# Handbook of Monetary Policy

## PUBLIC ADMINISTRATION AND PUBLIC POLICY

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# Preface

A market economy depends on government for its very existence. In the United States, the federal and state governments establish the institutions, laws, and regulations that are necessary for the market economy to function. Capitalist systems are inherently unstable. They are often characterized by periods of economic prosperity followed by periods of contraction and recession. This has been the experience in the United States.

Following enactment of the Employment Act of 1946, the government of the United States has been committed to maintaining full employment and price stability. Since 1979, economic policymakers in the United States, and in many other countries, have been committed to a policy of relative price stability. Today, central banks not only agree, more or less unanimously, that price stability should be the main goal of monetary policy, but most of them have in fact achieved it. The average inflation rate in the rich economies is currently just above 1%, its lowest in almost half a century.

The purpose of this handbook is to explain the development and implementation of monetary policy. We first examine theories and issues related to the preservation of economic activity, and include chapters that explore the business cycle, how it has changed over the years, and why the preservation of economic stability is a principal goal of public policy. In addition, several contributions provide a historical perspective on the development of economic theories and government economic policies. Moreover, we do not neglect the political dimensions of economic policy and how government and private organizations use the tools of economics to forecast and to measure economic activity.

Arguably, monetary policy is the most powerful weapon available to government for the management of economic activity. Certainly, that has been the experience in the United States in recent decades. Thus, the second part of the handbook reviews the development of monetary policy and its institutions. It also explores the challenge of inflation and how it has been the principal target of monetary policy. Other articles in this part examine the development and role of financial markets and institutions, issues associated with the implementation of monetary policy, and the management of interest rates.

The companion volume, the *Handbook of Fiscal Policy*, contains several articles that explain the development of government fiscal policymaking and the legacy of John Maynard Keynes. Other selections examine taxes and tax policies, government budgeting and accounting, and issues associated with government debt management. Several articles dis-

cuss the role of government in the formulation of economic policies for growth and for full employment. It concludes by reviewing issues associated with the implementation of fiscal policies.

*Jack Rabin*
*Glenn L. Stevens*

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# Handbook of Monetary Policy

# 1

# *Beyond Shocks* What Causes Business Cycles? An Overview

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In the summer of 1997, when the Federal Reserve Bank of Boston selected the topic for its forty-second annual economic conference, many pundits were asking: "Is the business cycle dead, or at least permanently dampened?" By the time the Bank's conference convened in June 1998, the same pundits queried: "What caused the massive recessions in Asia?" and "Can the United States remain 'an oasis of prosperity,' as Fed Chairman Alan Greenspan termed it, while economies worldwide are under siege from financial crises?" How quickly things change!

*Beyond Shocks: What Causes Business Cycles?* turned out to be a particularly timely conference. Of course, the answers to the pundits' questions are inextricably tied to an underlying fundamental question: What makes economies rise and fall? To determine whether the business cycle is dead, one must first determine whether economic fluctuations arise from the decisions of governments, financial market participants, and businesses, or simply from unexpected events (that is, "shocks"). To determine why Asian economies plunged into severe recession, it is necessary to understand how external pressures on vulnerable financial markets can lead to a sudden collapse, with severe consequences for nonfinancial sectors. And to determine whether the robust economic expansion in the United States will continue, it is necessary to evaluate how a slew of adverse economic factors, financial and real, could interact to end it.

So, what caused the Asian crisis, the recessions of the 1970s and 1980s, and even the Great Depression? According to many modern macroeconomists, shocks did. This unsatisfying answer lies at the heart of a currently popular framework for analyzing business cycle fluctuations. This framework assumes that the macroeconomy usually obeys simple behavioral relationships but is occasionally disrupted by large "shocks," which force it temporarily away from these relationships and into recession. The behavioral relationships then guide the orderly recovery of the economy back to full employment, where the economy remains until another significant shock upsets it.

