Nelson (2000) also tests for the effect of changes in real money balances on aggregate demand using data from the United States and the United Kingdom.

42. The lone exception is Malta, where the correlation is 0.84. For all other countries, the correlation exceeds 0.90.
43. For a useful discussion of such policies and the inflation they engendered in the United States, see Mayer (1999).
44. Examples of recent studies employing such models include Rudebusch and Svensson (1999, 2000) and McCallum and Nelson (1999), among others.

The Correlation between Money and Prices



Source: International Monetary Fund, International Financial Statistics CD, December 2000.

TABLE 4
Detrended Output Regressions: M1

Country	y_{t-1}	y_{t-2}	$real_{t-1}$	$real_{t-2}$	$money_{t-1}$	$money_{t-2}$	adjR^2	DW
Canada	1.084	–0.297					0.710	1.85
	(7.76)	(1.86)						
	1.194	–0.387	–0.007	0.004	0.059		0.785	1.86
	(7.36)	(2.46)	(3.67)	(2.54)	(1.23)			
Chile	1.285	–0.659					0.799	2.53
	(8.54)	(4.43)						
	0.969	–.0387	0.001		0.210		0.821	2.43
	(6.05)	(2.43)	(0.30)		(2.15)			
Denmark	1.112	–.0267					0.760	1.94
	(8.31)	(2.70)						
	1.231	–0.418	–0.002		0.107	–0.113	0.787	1.91
	(7.55)	(2.32)	(1.20)		(1.85)	(2.01)		
Japan	1.259	–0.390					0.847	1.93
	(9.23)	(3.19)						
	1.027	–0.256	–0.001		0.282		0.877	1.76
	(6.34)	(1.99)	(0.70)		(4.29)			
South Africa	1.049	–0.450					0.588	1.86
	(6.84)	(3.32)						
	0.898	–0.327	–0.001		0.103		0.599	1.86
	(5.01)	(2.06)	(0.70)		(1.97)			
Pakistan	0.884						0.768	1.64
	(10.92)							
	0.856		0.002		–0.114		0.774	1.52
	(9.56)		(1.63)		(1.84)			
United States	1.155	–0.442					0.685	1.96
	(8.31)	(3.29)						
	1.030	–0.250	0.001		0.107		0.686	1.81
	(7.62)	(1.25)	(0.42)		(1.10)			

Notes: All equations include a constant term. Figures in parentheses are absolute values of t-statistics based on White heteroskedasticity-consistent standard errors.

In contrast to previous findings (such as Rudebusch and Svensson 2000), Nelson reports that deviations in real output from its trend (or potential) are explained by real short-term interest rates *and* real monetary base growth. Nelson's finding is important because it demonstrates a direct, independent effect of changes in monetary aggregates on aggregate demand.[45] Movements in the monetary base—an aggregate over which the monetary authority arguably has some control—thus affect the real economy in the short run. Nelson argues that "when yields besides the short-term rate enter both the IS and LM relations, it is possible that real money growth might be a valuable summary statistic for these yields and might therefore contain information about GDP not present in short-term interest rates" (2000, 18).[46]

This article tests for the independent effects of real money balances on real output once the effects of a real short-term interest rate have been accounted for. Using Nelson's approach, the following equation is estimated:

$$y_t = a + b_i y_{t-i} + c_i r_{t-i} + d_i m_{t-i} + e_t, \qquad (5)$$

where y is deviations of real output from trend, r represents the real rate of interest, m is real money balances, e is an error term, and the terms a–d are coefficients to be estimated. Nelson (2000) provides a discussion of the underlying theory, which predicts that the expected sign on the real rate of interest should be negative: An increase in the real rate, if all other factors remain the same, should lower aggregate demand. The expected sign on real money balances is positive, suggesting that expansionary monetary policy leads to a (temporary) increase in real output growth above trend.

The paucity of data on short-term rates reduces the sample to seven countries: Canada, Chile, Denmark, Japan, Pakistan, South Africa, and the United States.[47] As a first approximation, real interest rates are calculated as the observed nominal interest rate minus the actual rate of inflation. To calculate the growth of real money balances, nominal money balances are deflated by the CPI, and the logarithmic first difference of the series is calculated. Finally, recent work focuses on the impact of real rates and real balances on deviations of real GDP from potential or trend values. Since measuring potential GDP is difficult under the best of circumstances, this analysis measures the output gap as deviations of real GDP from a quadratic trend.[48]

Table 4 reports the outcome from estimating equation (5) for the seven countries when M1 is the monetary aggregate used. Two regressions are reported for each country. The first is a regression of the output gap on its own lagged values. The lag length reported is based on experimentation with longer lag lengths, using only the last lag that achieves statistical significance. In most instances the significant lags are limited to the first two. The second equation adds to this equation lagged values of the real interest rate and lagged values of real money growth.

The results generally indicate that lagged real interest rates do not achieve statistical significance. For example, the real rate is significant only for Canada, and even there the cumulative effect is quite small. Similarly, Nelson (2000) also reports that the real rate is insignificant (and positive) for the United Kingdom. These results do not support the hypothesis that changes in the real rate of interest explain movements in detrended output growth. The results for lagged real M1 growth are more positive, though not overwhelming. Across the countries tested, this study finds that money generally exerts a positive effect on detrended real output for Chile, Japan, and South Africa. In two instances, Denmark and Pakistan, the estimated coefficients are counter to the theoretically expected positive sign.[49]

Table 5 reports the results when M2 is used to estimate equation (5). Switching to the broader measure leads to money's insignificance for Chile, in contrast to the outcome found using M1. However, switching to the broader measure produces a significant result for the United States. Overall, using M2 yields a significant monetary effect on the output gap in Canada, Denmark, Japan, South Africa, and the United States. In these five cases, an increase in real M2 growth, all other things being equal, is associated with an increase in the output gap.

These results are supportive of Meltzer (1999) and Nelson (2000). It appears that changes in the real money stock may significantly affect short-term economic activity even after the impact of changes in the real rate of interest is accounted for. Moreover, it should be noted that the importance of the real rate of interest is by no means supported in these results. Though tentative, the results reported here, especially using M2, do not support the widely held opinion that money should play no role in monetary policy.

45. There is literature that addresses the unresolved issue of whether real output is affected in the short run by changes in money growth independently of changes in short-term interest rates. For recent studies of this issue and evidence suggesting that there is a significant money-output link, see Hafer and Kutan (1997) or Swanson (1998) and the articles cited therein.
46. Nelson (2000) provides a theoretical model in which the appearance of real money balances is justified as an explanatory variable in the model. As he suggests (p. 28), real money balances act as a proxy for the effects of policy actions on the multitude of yields that in all likelihood enter the aggregate demand and money demand functions.
47. The rates used for each country are the T-bill rate (Canada and South Africa), market lending rate (Chile), discount rate (Denmark), call money rate (Japan and Pakistan), and the federal funds rate (the United States). All rates are from the International Monetary Fund's International Financial Statistics database.
48. This series is generated as the residual from a regression of log real GDP on time and time squared.
49. Although not reported, this analysis also tested for temporal stability in the extended equations. In all cases except Canada, the calculated test statistics do not permit rejection of the hypothesis of stability. The break point tested is 1980.

TABLE 5
Detrended Output Regressions: M2

Country	y_{t-1}	y_{t-2}	$real_{t-1}$	$real_{t-2}$	$money_{t-1}$	$money_{t-2}$	adjR^2	DW
Canada	1.084	–0.297					0.710	1.85
	(7.76)	(1.86)						
	1.171	–0.396	–0.008	0.004	0.034		0.776	1.86
	(6.34)	(2.20)	(3.32)	(2.79)	(0.32)			
Chile	1.285	–0.659					0.799	2.53
	(8.54)	(4.43)						
	1.235	0.640	0.001		0.073		0.780	2.42
	(5.76)	(3.89)	(0.11)		(0.28)			
Denmark	1.112	–0.0267					0.760	1.94
	(8.31)	(2.70)						
	1.113	–0.278	–0.002		0.144		0.779	1.81
	(7.26)	(1.56)	(1.22)		(2.12)			
Japan	1.259	–0.390					0.847	1.93
	(9.23)	(3.19)						
	1.241	–0.373	–0.002		0.409	–0.238	0.886	1.95
	(10.07)	(3.20)	(0.84)		(4.57)	(2.12)		
South Africa	1.049	–0.450					0.588	1.86
	(6.84)	(3.32)						
	0.736	–0.185	–0.001		0.361		0.660	1.79
	(5.31)	(1.43)	(0.83)		(3.39)			
Pakistan	0.884						0.768	1.64
	(10.92)							
	0.855		0.002		–0.084		0.776	1.56
	(8.98)		(1.42)		(1.26)			
United States	1.155	–0.442					0.685	1.96
	(8.31)	(3.29)						
	0.728	0.155	0.001		0.435		0.796	1.69
	(5.24)	(0.77)	(1.13)		(4.79)			

Notes: All equations include a constant term. Figures in parentheses are absolute values of t-statistics based on White heteroskedasticity-consistent standard errors.

Conclusion

So what does remain of monetarism? Does money matter? The evidence presented in this article suggests that a blanket dismissal of monetary aggregates as uninformative for policy decisions is premature. The data from a variety of economies indicate that money growth is directly related to nominal income growth and inflation. Moreover, the evidence suggests a weaker relation between money growth and real output growth in the long run. These findings change as the time horizon moves from annual to multiyear averages. But the pattern is what monetarism suggests should occur, in keeping with its foundation in the quantity theory. While these results do not support a version of monetarism in which short-term manipulation of the monetary aggregates delivers direct and precise control over movements in income and prices, they also do not reject the notion that changes in money growth have important effects on the economy. Failure to acknowledge this empirical fact could give rise to undesirable policy consequences, as evidenced by the inflation of the 1970s or the dramatic and deep recession of the early 1980s.

If one is skeptical about the role of money and prefers interest rates as the key policy tool, the results presented here do not provide overwhelming support for that position. It appears that there is more likely to be a short-run response of real output to a change in money growth than a change in real interest rates. Of course, these estimates are based on only one measure of the real rate, but the outcome is similar to Nelson's (2000) more rigorous analysis. Together, his results and those in this study do not provide much empirical support for the use of interest rates as key policy variables to achieve stable economic growth.

The results presented here signal a call for continued research into the links between money and the economy, the assessment of existing and new measures of the money aggregates, and the role that money should play in policy. In the end, it appears that quite a bit of monetarism remains.

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Assessing Simple Policy Rules: A View from a Complete Macroeconomic Model

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POLICY ANALYSTS MUST MAKE TOUGH CHOICES: SHOULD THEY USE A MODEL IN WHICH THE ECONOMIC BEHAVIOR IS STRIPPED DOWN AND EASY TO UNDERSTAND BUT WHOSE FIT TO DATA IS CRUDE, OR SHOULD THEY USE A MODEL WHOSE FIT AND FORECAST PERFORMANCE ARE GOOD BUT WITH ECONOMIC BEHAVIOR THAT IS NOT VERY DETAILED? THE NEED TO TELL TIDY stories frequently dominates the desire to fit data. This is not a choice between "simple" and "complex" though it is sometimes couched as such. A model must be simple if it's to be understood. It must be understood if it's to inform policy debates. Unfortunately, we understand models on a qualitative level, while we use them for policy analysis on a quantitative level. Tensions arise in moving from qualitative discussion to quantitative prediction.

The tensions are well illustrated by two popular approaches to empirical analysis of monetary policy: the New Keynesian (NK) and the identified vector autoregression (VAR) approaches. Stylized models of private behavior coupled with simple rules describing policy behavior characterize NK work. VARs consist of minimally identified dynamic descriptions of private behavior coupled with a detailed rule for policy behavior.[1]

The choice between the two approaches would not matter if they offered the same interpretations of policy behavior and the same predictions for the impacts of changes in policy. But they do not.

Much of the appeal of NK models derives from their simplicity.[2] Implications of the model are easy to communicate and have rapidly become a standard framework for discussing monetary policy. Simple models often produce stark conclusions. NK models deliver the stark conclusion that good monetary policy calls for the central bank to adjust the nominal interest rate more than one-for-one with inflation. Some authors argue that Federal Reserve behavior under Alan Greenspan is superior—nearly optimal, by some calculations—to Fed behavior before Paul Volcker became chair in 1979.[3] NK researchers base their case that policy has improved on estimates of the parameter that determines how much the Fed adjusts the federal funds rate when inflation changes. Estimates of a stronger response to inflation after 1979 than before 1979 underlie the NK case. An unstable policy rule is the linchpin in the NK case that monetary policy has improved. VARs, in contrast, tend to find little evidence of either important instability in policy parameters or instability in the dynamic impacts of exogenous shifts in policy.[4]

Simplicity also makes NK models vulnerable. In simple models, behavioral relationships are tightly circumscribed and sparsely parameterized. As a consequence, each parameter carries a hefty share of the model's implications: the value of a single parameter can mean the difference between inferring that policy was stabilizing or destabilizing. Because dynamics are carefully pruned, there is a great deal of simultaneous behavior. It is no surprise that this environment breeds identification problems.[5] Taken together, simplicity and simultaneity make it very difficult to nail down estimates of critical parameters. Despite this difficulty, single-equation estimation techniques constitute the bulk of the empirical work in the NK literature.

The choice between the New Keynesian and VAR approaches would not matter if they offered the same interpretations of policy behavior and the same predictions for the impacts of policy changes. But they do not.

Ironically, Taylor's (1993b) econometric modeling is the genesis for much of the recent NK work with simple policy rules. Identified VARs share with Taylor's analyses an emphasis on the economic system rather than on single behavioral relationships. In VARs, behavioral relationships are loosely consistent with theory. Dynamics are intricate, typically unrestricted, and difficult to interpret. These characteristics make the output of VARs hard to communicate, and the models often get treated as black boxes. Simultaneity is kept to a minimum: some of the most widely cited VAR models contain none at all. These blunt identifying assumptions, though controversial, can produce robust results. Rarely does instability of a single VAR parameter carry important qualitative implications.