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Attributing fluctuations to shocks—movements in important economic variables that occur for reasons we do not understand—means we can never predict recessions. Thus, a key goal of the conference was to try to identify *economic* causes of business cycles, rather than attributing cycles to "shocks." The greater the proportion of fluctuations we can classify as the observable and explainable product of purposeful economic decisions, the better chance we have of understanding, predicting, and avoiding recessions.

Several themes emerged during the conference. One was the concept of "vulnerability." It was especially prominent in discussions of the recent Asian crises and bears on the distinction between shocks and systematic economic behavior. Rudiger Dornbusch perhaps put it best in the following analogy. Consider the collapse of a building during an earthquake. While the proximate cause of the collapse was the earthquake, the underlying cause may better be attributed to poor construction techniques. Because of its structural defects, the building was going to collapse when the right "shock" came along. So it goes with financial and real economic collapses, Dornbusch and many others would argue.

While it will always be difficult to anticipate the particular event that precipitates a collapse, it is important to constantly assess the vulnerability of financial, product, and labor markets to potential shocks. Macroeconomists and forecasters tend to focus primarily on the overall health of the economy as measured by aggregate demand or by the unemployment rate; they may be able to improve their economic models by incorporating vulnerability. Likewise, policymakers should be vigilant against vulnerability. To do so, they will need to develop new tools. In Asia, for example, policymakers should have had a better assessment of the ability of the financial system to absorb shocks to currency valuations.

Developing such an assessment would likely have been hampered, many conference participants pointed out, by the inability to obtain key data on the debt portfolios of financial institutions, the performance of bank loans, and the exposure of the country as a whole to exchange rate risk. Proposals abounded for more accessible banking data and new indexes of risk exposure. Although little agreement was reached on exactly what information would be most useful, most agreed that policymakers and investors need new and more timely measures to adequately assess the vulnerability of economies to severe disruptions.

A second theme of the conference discussion was the role of systematic monetary policy in causing and preventing business cycles. Many have blamed the bulk of recessions on monetary policy. But as pointed out by Peter Temin, Christina Romer, and Christopher Sims, in assigning blame, it is important first to distinguish the systematic response of monetary policy to existing conditions from policy regime shifts and exogenous policy shocks. To take a leading example, did the Fed cause the Great Depression by raising domestic interest rates to maintain the gold standard, or was the outflow of gold from the United States following Great Britain's abandonment of the gold standard the cause, and the response of the Fed a "business as usual" response to that triggering event? Such questions are very difficult to answer, but a careful attempt to do so must be made if we are to understand the role of monetary policy in cycles.

Most participants agreed that the Fed played a significant role in causing many of the recessions of the past century, largely in the pursuit of its goal of long-run price stability. The degree to which monetary policy did or could moderate the effects of cyclical downturns was less clear. Many pointed to the apparent diminution of the amplitude of business cycles in the postwar period as evidence of the Fed's ability to lessen the severity of contractions.

Interestingly, Sims's more formal analysis of this question raised doubts that the systematic component of monetary policy either causes fluctuations or can offset them, at least

through interest rate movements. Using econometric substitution of modern interest rate policy back into the Great Depression era, Sims found that modern policy would have had little effect on employment or prices. While this finding met with a good deal of skepticism from participants, one skeptic who tried to prove Sims wrong—discussant Lawrence Christiano—reported that he could not. In any case, the suggestion that conventional interest rate policy is limited in its ability to offset major recessions is thought-provoking. Of course, the limitations of interest rate policy do not preclude alternative policies, such as deposit insurance and acting as lender of last resort in financial crises. These policies may be at least as important as interest rate policy.

A third conference theme was the importance of a deeper understanding of the contribution of changes in the efficiency and structure of production to business cycle fluctuations. Recently, some macroeconomists have advanced the idea that shocks to these supply-side or "real" factors cause many, if not most, of the ups and downs in the economy. This idea contrasts sharply with the traditional macroeconomic notion that changes in aggregate demand cause most fluctuations, and the two views generate quite different policy implications.