The two approaches share the objective of explaining post–World War II U.S. data. Identifying assumptions, which are what link economic behavior to economic data, sharply distinguish NK and VAR approaches. We pursue that distinction to explore the identification problems that plague any attempt to tease policy behavior out of the tangle of dynamic correlations in macro time series. We take the view that NK models are restricted VARs. Dynamic optimizing behavior generates both linear and cross-equation restrictions. The latter group typically arises to ensure that expectations are rational and consistent with the model's predictions.

In the first section of the article we use an off-the-shelf NK model to obtain identifying restrictions in a three-variable model. We argue that identification problems pervade the model. Calibration offers one solution to these problems. For example, calibrating key private parameters or policy parameters can deliver economically sensible system estimates.

In such models it can be misleading to base inferences about the effects of policy solely on estimated policy parameters. The article's next section displays models that are stable despite the fact that policy parameters do not satisfy the NK criterion for "stabilizing" policy.

Some of the NK models' simplicity stems from their position on money: it's irrelevant. Money plays no role in the transmission of monetary policy, in the setting of monetary policy, or in the formation of expectations about policy. The monetary sector is a sideshow. The third section introduces money. Although this creates some new identification challenges, we argue that interpretations of historical policy behavior can change dramatically once money is reintroduced into the analysis. Estimates in that section rely on identifying assumptions that separate the behavior of money demanders from that of the monetary authority. Our results underscore, however, that understandings of behavior can change drastically when one moves away from relying on reduced-form correlations.

The fourth section puts a sharp point on the trade-off between simplicity and robustness of inferences. The identified VARs we report in that section display remarkable stability across subperiods in the postwar data. The stability implies there may not have been important changes in the dynamic responses of the economy to exogenous shifts in policy, raising doubts about the premise of the NK conclusion of superior policy performance in the past twenty years. Policy may, in fact, have improved over time. But New Keynesians do not make the case.

Some authors argue that because the behavioral equations in NK models emerge from optimization, it is reasonable to treat them as invariant to policy (Rotemberg and Woodford 1997 and Woodford 1999b). Similar claims cannot be made for equations in identified VARs. Instead, building on Sims (1987), Leeper and Zha (2001) contend that VARs are linear approximations to an underlying nonlinear model and that, for many practical policy questions, the linear approximations may be quite accurate. We shall not pursue this topic further here; rather, we accept that, for the class of policy interventions we think best characterizes routine Federal Open Market Committee (FOMC) analysis, both approaches estimate private behavioral equations that are virtually invariant.

A Canonical New Keynesian Model

In this section we lay out a slight variant of the stylized NK model that forms the basis of the monetary policy analyses in Clarida, Gali, and Gertler (1999, 2000), Rotemberg and Woodford (1997, 1999), Woodford (1999a, 1999b), and elsewhere. Under certain parameterizations, the model specializes to Taylor's (1999b) reduced-form model. The empirical results in this section relate to Taylor's version of the model estimated with U.S. data over the period from 1959:Q1 to 2000:Q2.

The Theoretical Model. Because the microfoundations of the model are well known, we shall simply write down the relevant log-linearized equations.

The generalized IS (investment demand and saving) equation is[6]

$$\text{(1) IS:} \quad x_t = -(1/\sigma)[i_t - E_t(p_{t+1} - p_t) - r] + \kappa\theta x_{t-1} + \kappa(1-\theta)E_t x_{t+1} + \varepsilon_t^{IS};$$

and the aggregate supply (AS) or price setting equation is

$$\text{(2) AS:} \quad p_t - p_{t-1} = \lambda_0 x_t + \lambda_1 x_{t-1} + \psi(p_{t-1} - p_{t-2}) + (1-\psi)\beta E_t(p_{t+1} - p_t) + \varepsilon_t^{AS},$$

where x is the "output gap," defined as actual output minus potential output:

$$x_t = y_t - y_t^p.$$

Here, i is the nominal interest rate, which is set by the monetary authority; p is the aggregate price level and $p_t - p_{t-1}$ is the inflation rate at t;[7] ε^{IS} is an exogenous process reflecting nonmonetary policy sources of aggregate demand; $1/\sigma$ is the intertemporal elasticity of substitution; r is the steady state real interest rate; κ is an indicator function equal to 0 or 1; θ and ψ lie on the unit interval; ε^{AS} is an exogenous process reflecting deviations from the condition that real marginal cost and the output gap are proportional; and β is the discount factor. The expectation E_t is taken with respect to an information set that contains all variables dated t and earlier.

As written in equations (1) and (2), our approach allows for the possibility of both forward- and backward-looking behavior in the IS and AS relationships. The parameters θ and ψ determine the extent to which behavior looks forward and backward. We are less concerned with whether backward-looking behavior can be sensibly rationalized in an optimizing framework than we are with extracting the model's implications for empirical work. To that end, it is desirable to work with a flexibly parameterized model.

Complete the model with the monetary policy (MP) rule

$$\text{(3) MP:} \quad i_t = \gamma_0 + \gamma_{\pi 1}[(p_t - p_{t-1}) - \bar{\pi}] + \gamma_{\pi 2}[(p_{t-1} - p_{t-2}) - \bar{\pi}] + \gamma_{x1}x_t + \gamma_{x2}x_{t-1} + \gamma_{m1}[(M_t - M_{t-1}) - \bar{\mu}] + \omega i_{t-1} + \varepsilon_t^{MP},$$

where ω is a parameter that allows for partial adjustment to the target interest rate and determines the degree of interest rate smoothing and ε^{MP} is a policy disturbance; $\gamma_{\pi 1}$ describes how policy responds to inflation and is the parameter that receives the most attention in the NK literature. $\bar{\pi}$ and $\bar{\mu}$ are target levels for inflation and money growth. This rule represents a substantial generalization of the class of rules typically considered in NK research as it allows policy choice to depend on the lagged inflation rate and output gap as well as on current and past money growth.[8] The rule that Taylor (1993a,

1. NK work is associated with Rotemberg and Woodford (1997, 1999), Clarida, Gali, and Gertler (1999, 2000), and McCallum and Nelson (1999); identified VARs are associated with Leeper, Sims, and Zha (1996), Christiano, Eichenbaum, and Evans (1999), and Bernanke and Mihov (1998). A third approach combines simple Taylor-type rules with large econometric models of the economy as in Bryant, Hooper, and Mann (1993), Taylor (1993b), and Levin, Wieland, and Williams (1999).
2. At the conference, a semantic debate took place concerning whether the class of models we have in mind are "New Keynesian." Nothing substantive rests on the terminology. We adopted the term from Clarida, Gali, and Gertler (1999), who labeled the literature "New Keynesian."
3. See, for example, Rotemberg and Woodford (1999) or Gali, Lopez-Salido, and Valles (2000).
4. See, for example, Bernanke and Mihov (1998), Sims (1999), Leeper and Zha (2001), or Hanson (2000b).
5. NK models are not unique in this regard. Virtually all dynamic stochastic general equilibrium models suffer from the kind of identification problems that concern us (see Canova and Pina 2000).
6. Although, strictly speaking, IS involves output rather than the output gap, in equation (1) we follow the convention in the NK literature.
7. In the empirical work below, we convert this to the annual rate $4(p_t - p_{t-1})$. To avoid notational clutter, we leave the conversion out of the theoretical expressions.
8. Papers by Clarida, Gali, and Gertler (2000) and Bernanke and Woodford (1997) also include policy responses to expected inflation and output. This makes little difference for our purposes.

1999a, 1999b) employs, and is now nearly standard equipment in an NK model, sets i solely as a function of the current inflation rate and output gap:

$$\text{(4) MP (Taylor):} \quad i_t = \gamma_0 + \gamma_{\pi 1}[(p_t - p_{t-1}) - \bar{\pi}] + \gamma_{x1} x_t + \varepsilon_t^{MP}.$$

The two exogenous processes associated with private behavior are ε_t^{IS} and ε_t^{AS}, and ε_t^{MP} is the exogenous part of policy behavior.

Potential Identification Problems. Nearly all the NK papers assume certain values for the private parameters in equations (1) and (2). They then estimate the policy parameters using ordinary least squares (OLS) or instrumental variables methods or they impose particular policy parameters. Suppose instead that the reduced form—or solved-out version—of equations (1), (2), and (3) were to be estimated simultaneously. Although the reduced form confounds private parameters and policy parameters, we may work with it as long as we do not intend to change policy parameters while holding fixed the reduced-form parameters in the nonpolicy equations. We can even solve the model numerically, noting, where possible, the linear restrictions the model implies and then imposing those restrictions on our estimation. In this procedure we concentrate on restrictions on contemporaneous interactions among variables, which are the most common identifying restrictions used in empirical work. Because cross-equation restrictions are often at odds with data, we limit ourselves to the linear restrictions that theory implies.

Even if particular policy parameters are unstable, when the dynamics of behavior are well modeled, the equilibrium effects of policy are quite stable.

Inspection of the three equations of the model suggests the potential for several identification problems to arise. First, both IS and policy link the current nominal rate to inflation and the output gap. If inflation is close to a random walk, then both equations involve (x_t, π_t, i_t), and without additional restrictions they cannot be distinguished. This problem is critical as it potentially confounds the impact of monetary policy with other sources of disturbance to aggregate demand, causing misleading interpretations of the role of monetary policy.

Taylor (1999b) resolves the identification problem by considering the model that emerges when $\kappa = 0$, $\lambda_0 = 0$, and $\psi = 1$. In that case, the reduced-form expression for IS makes $x_t = a(i_t - \pi_t - r) + \xi_t$, for some coefficient a, producing an additional restriction that separates IS from monetary policy.[9] If, in contrast to Taylor's specification, the IS curve is dynamic ($\kappa = 1$, $\theta \in [0, 1]$), then Taylor's additional restriction does not hold generally, and nothing distinguishes the reduced forms for IS and policy.

One way to separate IS and MP is to adopt the approach taken in some of the identified VAR literature and advocated by McCallum (1999) in NK models: an operational rule cannot make policy choice depend on variables the Fed does not observe contemporaneously. Because the Fed does not observe inflation and output contemporaneously, we might posit the rule

$$\text{(5) MP (Taylor lagged):} \quad i_t = \gamma_0 + \gamma_{\pi 2}[(p_{t-1} - p_{t-2}) - \bar{\pi}] + \gamma_{x2} x_{t-1} + \varepsilon_t^{MP}.$$

This rule equates the surprise in the federal funds rate, given past inflation and output, to the exogenous disturbance in monetary policy. Unfortunately, it is well documented that this identification can generate empirical anomalies; a prominent anomaly is that an exogenous monetary contraction raises the funds rate, lowers output, and raises the inflation rate (see, for example, Gordon and Leeper 1994).

Although it is no longer fashionable to include money in models of monetary policy, the Fed does observe growth rates of various monetary aggregates contemporaneously. And for much of the postwar period the Fed established target growth rates for aggregates. These targets have been pursued with varying degrees of vigilance over the years because, when velocity is fairly predictable, money growth can be informative about future inflation. Adding current money growth to the policy rule in equation (5) produces

$$\text{(6) MP (with money):} \quad i_t = \gamma_0 + \gamma_{m1}[(M_t - M_{t-1}) - \bar{\mu}] + \gamma_{\pi 2}[(p_{t-1} - p_{t-2}) - \bar{\pi}] + \gamma_{x2} x_{t-1} + \varepsilon_t^{MP}.$$

This specification is close to the rule that Ireland (2000) estimates in an NK model. A policy rule like equation (6) carries two important implications. First, money is no longer an appendage to the NK model. Now interaction of supply and demand in the money market determines the money stock and the nominal interest rate simultaneously. This raises the tricky problem of separating money demand and monetary policy. Second, the dynamic IS and AS relationships imply that current inflation and output depend on the entire expected future path of policy. If money enters the policy equation, then it plays a role in forming expectations of policy. The reduced forms for IS and AS now must include the current money stock.

The presence of money in the IS equation raises a new identification problem. Now both IS and money demand include output, the price level, the nominal interest rate, and the money stock. Without further restrictions, IS and money demand are indistinguishable. Homogeneity restrictions play a prominent role in money demand regressions; in fact, the money demand relationship is usually written in terms of the demand for real money balances, reflecting one homogeneity restriction. Another restriction, which many general equilibrium models of money demand imply, is unitary income elasticity. Some VAR work has found it necessary to impose both homogeneity restrictions to model the money market (for example, Cushman and Zha 1997).

Estimated Models. We now illustrate some of these identification problems with estimated models. The reduced form for the NK model with three endogenous variables can be written as

$$X_t' A_0 = C + X_{t-1}' A_1 + X_{t-2}' A_2 + \varepsilon_t', \tag{7}$$

where $X_t = (y_t, p_t, i_t, y_t^p)'$, C is a vector of intercept terms, and $\varepsilon_t = (\varepsilon_t^{IS}, \varepsilon_t^{AS}, \varepsilon_t^{MP}, \varepsilon_t^{yp})'$.[10] We take the exogenous disturbances to be independent and identically distributed with $\varepsilon_t \sim N, (0, I)$. In the estimation, we follow tradition and treat potential output, y^p, as exogenous and estimate an AR(1) process for it. Adding y^p to the model in an exogenous block alters the order condition substantially: it buys us three zero restrictions while adding only one free parameter. Most NK work, however, includes the gap, rather than y and y^p separately. To keep in the spirit of that work, we assess the order condition as if we estimated the model in terms of (x, p, i).

All data are quarterly and all but the interest rate are seasonally adjusted. The estimation period in this section runs from 1959:Q1 to 2000:Q2; y is real gross domestic product (GDP) (chained 1996 dollars), p is the personal consumption expenditures deflator (chained 1996 dollars), i is the federal funds rate, and y^p is the Congressional Budget Office's measure of potential GDP (chained 1996 dollars). We choose to estimate data in terms of levels, rather than growth rates, in order to connect the work more closely to the identified VAR literature. We impose all the linear restrictions implied by the NK model and execute maximum likelihood estimation (MLE).[11] All variables are logged except the funds rate, which is a percentage.

In the models reported below we display both the estimated parameters and the impulse response functions computed from

$$X_t = B(L)\varepsilon_t, \tag{8}$$

where $B(L) = (A_0' - A_1' L - A_2' L^2)^{-1}$.

Because many of our points are logical, illustrating the nature of identification problems rather than statistical problems, we do not report standard errors or error bands for most of the estimated models.

Taylor's (1999b) Model. Taylor's model is described by

$$\begin{aligned} &\text{IS:} && x_t = -(1/\sigma)(i_t - \pi_t - r) + \varepsilon_t^{IS} \\ &\text{AS:} && \pi_t = \lambda_1 x_{t-1} + \pi_{t-1} + \varepsilon_t^{AS} \\ &\text{MP:} && i_t = \gamma_0 + \gamma_{\pi 1}\pi_t + \gamma_{x1} x_t + \varepsilon_t^{MP}, \end{aligned} \tag{9}$$

where $\pi_t = p_t - p_{t-1}$ is the inflation rate. In this model, π_t is inertial or predetermined while x_t and i_t are determined simultaneously. Based on restrictions on A_0 alone, the model is not identified unless some additional restriction is imposed. Taylor imposes the restriction that the coefficients on the nominal rate and inflation in the IS equation are equal and of opposite sign.[12] Imposing that restriction yields the estimates[13]

$$\begin{aligned} x_t &= 0.795\left[i_t - (p_t - p_{t-1})\right] - 0.024 \\ p_t - p_{t-1} &= 0.077 x_{t-1} + (p_{t-1} - p_{t-2}) \\ i_t &= 0.820(p_t - p_{t-1}) - 0.597 x_t + 0.032. \end{aligned} \tag{10}$$

With the exception of the AS relationship, none of these parameters is reasonable. IS and MP relationships are confounded: the pattern of coefficients in IS makes more sense as a policy rule, and the pattern

9. In this case, $\pi_t = \lambda_1 x_{t-1} + \pi_{t-1}$, so the IS relationship implies $a = -1/\sigma(1 - \lambda_1)$.

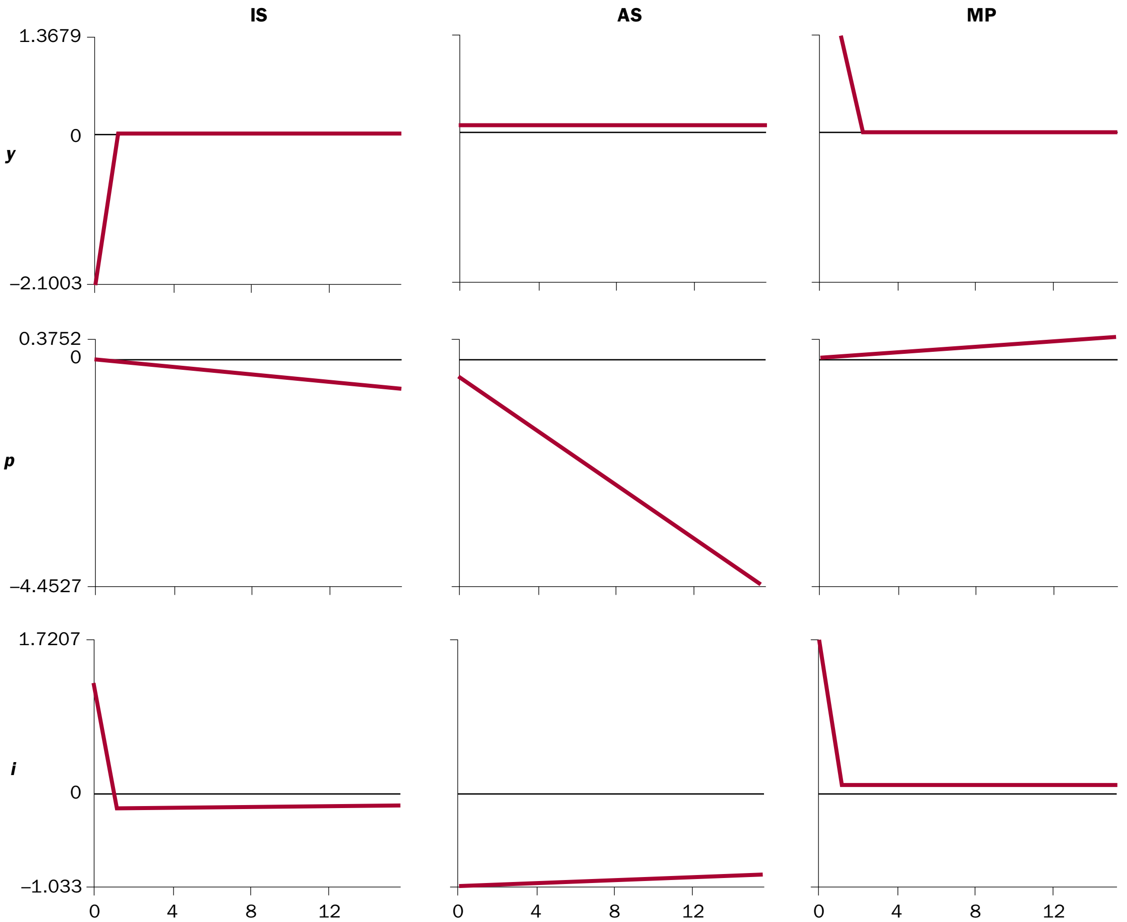
10. We impose restrictions to express equations in terms of inflation or the output gap.

11. First we obtain maximum likelihood estimates of A_0; then we obtain estimates of (A_1, A_2, C), conditional on the MLE of A_0.

12. In Taylor's model, the current output gap is excluded from AS. This exclusion restriction is necessary for identification from restrictions on A_0 alone. Without it, the model is underidentified for two reasons: because it adds the coefficient on x_t in AS and because, if x_t enters AS, then the restriction on IS that the coefficients on i and π be equal and of opposite sign no longer holds. See footnote 9.

13. The process for potential output is estimated to be $y_t^p = 0.0297 + 0.998\, y_{t-1}^p$.

CHART 1
Confounding IS and MP in Taylor's Model



of coefficients in the policy equation makes more sense as an IS curve. Chart 1 confirms this interpretation.[14] The shock identified as IS raises the funds rate and lowers output (although only slightly), while the shock identified as MP raises output, the price level, and the funds rate. The latter is reasonable when interpreted as an endogenous response of policy to higher output and inflation; it is unreasonable when interpreted as an exogenous monetary policy contraction.

Without further restrictions, there appears to be no way to separate the two components of aggregate demand in the model. We turn now to two alternative solutions to this problem.

Calibration as Identification. Perhaps the most popular solution to identification problems is to impose parameter values obtained from other data sets or previous research. While this approach gained popularity initially in the real business cycle literature, its popularity has carried over to research using NK models. We show that transporting parameters from other studies certainly can solve the identification problems inherent in separating IS from MP. First we impose the intertemporal elasticity of substitution, $1/\sigma = 2$, which is within the range of values used in the literature, and freely estimate the remaining parameters.[15] Next we impose $\gamma_{\pi 1} = 1.5$ and $\gamma_x = 0.5$ in the Taylor rule and estimate the rest of the model. Both approaches produce sensible results, with monetary policy shocks having important effects on output. Inflation, however, appears to be entirely an aggregate supply phenomenon.

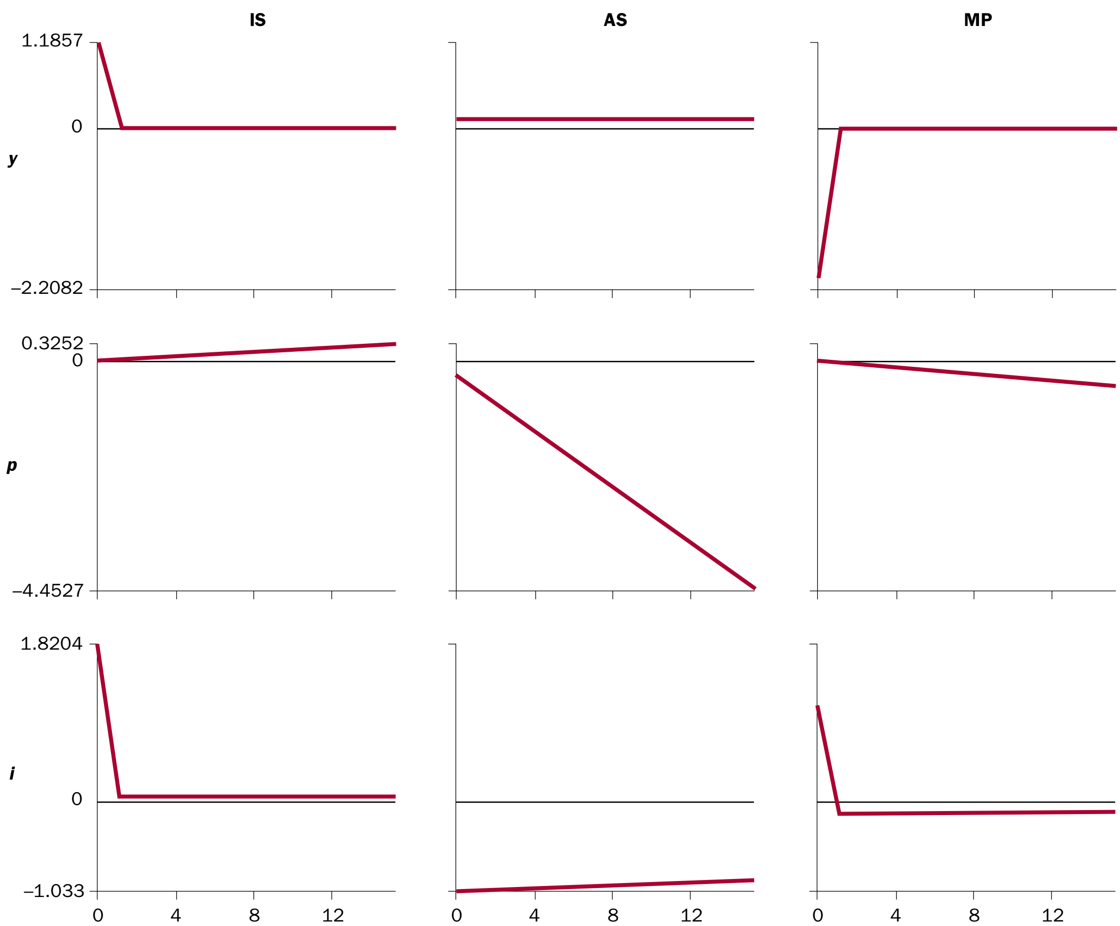
Imposing $1/\sigma = 2$ and not imposing Taylor's restriction on IS leads to the estimates

$$x_t = -\underline{2.0}\, i_t + 1.658(p_t - p_{t-1}) + 0.063 \quad (11)$$
$$p_t - p_{t-1} = 0.077\, x_{t-1} + (p_{t-1} - p_{t-2})$$
$$i_t = 1.027(p_t - p_{t-1}) + 1.535\, x_t + 0.030,$$

where underlining indicates an imposed parameter value.

All the estimated parameters are reasonable. The IS elasticity with respect to inflation is positive, as

CHART 2
Dynamic Responses in Taylor's Model



one would expect if output depends on the real interest rate.

Most striking are the estimated policy parameters. The Fed raises the funds rate more than one-for-one with the inflation rate. It raises the funds rate about 150 basis points in response to a 1 percent increase in the output gap. A coefficient on inflation that exceeds 1 implies stabilizing policy, according to the standard interpretations of the policy rule (for example, Taylor 1999b or Clarida, Gali, and Gertler 1999). The system estimates in equation (11) are in sharp contrast to OLS estimates of the policy rule over this period:

$$(12)\quad \text{OLS:}\quad \underset{}{i_t} = \underset{(0.07)}{0.86}(p_t - p_{t-1}) - \underset{(0.07)}{0.14}\,x_t + \underset{(0.003)}{0.03},$$

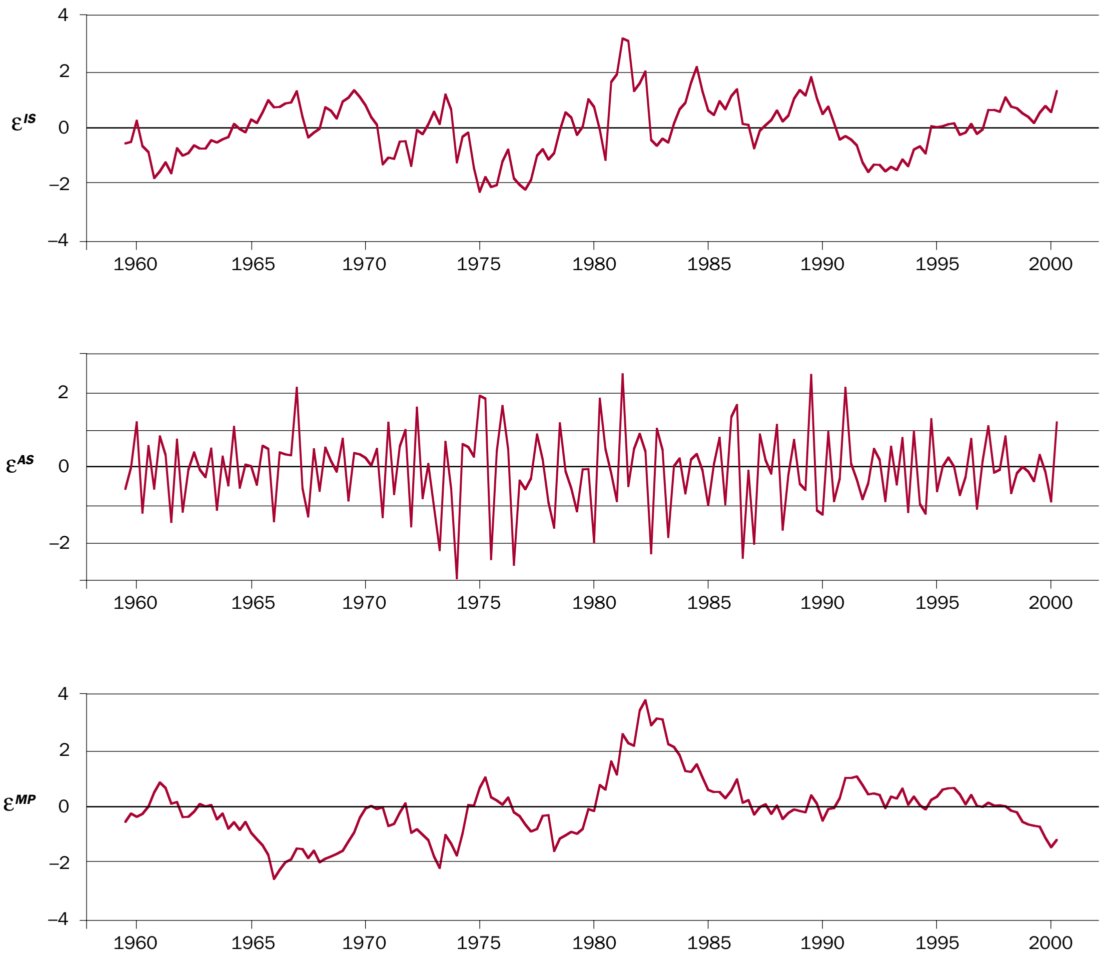
which would seem to suggest that policy has not been stabilizing on average since 1959. The substantive difference in estimates underscores the importance of estimating policy behavior and private behavior simultaneously. Inferences about policy behavior based on the system estimates in equation (10) are qualitatively different from those based on single-equation estimates in equation (12).