Two real shocks were evaluated. One is a shock to the technological efficiency of firms' production of goods and services. Technological changes are very positively correlated with output and business cycles, a relationship that has led many observers to conclude that technology shocks cause fluctuations. Susanto Basu, however, demonstrates that more detailed and sophisticated estimates of technological change substantially reduce, if not completely eliminate, the correlation between technology shocks and the business cycle. He also shows how modern macroeconomic models, especially those that rely primarily on technology shocks, have difficulty fitting the data. Proponents of technology-oriented models were predictably skeptical of his results.

The second real shock is a change in the desired distribution or allocation of economic resources across firms, industries, and regions. Restructuring involves the costly and time-consuming reallocation of factors of production, especially workers, between firms, industries, and regions through the processes of job creation and destruction. It also typically involves lower output, higher unemployment, and often even recessions. In fact, job reallocation and job destruction rise sharply during recessions, leading some to surmise that shocks to the process of reallocation itself may be responsible for recessions and should therefore be taken into consideration by macroeconomic models. Scott Schuh and Robert Triest discover strong correlations between job reallocation and the primary determinants of how jobs are allocated across firms and industries: prices, productivity, and investment. Correlations between these determinants and job reallocation suggest that it is not mysterious allocative shocks that cause business cycles, but significant changes in observable economic variables.

Together, the two studies of real shocks reaffirm the fact that the production and employment behavior of firms is subject to substantial variation over the business cycle, but they deepen doubts that the variation is due to real shocks. Instead, the correlations between output and simple measures of real shocks reflect the failure of conventional analyses to incorporate a sufficiently detailed specification of production and market structure. As more and more of firms' behavior is accounted for in macroeconomic models, less and less scope remains for real shocks to generate business cycles. However, much is still to be learned about business cycles from the behavior of factor utilization, investment, prices, productivity, and the like.

## OPENING ADDRESS: HISTORY OF THOUGHT ON THE ORIGINS OF BUSINESS CYCLES

Paul Samuelson's opening address begins with the question "Is the business cycle dead?" While the macroeconomy appears to have stabilized over the past 50 years, perhaps owing to successful countercyclical macropolicy, Samuelson sees no evidence of a trend toward the elimination of business cycle fluctuations. He notes that after most periods of extended expansion, especially those accompanied by outstanding performance in asset markets, suggestions of a "new era" of recession-proof prosperity have arisen, and they have been received "with increasing credulity" as the expansion rolls on. Acknowledging this historical association between healthy economies and booming asset markets, Samuelson takes a more realistic view, stressing also the intertwined histories of business cycle downturns and bubbles and crashes in asset markets.

Samuelson cites Victor Zarnowitz's recent observation that in the seven decades between 1870 and World War II, the United States suffered six major depressions. In the past 50 years, we have had no declines of comparable severity. Samuelson attributes this improved performance to changes in "policy ideology, away from laissez-faire and toward attempted countercyclical macropolicy." But despite the gains in policy's management of the economy, Samuelson sees no "convergence towards the disappearance of non-Pareto-optimal fluctuations. We are not on a path to Nirvana." The scope for improved performance arising from better government policies appears marginal today.

So pronounced fluctuations in production, prices, and employment are here to stay, despite the best efforts of policymakers. But why? In the end, Samuelson argues, fluctuations are usually the product of two factors. First, on the upside, asset price bubbles will always be with us, because individuals have no incentives to eliminate "macromarket inefficiency." While we have made tremendous progress toward "micro-efficiency"—making individual financial markets more efficient through the widespread use of options and other derivatives, for example—little evidence can be found, either in economic history or in economic theory, that "macromarket inefficiency is trending toward extinction." One can make money by correcting any apparent mispricing of a particular security, but one cannot make money attempting to correct apparent macro inefficiencies in the general level of stock market prices.

Economists and financial market participants simply have no theory that can predict when a bubble will end. As a result, an individual investor will be perfectly rational in participating in a bubble, as he will make money from the bubble so long as it continues, which could be indefinitely. As Samuelson puts it, "You don't die of old age. You die of hardening of the arteries, of all the things which are actuarially . . . associated with the process. But that's not the way it is with macro inefficiency." Bubbles go on until they stop, and no one has ever been able to predict when that will be.