Chart 2 displays the system's responses to exogenous disturbances over four years. The third column shows that MP has important effects on output: a 100 basis point exogenous contraction reduces output by 2 percent (as the calibrated value for σ implies), though the effects die out immediately. Policy disturbances matter for output, accounting for over a third of its variability. Exogenous shifts in policy, however, have little impact on inflation.

14. All charts depict impulse responses that have been multiplied by 100.

15. Rotemberg and Woodford (1997) estimate σ = 0.16, producing an IS interest elasticity of –6.25, while McCallum and Nelson (1999) estimate σ = 4.93, making the interest elasticity –0.20. Clarida, Gali, and Gertler (2000) and Gali, Lopez-Salido, and Valles (2000) calibrate their models to log preferences, so σ = 1.

CHART 3
Implied Structural Shocks in Taylor's Model



Policy is strongly endogenous. Policy disturbances account for 20 percent of the variation in the funds rate over the first year and for 10 percent over longer horizons. Endogeneity of policy shows up in the responses of the funds rate to IS and AS disturbances. An IS shock that increases the output gap and gradually raises the price level brings forth a higher funds rate. An outward shift in AS persistently raises the output gap, permanently lowers the price level, and induces the Fed to lower the funds rate. Only very gradually does the Fed return the rate to its initial level.

Monetary policy shocks are the dominant source of output variation (75 percent over the four-year horizon), and AS disturbances are the sole source of price level movements (more than 98 percent over the horizon). AS shocks also account for three-quarters of funds rate variability at four-year horizons.

Chart 3 displays the time paths of structural shocks implied by the estimated model. With the exception of the AS shock, the estimated disturbances exhibit strong patterns of serial correlation, which arise from the absence of dynamics in the behavioral equations.[16] The time path of the monetary policy disturbances in the bottom panel of the chart resembles the "policy mistakes" that Taylor (1999a) reports in his historical analysis of policy rules. Taylor computes the gap between the actual funds rate and value of the rate implied by two policy rules. He concludes that when the gap was positive the funds rate was "too high" and when it was negative the funds rate was "too low." In Chart 3, a positive value of ε^{MP} is an exogenous tightening of policy and a negative value is an exogenous loosening. Unlike Taylor's work, the chart does not report that policy in the early 1960s was "too loose." It is consistent with Taylor's findings that in the second half of the 1960s and the 1970s policy was "loose," while in the early to mid-1980s policy was "tight." The chart is also generally consistent with Taylor in finding that through the 1990s "policy mistakes" were small.

We are unwilling, however, to draw the normative conclusions Taylor does. In the model, as Chart 2 attests, exogenous shifts in policy have unrealistically large impacts on output and essentially no impacts on inflation. We prefer to link normative statements about policy to the impacts policy has on variables that affect private agents' welfare. If those estimated impacts are implausible, it seems premature to deduce how well policy has performed from the estimated pattern of residuals in the policy equation.

Not surprisingly, the data strongly reject equation (11), a model with severely pruned dynamics. Letting ξ denote twice the difference of the log likelihoods of the unrestricted and restricted models, $\xi = 2[\log(L_U) - \log(L_R)]$, we find $\xi = 775.06$, which has a p-value of 0.00. Critical values for the Schwarz and Akaike criteria are 122.4 and 48.

Imposing that policy be set according to the parameters Taylor (1993a, 1999a) employs ($\gamma_{\pi 1} = 1.5$, $\gamma_{x1} = 0.5$) leads to the estimates

(13)
$$\begin{aligned} x_t &= 0.732\, i_t + 0.545\left(p_t - p_{t-1}\right) + 0.024 \\ p_t - p_{t-1} &= 0.077\, x_{t-1} + \left(p_{t-1} - p_{t-2}\right) \\ i_t &= \underline{1.5}\left(p_t - p_{t-1}\right) + \underline{0.5}\, x_t + 0.009, \end{aligned}$$

where underlining indicates imposed parameter values. The qualitative impacts of the three disturbances are much like those depicted in Chart 2 and are not reported. Because the model's parameters are different, however, the quantitative implications differ somewhat. The estimated interest elasticity of IS is lower than in system (11), so the output effects of policy disturbances in this model are smaller, accounting for no more than 35 percent of output variability. AS shocks explain one-quarter of output forecast error variance and 80 percent of funds rate variability over four-year horizons.

It is difficult to distinguish the reduced-form expressions for IS and MP that emerge from the NK model without introducing additional restrictions. We showed that imposing an interest elasticity of IS of –2.0, which is in the ballpark for calibrated NK models, can solve the identification problem. Estimates of policy behavior from the 1959:Q1 to 2000:Q2 period are consistent with the interpretation that the Fed has, on average, been stabilizing: it raised the federal funds rate more than one-for-one with inflation. This result comes from system estimates; OLS estimates of policy behavior produce a response to inflation that is substantially below 1.0. Although we solved the identification problem, the estimated models imply little role for monetary policy in influencing inflation.

Inferences about Stability Based on Policy Parameters

One piece of conventional wisdom to emerge from the NK work on MP is that policy is stabilizing when it raises the nominal interest rate more than one-for-one with the inflation rate. This increases the real interest rate, the argument goes, reduces aggregate demand, and counteracts the incipient inflation. In Taylor's policy rule, equation (4), this requires that $\gamma_{\pi 1} > 1$. Several authors have drawn inferences about how policy impacts the economy based on estimates of $\gamma_{\pi 1}$ (for example, Clarida, Gali, and Gertler 1999, 2000; Rotemberg and Woodford 1997, 1999; and Taylor 1999a).

Stability is a characteristic of an equilibrium and, as such, is an implication of a model. Much of the recent work on simple rules may give the impression that one can deduce this model implication merely by estimating a policy rule. Implicitly, many authors are conditioning their assertions about the magnitude of a particular policy parameter on the structure and parameter values of an entire model.

Two different but related interpretations of U.S. monetary policy behavior before the Volcker-Greenspan era stem from inferences about stability drawn from estimated policy rules. Taylor (1999b) argues in the following way that policy is "stabilizing" when $\gamma_{\pi 1} > 1$. Modify the AS relationship in his model, equation (9), to be

(14) AS: $$\pi_t = \lambda_1 x_{t-1} + \delta \pi_{t-1} + \varepsilon_t^{AS}.$$

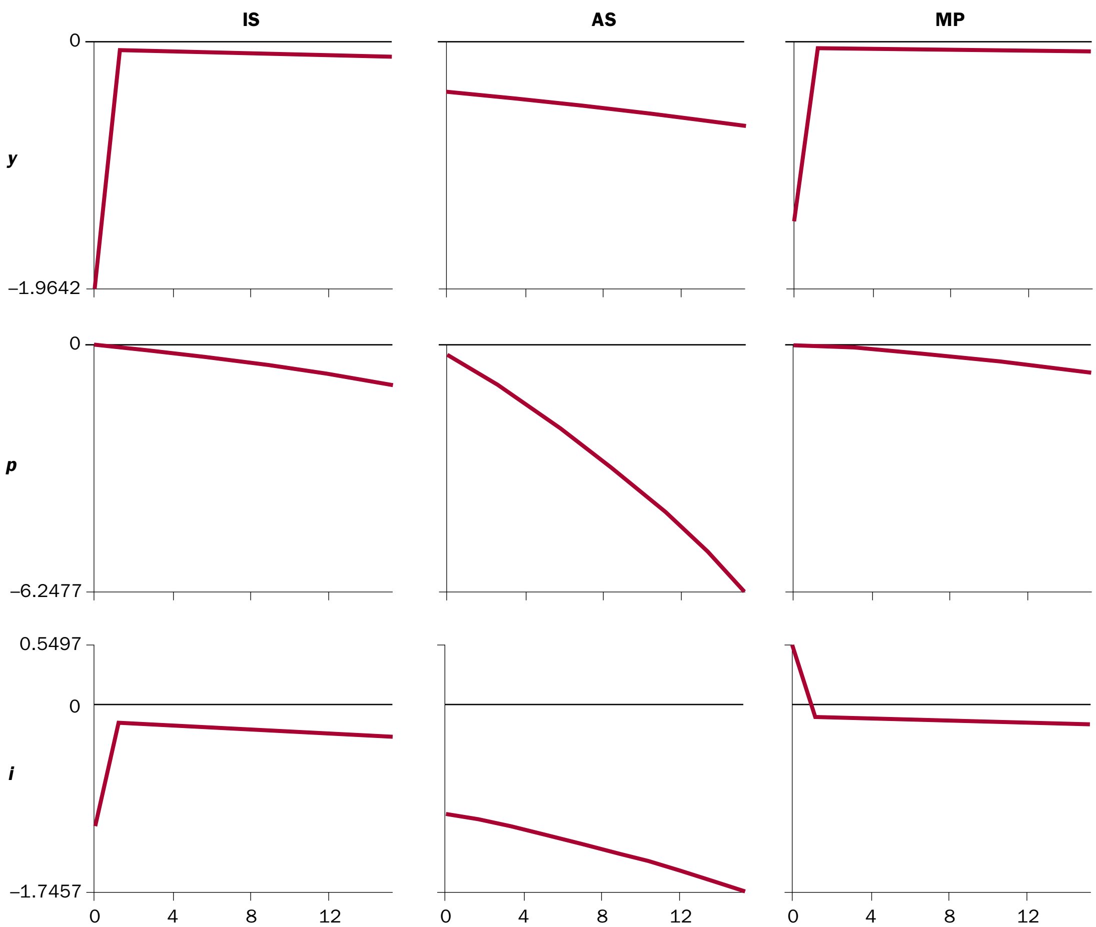
Substituting MP into IS, and the resulting expression for x into AS, yields a first-order difference equation describing the evolution of equilibrium inflation:

(15)
$$\begin{aligned} \pi_t = &\left(\frac{\lambda_1(1-\gamma_{\pi 1})}{\sigma + \gamma_{x1}} + \delta\right)\pi_{t-1} \\ &- \frac{\lambda_1}{\sigma + \gamma_{x1}}\varepsilon_{t-1}^{MP} + \frac{\lambda_1 \sigma}{\sigma + \gamma_{x1}}\varepsilon_{t-1}^{IS} + \varepsilon_t^{AS}. \end{aligned}$$

Taylor imposes $\delta = 1$. In that case, if λ_1, σ, $\gamma_{x1} > 0$, which are reasonable assumptions, then $\gamma_{\pi 1} > 1$ is necessary and sufficient for equation (15) to be a stable difference equation. Suppose the economy is hit by an adverse AS shock that increases inflation. A

16. Clearly these errors are not independent and identically distributed as assumed in the estimation. Rather than estimate patterns of serial correlation for the shocks to render some residuals as white noise, we prefer to account for the data's persistence through behavioral relationships. Allowing serially correlated errors, as is common in the literature, would improve the fit but would not contribute to the economic interpretation of the data.

CHART 4
An Unstable Equilibrium in Taylor's Model (1959:Q1–1979:Q3)



sufficiently strong policy response to the initial increase in inflation would raise the real interest rate, reduce output, and stabilize inflation. In the absence of a strong policy response, output might rise and, through the AS relationship, raise inflation still more in the future. The process can be explosive.

A second interpretation of the implications of $\gamma_{\pi 1} < 1$ comes from Rotemberg and Woodford (1997) and Clarida, Gali, and Gertler (2000). In a maximizing model with typical assumed values for private parameters, $\gamma_{\pi 1} < 1$ implies that sunspot equilibria cannot be ruled out. Expectations of higher inflation that arise for unexplained reasons can be self-fulfilling. Sunspot fluctuations may arise because economic agents rationally believe that the Fed will accommodate higher expected inflation by letting short-term real interest rates fall, stimulating aggregate demand, and raising inflation further. We do not pursue this interpretation in the present paper.

Both interpretations rely on estimates of $\gamma_{\pi 1}$ that are substantially below 1.0 in the United States before 1979.

We can see precisely the phenomenon that Taylor discusses when we reestimate the model in equation (10) over the sample 1959:Q1–1979:Q3. The estimates are

$$(16)\qquad x_t = -2.621\left[i_t - \left(p_t - p_{t-1}\right)\right] + 0.041$$
$$p_t - p_{t-1} = 0.105\,x_{t-1} + \left(p_{t-1} - p_{t-2}\right)$$
$$i_t = 0.671\left(p_t - p_{t-1}\right) + 0.571\,x_t + 0.023.$$

The critical policy parameter, the response of the funds rate to inflation, is substantially less than 1 at 0.671. According to conventional wisdom, policy was not stabilizing. Impulse response functions in Chart 4 bear out the conventional wisdom. Although the short-run patterns make economic sense, the responses to AS shocks are explosive, with output, the price level, and the funds rate shooting off to negative infinity. Explosiveness stems from the source Taylor highlights: the eigenvalue of the model's difference equation in inflation in equation (15) exceeds 1.0.[17]

It may be surprising that an important ingredient in generating instability is the restriction that $\delta = 1$ in the AS specification in equation (14). We turn to the NK model laid out in the first section, but move away from the specific parameterization Taylor used. Instead, we consider an environment in which behavior in both the IS and the AS equations is dynamic.

To obtain restrictions motivated by the theoretical NK model, we calibrate and solve the model, deriving the theory's analogs to the (A_0, A_1, A_2, C) matrices in the estimated model, equation (7). We then apply the pattern of linear restrictions implied by the theory to our empirical model.[18] Let $X_t = (x_t, p_t, i_t)'$ and order the equations (IS, AS, MP). Let column j of A_i represent equation j, j = IS, AS, MP. As an example, the pattern matrices for Taylor's (1999b) model, specified in equation (9) and estimated in equation (10), are

(17)
$$A_0=\begin{bmatrix} \times & 0 & \times \\ -\times_1 & \times_2 & \times_3 \\ \times_1 & 0 & \times \end{bmatrix}, A_1=\begin{bmatrix} 0 & \times & 0 \\ -\times_1 & 2\times_2 & \times_3 \\ 0 & 0 & 0 \end{bmatrix}, A_2=\begin{bmatrix} 0 & 0 & 0 \\ 0 & -\times_2 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

where $\times$ denotes a freely estimated coefficient, 0 denotes a coefficient that is excluded, and $\times_i$ denotes a coefficient estimated subject to a dynamic linear restriction within an equation. After estimation, setting the diagonal terms in A_0 to 1 normalizes the matrices. There are six freely estimated parameters in A_0, so the model is just identified.[19]

We now consider other versions of the NK model. IS and AS relationships are dynamic with both forward- and backward-looking behavior; policy follows the Taylor rule $i_t = 2+1.5\pi_t + 0.5x_t$.[20] The reduced form for this model implies the pattern matrices

(18)
$$A_0=\begin{bmatrix} \times & \times & \times \\ \times & \times & \times_1 \\ \times & 0 & \times \end{bmatrix}, A_1=\begin{bmatrix} \times & 0 & 0 \\ \times & \times & \times_1 \\ 0 & 0 & 0 \end{bmatrix}, A_2=\begin{bmatrix} 0 & 0 & 0 \\ 0 & \times & 0 \\ 0 & 0 & 0 \end{bmatrix}.$$

Now the model determines all three variables simultaneously. With eight free parameters in A_0, the model is not identified. We follow Taylor in forcing the effect of the output gap on inflation to occur with a one-period lag (making $A_0[1, 2] = 0$ and $A_1[1, 2] = \times$), and we add the restriction that the nominal interest elasticity of IS is –2.0: $\sigma = A_0(3, 1) = 1/2$. The estimated model for the period 1959:Q1–1979:Q3 is

(19)
$$\begin{aligned} x_t &= -\underline{2.0}\,i_t + 1.126(p_t - p_{t-1}) + 1.495\,x_{t-1} + 0.060 \\ p_t &= 0.025\,x_{t-1} + 1.9615\,p_{t-1} - 0.9618\,p_{t-2} \\ i_t &= 0.690(p_t - p_{t-1}) + 0.517\,x_t + 0.023. \end{aligned}$$

Although we did not impose that the AS function can be written in terms of the inflation rate, the estimates are very close to $\pi_t = 0.025x_{t-1} + 0.962\pi_{t-1}$. As in system (16), we estimate that the policy response to inflation is well below one-for-one. This model, however, does not display the instability following AS shocks that appears in the previous model. Chart 5 displays the impulse response functions over a four-year horizon. All the responses look reasonable and converge after about ten years. The absolute values of the largest eigenvalues of the estimated system are 0.996 and 0.997. Evidently, $\gamma_{\pi 1} > 1$ isn't necessary for stability.

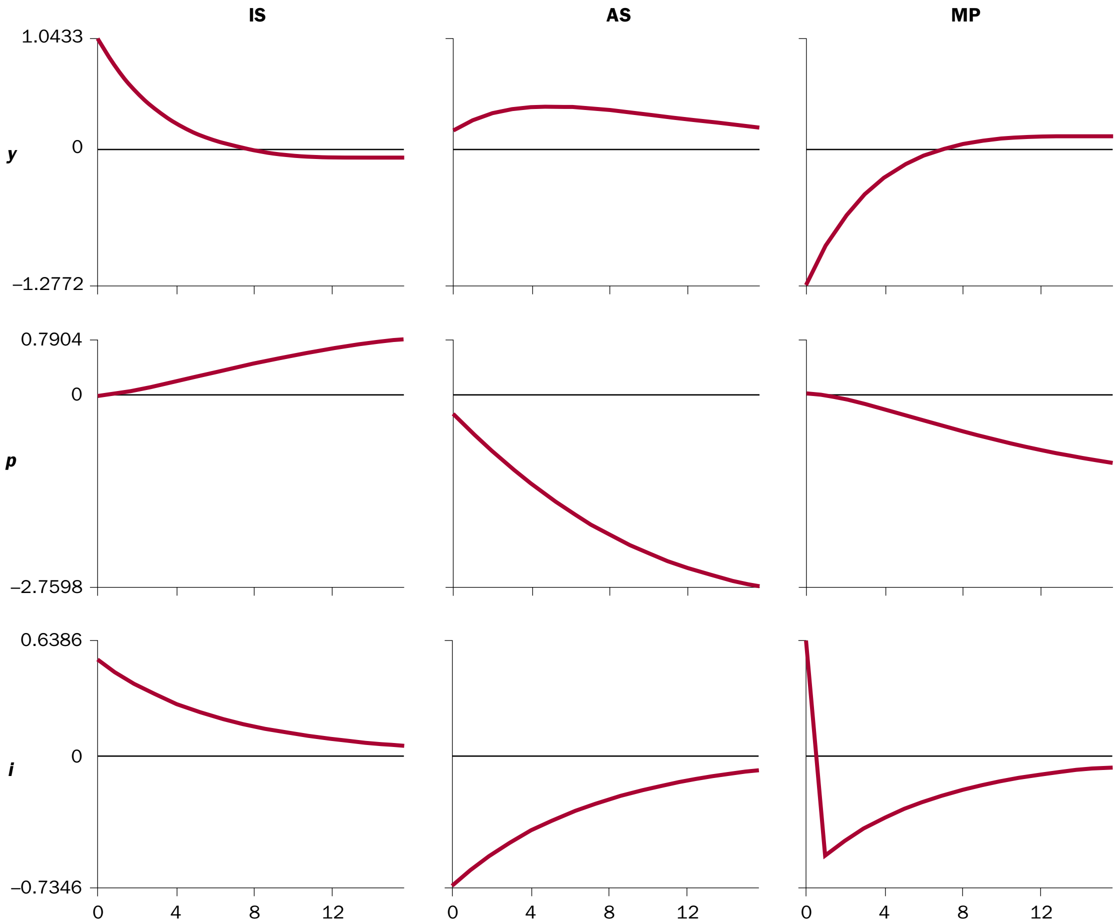
Although the estimated response of policy to inflation is weak, policy behavior is strongly endogenous. Over forecast horizons of one to four years, over 20 percent of the fluctuations in the funds rate are due to IS shocks and 45 percent are due to AS shocks. Inflation is again estimated to be primarily an aggregate supply phenomenon, with 85 to 100 percent of price level variation due to AS shocks. Policy disturbances simply do not move the price level very much, though they are more important than IS shocks in accounting for output fluctuations in the short run (60 percent versus 40 percent).

In spite of the widespread belief that the Fed raised the funds rate less than one-for-one with inflation in the period from 1959:Q1 to 1979:Q3, it is worthwhile estimating the same model with identification achieved by imposing the policy rule $i_t = \gamma_0 + 1.5\pi_t + 0.5x_t$. With these two restrictions on A_0, we now freely estimate the interest elasticity of IS ($A_0[3, 1]$) and the contemporaneous effect of output on price setting behavior ($A_0[1, 2]$). The model determines (x_t, i_t) simultaneously. The estimates are

(20)
$$\begin{aligned} x_t &= -0.555\,i_t + 0.069(p_t - p_{t-1}) + 1.090\,x_{t-1} + 0.027 \\ p_t &= 0.053\,x_{t-1} + 1.979\,p_{t-1} - 0.979\,p_{t-2} \\ i_t &= \underline{1.5}(p_t - p_{t-1}) + \underline{0.5}\,x_t + 0.11. \end{aligned}$$

17. The largest eigenvalue is estimated to be 1.036.
18. Because we do not impose the cross-equation restrictions that the theory implies, the empirical model may be underidentified even when the theoretical model is not.
19. As equation (17) makes clear, there are additional restrictions among coefficients across the A_i matrices. When we evaluate the order condition, we do not count these and focus exclusively on restrictions on A_0. One could instead investigate achieving identification through the dynamic restrictions.
20. We set $r = 2$, $\sigma = 1$, $\theta = 0.2$, $\kappa = 1$, $\lambda_0 = 0.3$, $\beta = 0.99$, $\psi = 0.2$, $\gamma_0 = 2$, $\gamma_{p1} = 1.5$, $\gamma_{x1} = 0.5$, and the remaining parameters to zero.

CHART 5
A Stable Equilibrium in Taylor's Model (1959:Q1–1979:Q3)



Once again the model is stable, with largest eigenvalues equal to 0.997 and 0.999. Dynamic responses to exogenous disturbances look reasonable, as shown in Chart 6. The most notable quantitative difference between this model and the previous one, equation (19), is that now IS and MP disturbances are more important sources of inflation variation, accounting for 25 percent each over horizons of four years. AS shocks continue to be the dominant source of inflation in the short run, but over longer periods, aggregate demand is as important as aggregate supply.

We also estimated two versions of the NK model where AS behavior is forward looking only. IS continues to be forward and backward looking. Eliminating backward-looking price-setting behavior excludes current inflation from the IS equation. The resulting pattern matrices are

$$(21)\quad A_0 = \begin{bmatrix} \times & \times & \times \\ 0 & \times_1 & \times_2 \\ \times & 0 & \times \end{bmatrix}, A_1 = \begin{bmatrix} \times & 0 & 0 \\ 0 & \times_1 & \times_2 \\ 0 & 0 & 0 \end{bmatrix}, A_2 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}.$$

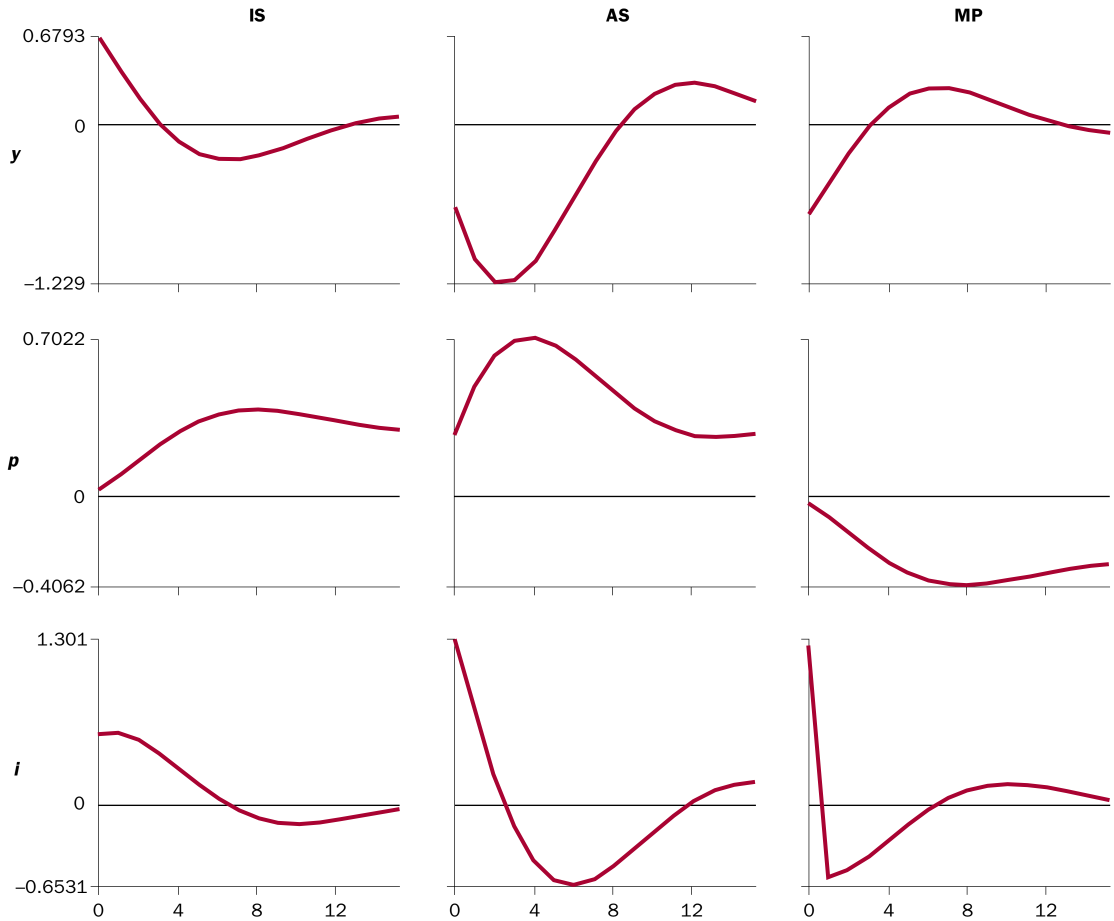
One more restriction on A_0 is needed to identify the model. We considered (i) excluding x_t from AS and (ii) imposing an interest elasticity of –2.0 on IS. In both cases the estimated models were stable in spite of the policy's less than one-for-one response of the funds rate to inflation.

Whether or not monetary policy is stabilizing depends on policy and private behavior. We found that over the pre-Volcker-Greenspan era (1959:Q1–1979:Q3), Fed behavior appears not to be stabilizing when we impose the Taylor (1999b) restrictions on aggregate supply. In contrast, when we impose AS restrictions implied by the dynamic NK model, policy over the period appears to be stabilizing. In both cases we estimate that the Fed adjusted the funds rate less than one-for-one with inflation.

The Disappearance of Money from Monetary Policy Analyses

Money plays no role in NK models of monetary policy. To some observers this may seem odd. This section reviews and dis-

CHART 6
Another Stable Equilibrium in Taylor's Model (1959:Q1–1979:Q3)



cusses the reasons for money's disappearance. The section then turns to some empirical implications of reintroducing money.