Downturns can develop from the asset markets themselves, and they can develop quite quickly. Because asset prices are based on the "prudent ex ante expectations" of market participants, swings in market expectations can produce large and rapid swings in asset prices, causing massive revaluation of asset-holder's wealth. This was in part the cause of the ongoing Asian crisis, according to Samuelson. Market participants reasonably reassessed the valuation of investments (and therefore currencies) in Asia and quickly altered the direction of capital flow, precipitating a currency and banking crisis there.

Given the lack of private incentive to restrain the stimulative effects of this "oldest business cycle mechanism," we come to the second factor that contributes to business cy-

cle fluctuations: government policy. Samuelson noted that he has often said, "When the next recession arrives, you will find written on its bottom, 'Made in Washington.' " This is not, as he points out, because the Fed is a sadistic organization. Rather, "if the central bank and fiscal authorities did not step on the brakes of an overexuberant economy *now*, they might well have to overdo that later." When persistent macromarket inefficiencies threaten both employment and price stability and private incentives fail to encourage financial markets back into line, only policymakers can take the systemic view necessary to guide the economy back into balance.

## HISTORICAL EVIDENCE ON BUSINESS CYCLES: THE U.S. EXPERIENCE

Peter Temin examines the causes of U.S. business cycles over the past century. In developing his taxonomy of causes, Temin points out three inherent problems with the effort. First, the idea of a "cause" is fraught with ambiguity. In part, this ambiguity arises from the difficulty in distinguishing the endogenous, or "normal response" component of government policies and private actions, from the exogenous, or out-of-the-ordinary actions of private and public agents. In Temin's view, only exogenous events should be seen as causal. He uses oil prices and the 1973–75 recession to illustrate the dilemma: Was the recession following the oil shock "caused" by the oil shock, or by the monetary policy response to the oil shock? The imputation of causes depends on one's model of economic history, and particularly on the degree to which one makes behavior endogenous or exogenous.

Second, the Great Depression should be treated as a unique event. As Temin notes, output lost during this enormous downturn was almost one-half of the sum of output lost in all other downturns in the past century. The body of writing on the Great Depression is larger than that on all other business cycles combined. Consideration of the causes of the Great Depression provides useful lessons about the causes of the less prominent cycles of the past century. For example, it seems implausible that a single "shock" in 1929 pushed the U.S. economy into massive depression. Instead, Temin argues, the Great Depression was likely the result of a sequence of contractionary influences. Prominent among these were the fear that the hyperinflationary pressures in Eastern Europe following the First World War would spread to the United States, the adoption by industrialized countries of the relatively inflexible gold standard in response to these pressures, and the breakdown of banking and legal systems. The Great Depression was really a sequence of smaller recessions large and persistent enough, given policy responses, to throw the world into depression.

Third, Temin cautions that his assignment of causes relies on the existing literature on the subject. The literature on recessions other than the Great Depression is quite sparse, with earlier recessions receiving considerably less attention than more recent ones. And within this limited set of sources, most authors focus on the *transmission* of cycles, rather than on the causes. Finally, most of the available sources do not highlight expectations and do not clearly distinguish anticipated from unanticipated changes.

Temin classifies the reported causes of recessions as either domestic or foreign, and either real or monetary. Changes in the relative prices of assets, both real and financial, are classified as real phenomena. Temin finds that the preponderance of cycles in the past century may be attributed to domestic causes, with the split between real and monetary causes

roughly equal for the entire period. Monetary causes of recessions were more prevalent in the pre–World War I period than during the post–World War II period, however.

Temin focuses on the larger downturns. The cause of the Great Depression of 1931 is classified in Temin's taxonomy as a foreign monetary phenomenon. The action of the Fed to maintain the gold value of the dollar by raising interest rates was to behave as a "traditional and responsible central banker" or, in other words, to follow a normal and expected endogenous policy course. Thus, the Fed's behavior cannot be viewed as an exogenous cause of the Great Depression, in Temin's view. The search for causes then reverts to the question of what produced this monetary policy response. Temin suggests that U.S. monetary policy was responding to the external gold drain that arose from Britain's departure from the gold standard, which threatened to weaken the dollar. The Fed's reaction in increasing interest rates, and the bank panics and failures that followed, were endogenous responses to the gold drain.

In assessing the causes of the four largest downturns of the century—the Great Depression, and the recessions of 1920, 1929, and 1937—Temin concludes first that no single cause explains all four downturns. Three of the four possible causes in Temin's taxonomy appear as causes of the downturns. Second, three of the four recessions appear to be responses to domestic shocks. Most often, we cannot blame our downturns on foreign causes.

Taking all of the cycles studied into consideration, Temin offers the following conclusions: (1) "It is not possible to identify a single type of instability as the source of American business cycles." Thus, Dornbusch's statement, "None of the U.S. expansions of the past 40 years died in bed of old age; every one was murdered by the Federal Reserve," is not supported by Temin's analysis. (2) Domestic real shocks—ranging from inventory adjustments to changes in expectations—were the most frequent source of fluctuations. (3) Other than the two oil shocks of 1973 and 1979, foreign real shocks were not an important source of U.S. cycles. (4) Monetary shocks have decreased in importance over time. (5) When measured by the loss of output, domestic sources have loomed larger than foreign sources; real sources have caused about the same losses as monetary sources.

Christina Romer takes issue both with Temin's classification scheme and with his interpretation of the literature on the causes of recessions. She suggests that an improved classification scheme and a different reading of the literature would yield a more critical role for domestic monetary shocks, particularly in the inter- and postwar periods.

Romer suggests that Temin's methodology is biased toward finding very few monetary causes of recessions. Whereas Temin classifies most Fed behavior as a fairly typical response to prevailing conditions and therefore not the ultimate cause of the recession, Romer would prefer a more practical classification of monetary policy actions. If the monetary policy action was the inevitable or highly likely result of a trigger, then we should consider the policy action endogenous and therefore not a cause. If, however, "a conscious choice was made" or if "alternative policies were . . . discussed at the time," then the policy should be considered at least partly exogenous, and monetary policy should get some blame for the recession.

Romer shows that, using this criterion, many more of the twentieth-century recessions have an important monetary policy aspect. Monetary factors would likely be given an important causal role in the 1931 recession, for example, as "reasonable men *at the time* were urging the Fed to intervene" in the face of financial panics. Thus, the choice not to intervene but to raise the discount rate was not inevitable or even most likely. Romer also

questions the extent of the constraint imposed by the gold standard, as U.S. gold reserves in 1931 were probably adequate to have allowed the Fed to pursue expansionary open market operations while maintaining the gold value of the dollar, as in fact it did in 1932.

Turning to the 1973 recession, for which Temin ascribes no monetary role, Romer argues that the central bank was not simply acting as "a respectable central bank [that] resists inflation," and therefore responding only as expected. Romer points out that the decision to tighten in 1974 was not a foregone conclusion but rather a conscious choice, as "the economy was already in a downturn and many were calling for loosening." Thus, "monetary policy and the oil shock share responsibility for the 1973 recession."

Romer also challenges Temin's attribution of the 1957 and 1969 recessions to declines in government spending. She points out that the high-employment budget surplus actually *falls* throughout the late 1950s, suggesting a net stimulative impulse from the federal government for the 1957 recession. For both recessions, Romer asserts that the Federal Reserve made a conscious decision to tighten in order to reduce inflation.

As Romer sees it, "the key change has not been from monetary to real shocks or vice versa, but from random shocks from various sources to governmental shocks." Since the Second World War, the government has been more effective at counteracting most shocks, accounting for the diminished frequency of cycles. However, the combination of a tendency toward over expansion and a few large supply shocks caused inflation to get out of hand. In sum, Romer would agree with the thrust of Dornbusch's statement, which is that monetary policy has played a vital role in postwar recessions. She might re-cast the role of the Fed, however, as "more like a doctor imposing a painful cure on a patient with an illness than a murderer."