Why Money Disappeared. Money disappeared for both practical and theoretical reasons. Throughout the 1980s, the Federal Reserve paid fairly close attention to the growth of various monetary aggregates in setting its target for the federal funds rate. Target growth rates for aggregates were established and taken seriously by observers of monetary policy. A decade ago researchers at the Federal Reserve Board developed the "P-Star" model, which relied on stable long-run values of velocity and output growth, to use M2 growth to predict inflation (Hallman, Porter, and Small 1991). Although doubts were raised at the time, any hope of exploiting M2 growth to forecast inflation evaporated when M2 velocity began to behave erratically in the early 1990s.[21] Since then, as a practical move, the Fed has deemphasized growth rates of aggregates as indicators of inflation. In 2000, the FOMC formalized this deemphasis, as the minutes from the June 27–28, 2000, meeting indicate:

> In contrast to its earlier practice, the Committee at this meeting did not establish ranges for growth of money and debt in 2000 and 2001. The legal requirement to set and announce such ranges recently had expired, and the members did not view the ranges as currently serving a useful role in the formulation of monetary policy. Owing to uncertainties about the behavior of the velocities of money and debt, these ranges had not provided reliable benchmarks for the conduct of monetary policy for some years. Nevertheless, the Committee believed that the behavior of these aggregates retained value for gauging economic and financial conditions and that such behavior should continue to be monitored.

21. Christiano (1989) raised some doubts.

Moreover, Committee members emphasized that they would continue to consider periodically issues related to their long-run strategy for monetary policy, even if they were no longer setting ranges for the money and debt aggregates.

Theoretical developments in the past decade reinforce the Fed's pragmatic response to unstable M2 velocity. Several authors showed that a nominal anchor need not come from control of a monetary aggregate: a policy rule that sets the nominal interest rate can uniquely determine the price level even in a rational expectations model.[22] This contradicted Sargent and Wallace's (1975) famous result that interest rate rules cannot determine the price level.[23] These developments initiated a literature about interest rate rules that continues to flourish.[24]

Even if the Fed now ignores money, it certainly has not always ignored it. Historical interpretations of policy behavior that ignore money run the risk of seriously misinterpreting past policy actions.

Several considerations arise from the absence of money in the analytical framework. First, even if the Fed ignores money when it sets the funds rate, this does not imply that money plays no role in the transmission of monetary policy or in individuals' and firms' consumption, investment, employment, and pricing decisions. In terms of the NK model, absence of money from the policy rule does not justify its absence from the IS and AS relationships. Interest rates need not be the only channel through which monetary policy affects economic activity.

Second, the fact that the Fed can ignore money without losing a nominal anchor does not imply the Fed does ignore it. The FOMC minutes leave open the possibility that the Fed may again choose to pay more attention to monetary aggregates. For example, it is hard to imagine that if M2 growth were to exceed 20 percent for four consecutive quarters that there would be no tendency for the FOMC to adjust its funds rate target in response.

Third, even if the Fed now ignores money, it certainly has not always ignored it. Historical interpretations of policy behavior that ignore money run the risk of seriously misinterpreting past policy actions.

Finally, if money plays any role at all in the FOMC's settings for the funds rate, then money is likely to enter private sector expectations of future funds rates. Money, therefore, will enter dynamic IS or AS relationships through the expectations terms, once expectations are solved out.

Adding Money. We add to the NK model a function that makes the demand for real money balances (MD) depend on the current nominal interest rate and current income. To focus on the marginal contribution of adding money to a model with simple policy rules, we adopt an agnostic view of the dynamics associated with IS, AS, and MD behavior. We posit the money demand function

$$\text{(22)} \quad \text{MD:} \quad M_t - p_t = \alpha_0 + \alpha_i i_t + \alpha_y y_t + lags + \varepsilon_t^{MD},$$

where M is a broad monetary aggregate, y is output (or income), and ε^{MD} is an exogenous disturbance to the demand for money. We exclude potential output entirely from MD. Money enters the econometric models in logged form.

Money is taken to be M2. Clearly, the federal funds rate is not the opportunity cost of M2. Based on the large models estimated in Leeper, Sims, and Zha (1996), modeling the details of the links between the markets for reserves and broad money complicates but does not substantively change the analysis. In addition, Gordon and Leeper (1994) found that correctly accounting for the own rate of return on M2 in computing the opportunity cost does not appreciably alter the conclusions that concern us here.

As discussed in the first section, there is the potential for confounding behavior described by IS with that described by either MD or MP. For the present purposes, we seek to minimize those identification problems by treating (y_t, p_t) as being determined in an "inertial" sector of the economy. This assumption treats output and inflation as predetermined for monetary variables: disturbances to MD and MP behavior affect y and p with a one-period lag. By lumping output and price determination into a single sector, we can no longer claim to have identified behavioral IS and AS equations; instead, we now have "x" and "p" equations.

The empirical work in this section contrasts two assumptions about policy behavior: the conventional Taylor rule, as given by equation (4), and an even simpler rule in which the Fed's choice for the funds rate depends only on current money growth:[25]

$$\text{(23)} \quad \text{MP (M rule):} \ i_t = \gamma_0 + \gamma_{m1}[(M_t - M_{t-1}) - \bar{\mu}] + \varepsilon_t^{MP}.$$

We have chosen to normalize this rule on the nominal interest rate, but it is equally consistent to imagine this as a rule that determines the supply of money, where that supply choice is sensitive to the nominal interest rate.

We order the equations "x," "p," MD, and MP and the variables x, p, M, and i. Common to both assumptions about policy behavior are the pattern matrices

(24)

$$A_0 = \begin{bmatrix} \times & \times & \times & \times_x \\ 0 & \times & \times_1 & \times_p \\ 0 & 0 & \times_1 & \times_M \\ 0 & 0 & \times & \times \end{bmatrix}, A_1 = \begin{bmatrix} \times & \times & \times & 0 \\ \times & \times & \times & \times_p \\ \times & \times & \times & \times_M \\ \times & \times & \times & 0 \end{bmatrix}, A_2 = \begin{bmatrix} \times & \times & \times & 0 \\ \times & \times & \times & 0 \\ \times & \times & \times & 0 \\ \times & \times & \times & 0 \end{bmatrix},$$

where either $\times_x$ and $\times_p$ are nonzero with $\times_M = 0$ (conventional Taylor rule) or $\times_M$ is nonzero with $\times_x = \times_p = 0$ (M rule). Coefficients denoted $\times_1$ reflect the homogeneity restriction making money demand the demand for real balances. The specification removes any dynamics from policy behavior.

We estimate the models from 1959:Q1 to 2000:Q2. For the model with the Taylor rule, estimates of the coefficients in A_0 imply

(25)
$$\left(M_t - p_t\right)^d = -0.242\, i_t + 0.204 y_t$$
$$i_t = 0.873\left(p_t - p_{t-1}\right) - 0.045 x_t,$$

where we suppress the lagged coefficients in money demand, all constants, and the coefficient on the output gap in the price equation.[26] It is clear that when the demand for money is appended to this model with a Taylor rule for policy, the variables can be solved recursively: the first equation yields x_t, which from the second equation implies p_t; together these yield i_t from the policy rule in equation (25), and M_t comes from the money demand equation in equation (25), given the value for exogenous potential output, y_t^p. Because M and i are not determined simultaneously, estimates of money demand have no effect on estimates of policy behavior.

The estimated parameters in equation (25) seem reasonable. The short-run semielasticity of money demand is negative, and the short-run income elasticity is positive. In contrast to what we found when estimating a model with severely restricted dynamics (see equation [11]), policy appears to adjust the funds rate less than one-for-one with inflation. This difference underscores the importance of *all* the model's identifying assumptions when drawing inferences about policy behavior from estimated policy rules. Model (11) determines x and i simultaneously through IS behavior; model (25) determines them recursively due to inertial behavior. In spite of the estimated policy behavior, the model is stable.

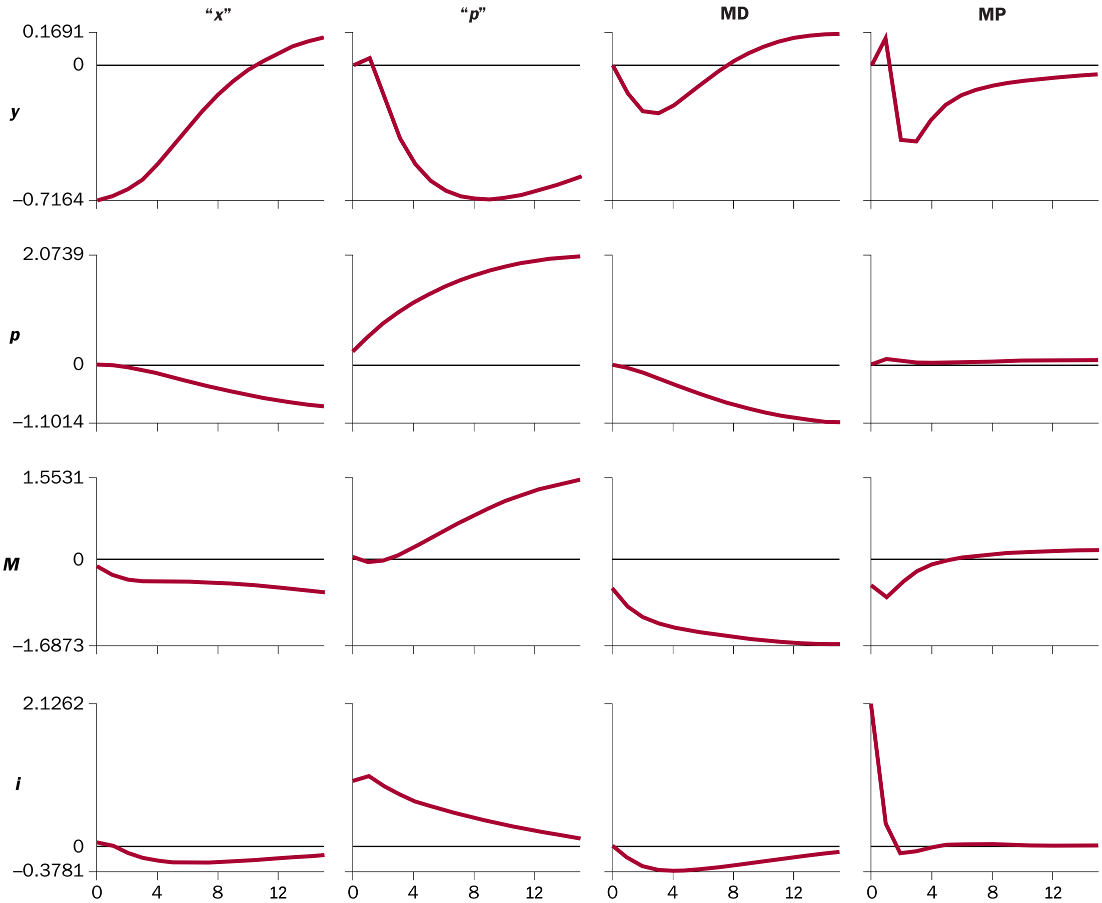
Chart 7 shows the Taylor rule applied to response functions over a four-year horizon. Responses to MP shocks are depicted in the fourth column: a policy contraction raises the funds rate substantially and reduces the money stock, generating a liquidity effect. Output has a strange positive blip in the quarter after the shock but then declines, following a hump-shaped path. There is no effect on the price level. Policy disturbances explain, at most, 13 percent of output, 41 percent of M2, and, in the initial period, over 80 percent of the funds rate. After four years, only 40 percent of funds rate variability is due to MP disturbances.

The endogeneity of policy appears in the first three panels of the bottom row of the chart. An "x" shock, which reduces output and the price level, produces a modest response from policy, while a "p" shock, which moves output and inflation in opposite directions, engenders a stronger offsetting reaction. Over 40 percent of funds rate fluctuations at four-year horizons arise from reactions to "p" shocks.

Policy also responds to money demand disturbances. An MD shock lowers M2 on impact. This is followed by falling prices and initially lower output; after about two years, output rises above its initial level.[27] Policy raises the funds rate smoothly, gradually returning it to its preshock level. The Taylor rule prevents the funds rate from jumping when MD shocks strike.

22. Authors include McCallum (1981, 1983) and Leeper (1991). Related work falls under the rubric of the "fiscal theory of the price level" advocated by Sims (1994) and Woodford (1998).
23. Sargent states the result as follows: "There is no interest rate rule that is associated with a determinate price level" (1979, 362). Predecessors to Sargent and Wallace that do not impose rational expectations include Patinkin (1949) and Gurley and Shaw (1960).
24. Analyses of the price level, inflation, and monetary policy without money are creeping into principles textbooks (see Romer 2000 and Stiglitz and Walsh 2000).
25. In estimation, we annualize the growth rate of money, so $4(M_t - M_{t-1})$ appears in equation (23).
26. All current and lagged coefficients in the output and price equations are identical between the two models with two different policy rules.
27. Textbook analyses typically have positive money-demand shocks lowering the price level. In simulations of the NK model, however, the pattern depicted in Chart 7 is common.