## HISTORICAL EVIDENCE ON BUSINESS CYCLES: BUSINESS CYCLES ABROAD

Michael Bergman, Michael Bordo, and Lars Jonung examine the broad cyclical properties of GDP, using a newly compiled data set of annual observations for a sample of "advanced" countries. Their data set spans the years 1873 to 1995. The authors show that the duration of business cycles (the calendar time from peak to peak or trough to trough) has been fairly similar across countries and fairly stable over time. The average duration rose from about four years in the pre–World War I period to about five and one-half years during the interwar period, falling back to just under five years in the period following World War II. The most severe recessions appear to have occurred prior to 1946, and the magnitude of all fluctuations in GDP seems to have decreased in the postwar period.

Formal statistical tests of diminished cyclical fluctuations in the postwar period generally confirm the visual evidence. This observation has often been interpreted as evidence that countercyclical policy has been more effective in the postwar period. However, an alternative explanation is that the increased integration of the world economy serves to mitigate the negative influence of any one country's disruptions on other countries.

Conventional wisdom holds that downswings are sharper and "steeper," whereas upswings are more gradual. Bergman, Bordo, and Jonung test this proposition and find that, for the United States, upswings are indeed more gradual than downswings. The evidence for other countries is more mixed, however, with most exhibiting this asymmetry prior to World War II but only a minority displaying asymmetry in the postwar period.

The authors then attempt to determine the extent to which different components of GDP—including consumption, investment, government expenditures and revenues, exports, and imports—account for its cyclical volatility. For virtually all countries and time periods, all components of GDP except consumption generally are more volatile than GDP. This finding is consistent with the presence of a consumption-smoothing motive, that is, the desire of consumers to maintain a relatively smooth stream of consumption over time in the face of volatility in their income and wealth.

The authors find that larger countries experience deeper recessions; the average decline in GDP below trend is larger for large countries than for small, open European countries. For most countries, the downturn in GDP during a recession is accounted for by declines in consumption, investment, and net exports.

Finally, Bergman, Bordo, and Jonung consider the patterns of international co-movement of output and prices in their data. They find that the correlations among real output in the 13 countries have increased over time, suggesting a more integrated world economy and possibly a stronger coherence of the business cycle across countries. During the gold standard, real GDP for most countries exhibited little or no correlation with real GDP in other countries. During the interwar period, U.S. GDP was significantly correlated with seven other countries, but corresponding correlations between other countries were not evident. The authors suggest that this correlation arises from the role of the United States as the "epicenter" of the Great Depression. Output linkages among European countries strengthened considerably in the postwar period, perhaps the result in part of the establishment of the European common market and in part of the common influence of the oil shocks in the 1970s.

Price levels appear to be much more consistently correlated across countries. Like output, price levels have become increasingly correlated over time, perhaps consistent with "increased global integration of goods markets," the authors suggest.

Richard Cooper offers a different perspective on Bergman, Bordo, and Jonung's conclusion that "the cyclical pattern . . . appears to remain surprisingly stable across time, regimes, and countries" and on the broad question of the international origin and transmission of the business cycle. He examines years in which the raw data for real GDP declined, for a set of nine countries during the periods 1873 to 1913 and 1957 to 1994. Cooper prefers this approach, as the author's results may depend on the filtering and detrending methods that they used in constructing their data.

The conclusions that he draws for the earlier period are as follows: First, "most downturns are domestic in origin, and are not powerfully transmitted to the other important trading nations." Second, if one were interested in international transmission, one would focus on 1876, a year in which the Continent and Canada experienced declines in GDP, and on 1879 and 1908, years in which several countries experienced output declines. Third, Belgium exhibits only one downturn during these periods, a suspicious finding given the 12 downturns in neighboring Netherlands and 14 in France. As a result, Cooper calls into question the reliability of the annual data for any of these countries prior to 1914.

For the period 1960 to 1995, Cooper notes that the few recessions have been concentrated in five years: 1958, 1975, 1981–82, and 1993. This suggests strong international transmission, in contrast to the earlier period. All of the recessions in the United States were accompanied by recessions elsewhere. The greater coherence may be attributed to the importance of the oil price shocks in these recessions, Cooper notes.

Cooper goes on to question the detrending method used by Bergman and his coau-

thors. Only 60 percent of their recessions match NBER reference dates. The issue of appropriate filtering is important when considering the welfare implications of business cycles, Cooper suggests. A departure of output below its (rising) trend may imply relatively little lost income or underutilized resources, whereas an absolute decline in output would almost surely entail significant welfare losses.

Cooper outlines a number of broad changes in industrial economies that would lead one to question Bergman, Bordo, and Jonung's conclusion about the stability of the business cycle over long spans of time. He suggests that "the most dramatic by far . . . is the reduction in the fraction of the labor force required for food production." The decline in this number from about one-half in 1880 to below 5 percent by 1995 for all of these countries is likely to have altered the dynamics of the business cycle significantly, according to Cooper. Other important secular changes include the increased participation of women in the paid work force, the growth in the importance of government expenditures, and major technological innovations, including electricity, automobiles, and aircraft. "A relatively unchanged economic cycle that survived these dramatic secular changes in modern economies would be robust indeed," Cooper suggests.

## GOVERNMENT POLICY AND BUSINESS CYCLES

Christopher Sims examines one of the most contentious questions in macroeconomics: the role of monetary policy in twentieth-century business cycles. Sims points out that one cannot determine the influence of monetary policy simply from observed changes in interest rates and output. The observation that a rise in interest rates precedes each postwar recession does not show that policy-induced interest rate movements *caused* the recession. If, for example, rapid expansion of private demand for credit systematically causes all interest rates to rise near the end of an expansion, this rise in interest rates should not be interpreted as the cause of a subsequent slowdown; it is a consequence of previous strong demand. Because such "eyeball" interpretations of the data can lead to confusion about the role of monetary policy, Sims advocates examining the interactions among many economic variables in order to obtain a clear picture of the role of any one of them in economic fluctuations.

Sims employs a methodology that allows each of six variables (industrial production, consumer prices, currency, a monetary aggregate, the discount rate, and commodity prices) to respond to lags of the other variables, and to the contemporaneous values of *some* of the other variables. The restrictions on the contemporaneous interactions among variables reflect common-sense notions about policy, goods market, and financial market behavior. Monetary policy-induced interest rate changes affect prices, output, and monetary aggregates only with a one-month lag; monetary policy responds to output and prices only with a lag, reflecting data availability; and commodity prices respond to everything contemporaneously, reflecting their auction-market, flexible nature.

This simple model is estimated on monthly data for the postwar years 1948 to 1997. Sims uses the model to show that most of the variation in the Fed's discount rate represents systematic policy responses rather than unanticipated shifts in policy. The discount rate responds primarily to movements in production, commodity prices, and M1. These three determinants of interest rate movements in turn cause the largest increases in CPI inflation, suggesting that the Fed responds to these as signals of future inflationary pressures.

When Sims estimates this same model on the interwar period from 1919 to 1939, he finds similarities but also some important differences in monetary policy responses and influences. One key difference is that the effect of interest rate changes in the early period is roughly double the effect in the later period. On the other hand, monetary policy in the early period appears to be more accommodative toward unanticipated increases in output, raising the discount rate less in response to output and thereby allowing greater inflation in commodity and in final goods prices. Interestingly, the model shows that when depositors' worries caused a rush into currency in the interwar period, the Fed typically *raised* the discount rate, accelerating the shrinkage of money.

This first set of exercises establishes that the systematic responses of policy to output and prices represent the dominant source of interest rate fluctuations in Sims's model, and that these interest rate movements are likely the most important source of policy's effects on the rest of the economy. Noting that economic fluctuations have been smaller in the postwar period, Sims proposes using his model to answer a key question: whether better systematic monetary policy is responsible for the improved economic performance of the postwar period.