CHART 7
Model with Money and a Taylor Rule (1959:Q1–2000:Q2)



Estimates of the model with the alternative M rule in equation (23) yield:[28]

$$(M_t - p_t)^d = -1.571\, i_t + 0.554\, y_t \qquad (26)$$
$$i_t = 2.913\left(M_t - M_{t-1}\right).$$

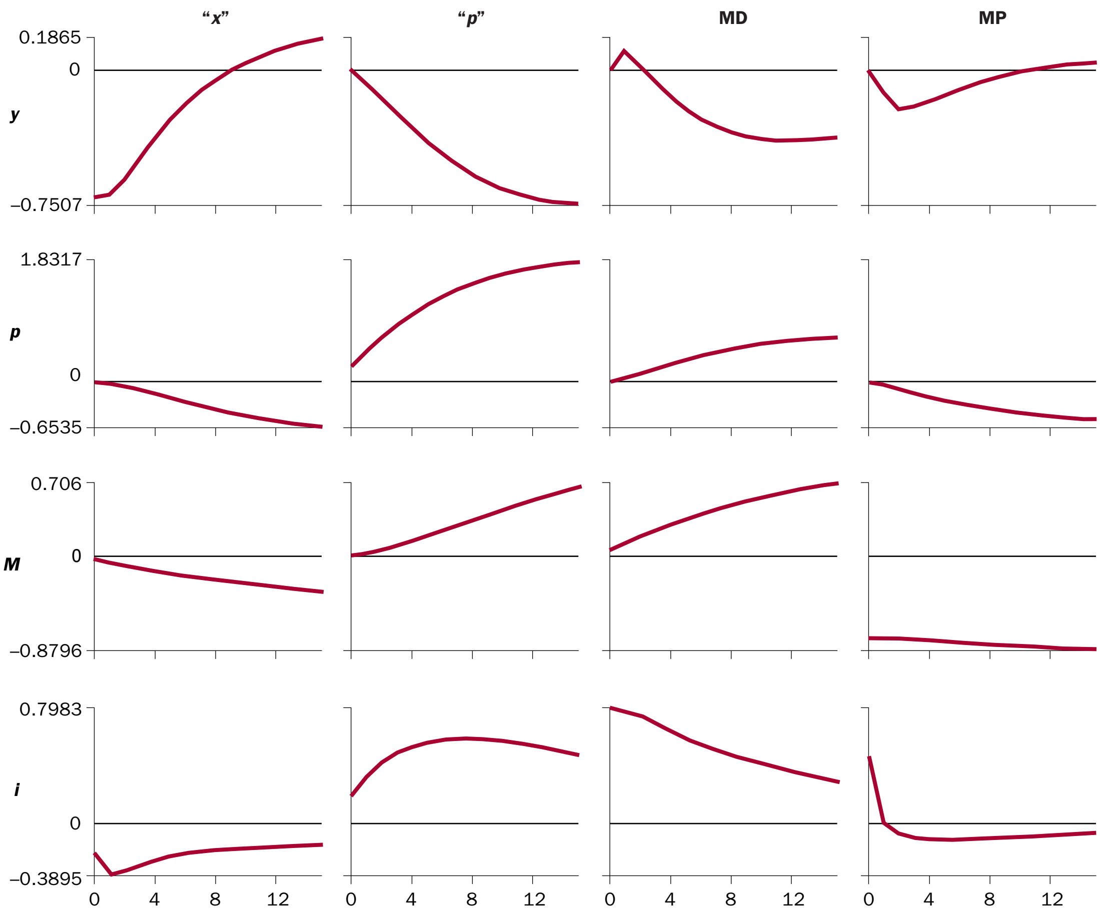
The large estimated coefficient on money growth, by conventional wisdom, implies that policy was stabilizing.[29] The model is no longer recursive, as the equations in equation (26) simultaneously determine M and i. Note that the negative correlation between money and interest rates, which equation (25) attributes entirely to the interest elasticity of money demand, now gets split into a stronger negative demand elasticity and a positive supply elasticity.

Dynamic responses to the shocks in the "inertial" sector, shown in Chart 8, are similar to those in the model with a Taylor rule. From the standpoint of endogenous reactions to the disturbances that have occupied much of the attention of NK authors, the two policy rules are nearly indistinguishable. Some differences show up in the effects of exogenous shifts in policy: with an M rule a contraction generates a hump-shaped decrease in output and a smooth decline in the price level.

Three differences between the models are worth noting. First, comparing Chart 7 and Chart 8, a monetary contraction under a Taylor rule only temporarily changes the level of the money stock, while under an M rule it does so permanently. This implies that under a Taylor rule, the open market operation that initially raises the funds rate must be reversed to bring the money stock back to its original level. Second, the money stock appears to be more endogenous under an M rule: at most, 20 percent of the variation in M is attributed to exogenous MD shocks. With a Taylor rule, over 60 percent of M fluctuations are due to MD, providing a substantial role to exogenous factors in determining the money supply.

Finally, we formally test the overidentifying restrictions in the two models. The model with a Taylor rule imposes one less restriction than does the model with an M rule. We obtain

CHART 8
Model with Money and a Money Rule (1959:Q1–2000:Q2)



Taylor rule	M rule
ξ = 418.3	ξ = 207.4
SC = 112.2	SC = 117.3
AC = 44	AC = 46
p = 0.00	p = 0.00

where SC is the Schwarz criterion and AC is the Akaike criterion. By any criterion the data reject both models. The test statistic in the M rule model is substantially less than in the Taylor rule model. These results suggest that a rule that makes the nominal interest rate respond to money growth—and nothing else—certainly fits no worse than a Taylor rule.

Estimates of identical models under two qualitatively different policy rules yield fairly similar results when judged by system properties like impulse response functions and stability. Based solely on estimated policy rules, however, the two models look very different.

The Recent Period. Much current research on Federal Reserve behavior draws sharp distinctions between the pre-1979 and the post-1979 periods. Rotemberg and Woodford (1997) focus on the 1980–95 period, Fuhrer and Estrella (1999) consider breaks in policy occurring in 1979:Q3, 1982:Q3, and 1987:Q2, while Taylor (1999a) estimates his rule from 1987:Q1 to 1997:Q3. We reestimate the two models in equations (25) and (26) over the period 1982:Q1–2000:Q2. The NK literature has concluded that during this period the Fed stabilized the economy by adjusting the funds rate strongly in response to inflation; it is also a period in which many authors believe no harm is done by ignoring money.

Estimates from the model with a Taylor rule are

$$(27)\qquad (M_t - p_t)^d = -0.182\, i_t + 0.303\, y_t$$
$$i_t = 0.311(p_t - p_{t-1}) + 0.269\, x_t.$$

28. Separate coefficients on M_t and M_{t-1} are estimated to be 2.913 and –2.902, so imposing equal and opposite coefficients does not move the estimates far from the peak of the likelihood function.
29. In the NK model, this coefficient also eliminates indeterminacy of equilibria.

System estimates do not recover a policy response to inflation that is even close to exceeding 1.0. In contrast, OLS estimates of the policy rule yield

$$\text{(28) OLS:} \quad \underset{}{i_t} = \underset{(0.19)}{1.03}\left(p_t - p_{t-1}\right) - \underset{(0.10)}{0.13}\, x_t + \underset{(0.006)}{0.035},$$

which is consistent with conclusions of earlier authors that policy was stabilizing. Impulse response functions for the model estimate a small anomalous price response following an exogenous monetary policy contraction (not reported).

Estimates of the model with an M rule over the 1982:Q1–2000:Q2 period offer a different interpretation of policy behavior:

$$\text{(29)} \qquad (M_t - p_t)^d = -4.503\, i_t + 1.442\, y_t$$
$$i_t = 1.272\,(M_t - M_{t-1}).$$

With the response of the funds rate to money growth exceeding 1.0, policy appears to be stabilizing. OLS estimates of the policy rule tell a different tale:

$$i_t = \underset{(0.072)}{0.344}\left(M_t - M_{t-1}\right) + \underset{(0.005)}{0.049}.$$

Responses to MP shocks in this model are not reported because they look very similar to those in Chart 8.

This section has presented evidence that the exclusion of money from NK empirical analyses is not innocuous. Substantive conclusions about the role of monetary policy and the behavior of the Federal Reserve can change when money is reintroduced in a way that generates interactions between MD and MP behavior. We also demonstrated that in practice it is difficult to distinguish a monetary policy that adjusts the nominal interest rate in response to inflation and output from a policy that adjusts the rate in response to the growth rate of the money supply. This raises some doubts that either specification of monetary policy—equation (27) or equation (29)—identifies policy decision rules. Instead, they may merely be alternative characterizations of equilibrium policy behavior.

In our results, the model with an M rule looks more reasonable than the model in which money is irrelevant to policy choice. These results seem to be at odds with Ireland (2000) and McCallum (2000). They show that money plays a quantitatively unimportant role in the class of general equilibrium models that includes NK models. The inconsistency between their quantitative-theoretic results and our empirical findings deserves further study.

Stability in an Identified VAR Framework

The first section estimated tightly parameterized behavioral relationships with simple policy rules. The third section loosened the restrictions on dynamics in equations, describing private behavior while it maintained simple static policy rules. To complete the progression, this section allows also for freely estimated dynamics in policy behavior, leading to specifications in line with the approach taken in the identified VAR literature.

We show that when dynamics are left unrestricted, the models exhibit remarkable stability across subperiods. With the loss of parsimony come increased sampling error and less precisely estimated parameters. To reduce sampling error we adopt the Bayesian methods developed by Sims and Zha (1998) and employed by Leeper, Sims, and Zha (1996) and Leeper and Zha (2001).

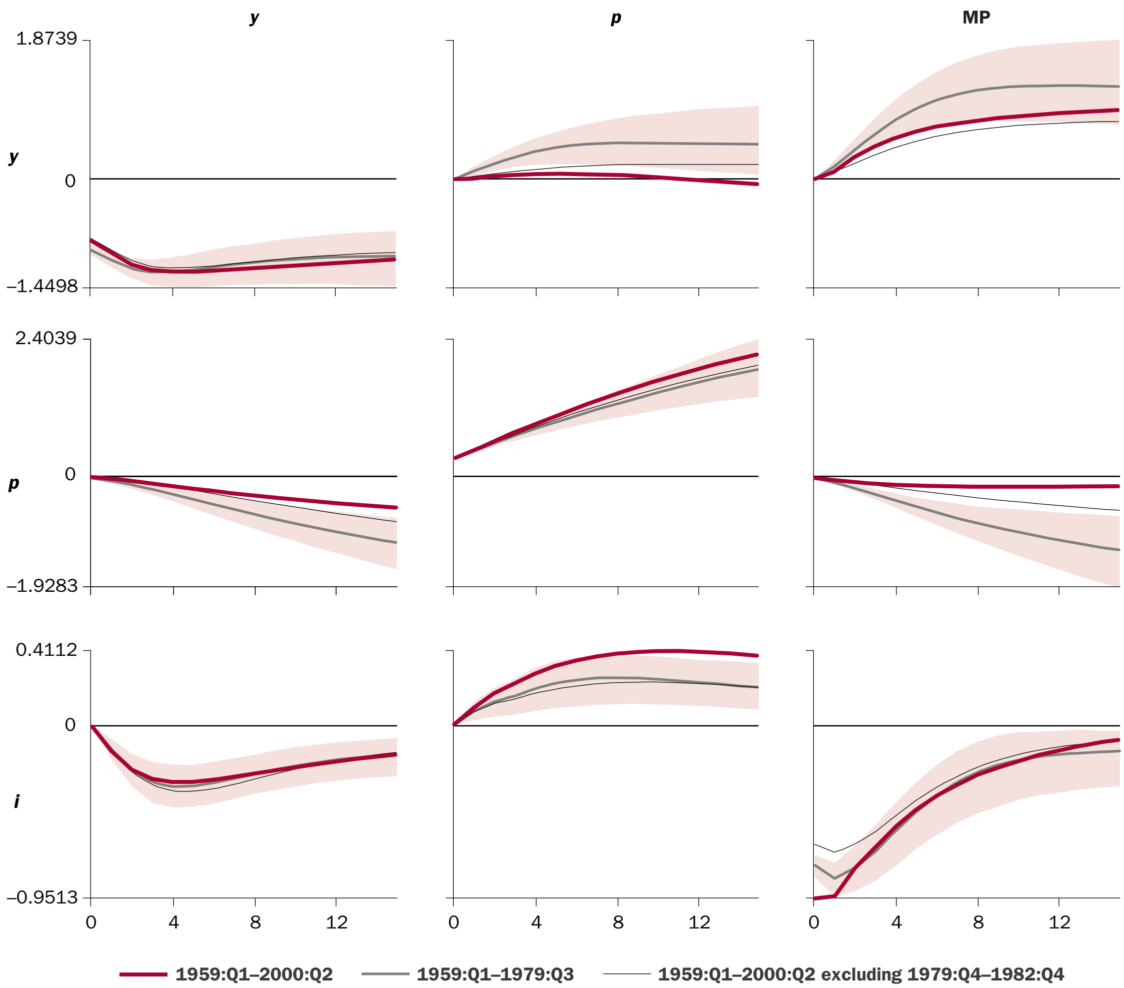
This section reports estimates from two weakly identified VARs. First we revisit the three-variable system consisting of output, the price level, and the federal funds rate. Although the system is fairly stable over time, it exhibits the price puzzle that has received attention in VAR work: an exogenous easing of policy lowers the funds rate, raises output, and *lowers* inflation.[30] The second model adds money to the system with two important effects: the price puzzle disappears and the responses to exogenous shifts in policy become more stable.

In choosing subperiods we face the usual problem that some "interesting" episodes may be too short to be informative. With brief time series, sampling error alone can dominate the estimates and produce misleading inferences. We check stability by estimating the system over three subperiods that coincide with ones frequently studied in work on Fed behavior: 1959:Q1–2000:Q2, 1959: Q1–1979:Q3, and 1959:Q1–2000:Q2 with 1979: Q4–1982:Q4 excluded. The models are estimated with four unrestricted lags and a constant term in each equation.[31] We found that adding potential GDP contributes little to the interpretation of results in this section, so we have dispensed with that variable.

Three-Variable Model. As in the third section, we treat output and inflation as determined in an inertial sector of the economy. This implies policy disturbances affect y and p with a one-period lag. We also take seriously the argument that an operational policy rule must make policy choice depend on observables. In the three-variable economy, where y and p are not observed contemporaneously, an operational rule sets the funds rate as a function of lagged values of all three series.

Because the VAR coefficients in this model are not interpretable, we move directly to the impulse

CHART 9
Three-Variable Identified VAR over Various Subperiods



Note: The shaded region is a 68 percent error band associated with the model estimated from 1959:Q1 to 1979:Q3.

response functions displayed in Chart 9. In each panel we report the three point estimates that correspond to the three subperiods and show a shaded region, which is a 68 percent error band associated with the model estimated from 1959:Q1 to 1979:Q3.[32] When, for the three subperiods, the responses to a shock fall within the error bands, the model makes stable predictions of the effects of that shock. For many policy purposes, this is sufficient evidence of stability.

Most responses over a four-year horizon fall within the error bands. Notable exceptions are the response of output and prices to a policy disturbance: the impacts of policy appear to weaken as more recent data are included in the sample. Another difference is that over the full sample, the funds rate responds more strongly to a "p" shock. This pattern is consistent with the view that, in the Volcker-Greenspan era, the Federal Reserve has placed increased emphasis on stabilizing inflation. Because in the model, both "p" and "y" shocks move output and prices in the same direction, they are both consistent with disturbances that shift aggregate demand. No shock in the model looks like aggregate supply.

Exogenous monetary expansions have strong and persistent effects on output. Even after four years,

30. Sims (1992) and Eichenbaum (1992) discuss the price puzzle.
31. In Sims and Zha's (1998) notation, the tightness of the prior is set as $\lambda_0 = 0.5$, $\lambda_1 = 0.4$, $\lambda_2 = \lambda_3 = 1.0$, $\lambda_4 = 0.2$, $\mu_5 = 1.0$, and $\mu_6 = 5$.
32. The error bands are computed from 50,000 draws using procedures developed by Sims and Zha (1999) and Waggoner and Zha (2000).

output remains well above its preshock level. The perverse response of the price level, though less pronounced in recent data, is consistent across subperiods. The stronger price puzzle exhibited in data up to 1979 conforms to Hanson's (2000a) findings in a different system of variables.

Chart 9 exhibits anomalies and enough instability that we are not comfortable with the identification of policy in the model. To address our concerns, we turn to a model with money.

Four-Variable Model. To identify policy behavior in the four-variable model with money, it is crucial to separate money demand from policy. We estimate the pattern matrix on contemporaneous variables

$$(30) \qquad A_0 = \begin{bmatrix} \times & \times & \times & 0 \\ 0 & \times & \times & 0 \\ 0 & 0 & \times & \times \\ 0 & 0 & \times & \times \end{bmatrix},$$

where the equations appear in columns in the order "y," "p," MD, MP, and variables appear in rows ordered y, p, M, i. We impose no additional restrictions on this matrix and no restrictions on lagged variables. Over the three sample periods, the estimates of A_0 are

(31)

$$A_0^{59-79} = \begin{bmatrix} 1 & 0.02 & -0.18 & 0 \\ 0 & 1 & -1.17 & 0 \\ 0 & 0 & 1 & -8.71 \\ 0 & 0 & 1.49 & 1 \end{bmatrix}, A_0^{59-00} = \begin{bmatrix} 1 & 0.02 & -0.43 & 0 \\ 0 & 1 & -0.59 & 0 \\ 0 & 0 & 1 & -9.93 \\ 0 & 0 & 1.44 & 1 \end{bmatrix}$$

$$A_0^{\text{no }79-82} = \begin{bmatrix} 1 & 0.03 & -0.43 & 0 \\ 0 & 1 & -1.89 & 0 \\ 0 & 0 & 1 & 13.29 \\ 0 & 0 & 3.47 & 1 \end{bmatrix}.$$

In all periods, money demand is estimated to have a negative interest elasticity and positive price and income elasticities. Over the entire sample and over the period up to 1979, the Fed raised the funds rate in response to higher money growth. When the 1979–82 period is excluded, the policy response to current money growth changes from positive to negative. It may be tempting to infer that policy behavior changed in important ways. This parameter is one of many that describes policy behavior in the VAR. The implications of changes in that parameter must be gleaned from the entire model.

Chart 10 illustrates the pitfalls of inferring policy behavior from a single parameter in the policy rule. Dynamic responses to policy disturbances are remarkably stable. Point estimates from the three subperiods lie within the 68 percent error bands derived from the 1959–79 period. There is some evidence in recent years that the output effects of policy shocks have weakened and the price effects have strengthened. In addition, much of the variance of the policy shocks over the entire sample derives from the 1979–82 period (note the smaller shock when that period is excluded). There is no evidence of a price puzzle: point estimates of price responses to a monetary contraction never rise, though the error band places some probability on a higher price path.

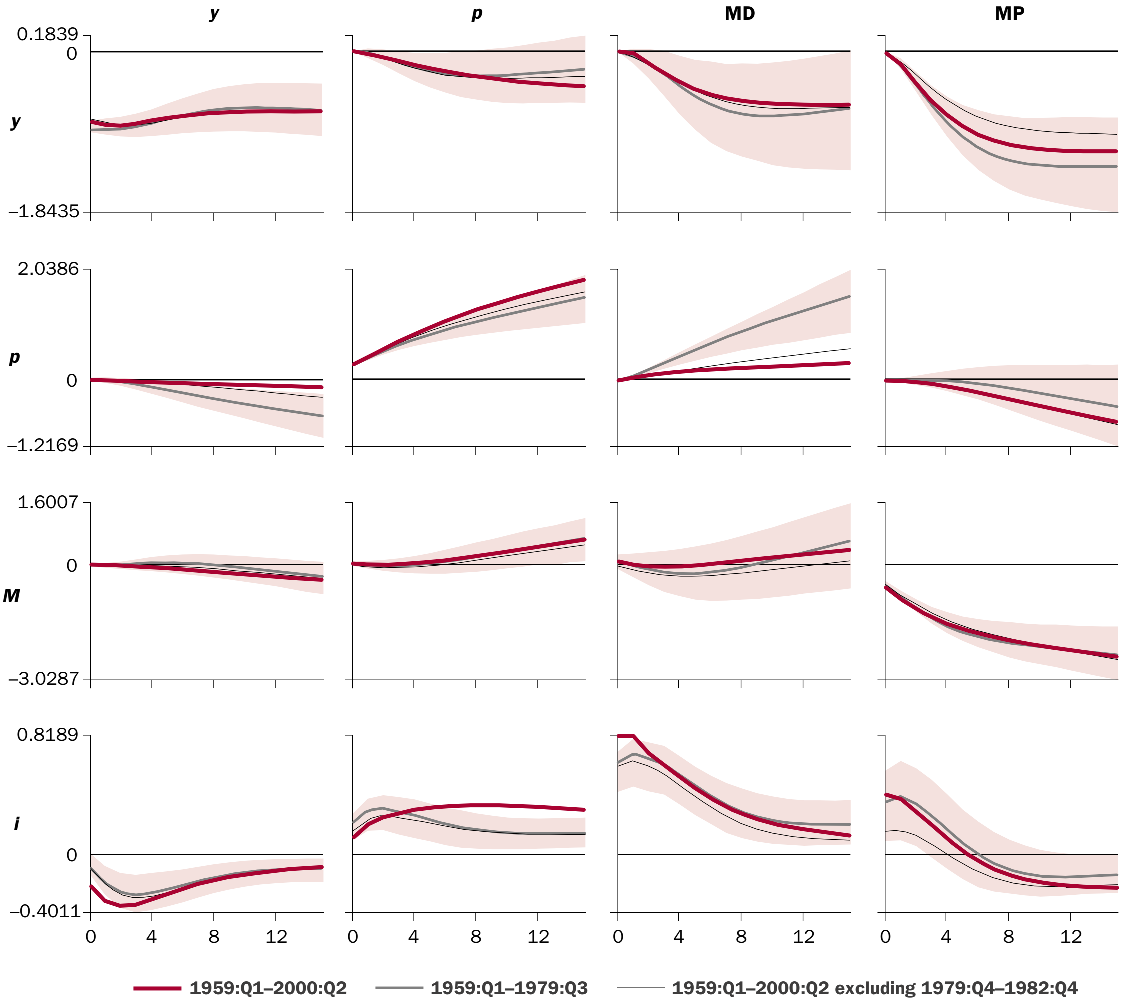
In contrast to the three-variable system, where both "p" and "y" shocks look like they shift aggregate demand, we now see distinct AS and AD disturbances. A "y" shock moves output and prices in the same direction, as one would expect from AD, while a "p" shock moves them in opposite directions, as would an AD disturbance. By separating the two kinds of aggregate shocks, the model allows a richer interpretation of policy behavior than can be gleaned from the model without money. When output and prices move together, policy responds to counteract the output effects. When output and prices move in opposite directions, policy tries to counteract the price effects. This pattern of policy responses is consistent with those found in the simple models with a Taylor rule (for example, Chart 2), but they appear under very different identifying assumptions.

Some instability does show up in the model with money. The price effects of MD disturbances appear to be much weaker in models using recent data. And as in the three-variable system, the response of policy to a "p" shock is stronger in recent years, though now we can interpret the "p" shock as AS.

In contrast to the previous models, the four-variable VAR has only one overidentifying restriction. When estimated from 1959–79, the data do not reject the model by any criterion: the test statistic is $\xi = 1.04$; SC = 4.43, AC = 2.0, $p = .69$. Over the full sample there is more evidence against the model: $\xi = 4.92$; SC = 5.12, AC = 2.0, $p = .03$.

Adding money alters many of the inferences from an identified VAR. Money appears to stabilize the system across time, it eliminates the anomalous price puzzle following MP shocks, and it helps to distinguish aggregate supply from nonmonetary policy aggregate demand disturbances. The instability of M2 velocity since the early 1990s, which has motivated some researchers to eliminate money from their analyses, does not appear to raise difficulties for identifying monetary policy behavior. Neither does it interfere with the stability of predictions about the dynamic impacts of exogenous shifts in policy.

CHART 10
Four-Variable Identified VAR over Various Sub-Periods



Note: The shaded region is a 68 percent error band associated with the model estimated from 1959:Q1 to 1979:Q3.

Implications of VAR Estimates. NK analyses with simple policy rules consistently find that Federal Reserve behavior has been qualitatively different since 1979. Indeed, many authors attribute the superior performance of the U.S. economy over the past decade to superior policymaking. Central to this conclusion is that estimates of simple rules display substantial instability across time. We find no such instability in loosely identified VAR models with money. The contrast in our findings raises the possibility that some authors have overinterpreted the apparently shifting parameters in simple policy rules. The VAR literature, which does not attempt to reduce all policy behavior to two parameters, leads one to doubt the NK conclusions about policy.[33]

Views about the price puzzle in VARs have been influenced by Sims's (1992) argument. The Fed bases its choices on more information than small VARs contain, Sims argues, so what appears in a VAR to be an exogenous policy move is actually a response to extra-model information about aggregate supply disturbances. If this behavior is systematic, it can create a pattern of lower funds rates being followed by higher output and lower inflation. That view led to expanding VARs to include commodity prices, which serve as an "information variable" about supply developments, and thus diminishes or eliminates the price puzzle.

Hanson (2000a) questions the commodity price fix for the price puzzle. He shows that with Christiano, Eichenbaum, and Evans's (1999) recursive

33. Evidence from estimates of policy "reaction functions" supports the VAR findings. For example, Sims (1999) estimates a regime-switching equation describing the Fed's behavior. Although he finds that parameters describing systematic policy responses to the economy seem to shift across regimes, allowing for such shifts contributes little to the overall fit of the equation.

identification scheme, allowing the Fed to respond to current information in commodity prices does not resolve the price puzzle in data before 1979.[34] We cannot discuss these arguments in detail here. We are sympathetic to Hanson's view that the role of commodity prices in policy behavior is poorly understood and that they seem like a weak reed on which to rest identification of policy. We also believe that the role of commodity prices in helping to identify policy behavior has been overemphasized. In the four-variable identified VAR system, exogenous policy contractions never exhibit a price puzzle: the price level smoothly and strongly declines in all sample periods. These results obtain without the contrivance of commodity prices. Conditioning on commodity prices is neither necessary nor sufficient for resolving the price puzzle.

Conclusion

New Keynesian research offers little advice on how, at the frequency of FOMC meetings, the Fed should behave. Few authors suggest the FOMC should mechanically obey the simple rule assumed in the theory. The most detailed discussion of the practical application of a simple rule comes from Taylor (1993a), who suggests that policymakers use it to compare recent FOMC decisions to the rule. And forecasts could include those of the funds rate using the rule. This analysis, Taylor suggests, could include a range of forecasts corresponding to different coefficients in the rule. This suggestion is close to how Leeper and Zha (2001) use an identified VAR to conduct counterfactual policy analysis. Jansson and Vredin (2000) propose blending the two approaches. From the standpoint of a practical policy analyst, therefore, the two approaches could be applied in similar ways.

Applying the estimated NK models to the kind of policy analysis Taylor suggests leads to a quandary. In all the NK models we estimated, the inflation effects of policy disturbances—or deviations from the estimated policy rule—are minimal. By extension, changes in policy parameters, if private decision makers view them as temporary, will also have trivial impacts on inflation. It is not at all clear what monetary policy can do to stabilize inflation in the estimated models.

We introduced the paper by noting that policy analysts face tough choices. Our results do nothing to make those choices easier. But an analyst who wishes to base policy advice on a stylized model and a simple policy rule should be aware of the pitfalls of doing so. While the stories are compelling, they also appear to be fragile. The trade-off between simplicity and robustness is an unpleasant reality of policy analysis.

To be sure, our analysis did not exploit all the structure embodied in the canonical IS-AS-MP New Keynesian model. Cross-equation restrictions implied by dynamic behavior may help resolve some of the identification problems we highlighted. On the other hand, experience suggests that those dynamic restrictions are precisely the ones most at odds with data.

It is a mistake to regard this paper as running a horse race between stylized models with simple rules and identified VARs with complex dynamics and loose behavioral interpretations. Each has its place in policy advising. For a model to help inform policy choice, though, its identifying assumptions should be robust and its fit—both in-sample and out-of-sample—should be respectable.

We have argued, and demonstrated in several ways, that it is treacherous to draw inferences about policy effects solely from policy rules estimated in isolation from a complete macro model. System estimates of policy parameters can differ substantially from single-equation estimates. And system properties do not align well with values of particular policy parameters.

A central theme of the NK literature is that the Fed's performance in the Volcker-Greenspan era is far superior to the Fed's performance in earlier periods. This dramatic conclusion is based on the following: policy parameters have changed across two subperiods; NK models predict that policy in the recent period produces more stable economic outcomes. We find that from the perspective of system estimation, instability of policy rules does not appear to be a serious concern. Even if particular policy parameters are unstable, when the dynamics of behavior are well modeled, the equilibrium effects of policy are quite stable. And it's the equilibrium effects that concern policymakers.

At a minimum our results argue forcefully that the bold NK conclusion—that U.S. monetary policy has improved dramatically in the past twenty years—deserves more careful scrutiny.

34. The price puzzle is not mere VAR esoterica. Taking Hanson's findings as background, Barth and Ramey (2000) propose that the price puzzle actually is no puzzle. Through the "cost channel," a monetary contraction reduces "working capital" and impacts both aggregate demand and aggregate supply. Under certain elasticities, the equilibrium price level should rise after a contraction. They offer industry-level support for the view that monetary contractions reduce output and raise price-wage ratios.

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