To answer this question, Sims transplants the estimated monetary policy equation for one period into the other period, then observes the estimated behavior of output, prices, and monetary aggregates under this counterfactual monetary regime. The results from these exercises are remarkable. In the first variant, the (estimated average) policy judgment of Burns, Volcker, and Greenspan is imposed on the 1920s and 1930s. Overall, Sims finds the outcomes—particularly the Great Depression—would have been little changed by this more responsive postwar policy. The drop in production from 1929 to 1933 is "completely unaffected by the altered monetary policy." Postwar policy would have made the 1920–21 and 1929–33 deflations less severe, but not by much. The upheaval of the 1920s and 1930s would have been the same, even if modern monetary policymakers had been at the reins. Sims notes that his methodology leaves the banking runs, panics, and currency speculations that plagued the Depression era as unexplained non-monetary shocks. To the extent that a persistent commitment to monetary ease would have alleviated such disruptions, the drop in output might have been less severe, he suggests.

The effects of substituting interwar monetary policy into the postwar economy are qualitatively the same. Even though the discount rate responds much more slowly to the postwar economic fluctuations, resulting in a markedly different interest rate pattern, the influence of this altered policy on industrial production and consumer prices is quite small at business cycle frequencies. The implications for output and inflation at longer horizons are what one would expect with a more accommodative policy: Output and inflation both rise higher in the 1970s, resulting in a larger recession in the 1980s, although Sims is careful to point out that these findings may well be statistically unreliable. Overall, he reaches the startling conclusion that "the size and timing of postwar U.S. recessions had little to do with either shocks to monetary policy or its systematic component."

Lawrence Christiano focuses on Sims's surprising conclusion that monetary policy played little or no role in the Great Depression. He disagrees with the methodology that Sims uses to reach this conclusion, but upon employing what he considers a superior method, he confirms Sims's results.

One criticism of Sims's methodology revolves around the assumption that private agents behaved the same in the postwar period after the creation of the Federal Deposit Insurance Corporation (FDIC) as they did during the interwar period prior to the FDIC. Christiano suggests that the frequency with which interwar depositors converted deposits to cur-

rency at the slightest sign of bad news, in contrast to the virtual absence of such bank runs in the postwar period, suggests that the presence of the FDIC fundamentally changed private agents' behavior. In particular, they may have viewed the commitment of Federal Reserve policy to maintain banking system liquidity quite differently in the postwar period, and in a way that cannot be captured by the simple "reaction functions" or interest rate equations in Sims's analysis.

The more important flaw in Sims's analysis, according to Christiano, is the characterization of the postwar monetary policy rule. Under this rule, after all, the Fed would have *contracted* the money supply by 30 percent in the 1930s. Christiano cannot conceive of a sensible policymaker who would pursue a contractionary monetary policy during a widely recognized, worldwide depression. So Christiano proposes instead to use a monetary policy equation that keeps money (M1) from falling during the episode.

Using this more plausible counterfactual policy in Sims's model for the interwar period, Christiano finds that a stable M1 path for the early 1930s would have prevented the dramatic price declines that actually occurred. Surprisingly, however, even under the more realistic policy response, which implies a more realistic path of money growth, "the basic course of the Great Depression would not have been much different," as shown by the similarity between the path of output in Christiano's simulation and the actual path of output.

Benjamin Friedman is also skeptical of the empirical results developed in Sims's paper, stating: "If the model he presents has succeeded in identifying Federal Reserve actions and measuring their economic effects, these findings should force us to reconsider many aspects of economics and economic policy." Friedman finds troubling Sims's result that postwar monetary policy would not have significantly altered the course of the Great Depression, and he views as even more problematic the finding that Depression-era monetary policy would have worked just the same in the postwar period as did actual policy. Friedman notes that the general price level was approximately the same at the onset of World War II as at the onset of the Civil War, while prices since that time have risen approximately tenfold. That the monetary policy that delivered the interwar *de*flation is the same one that delivered the "historically unprecedented phenomenon of a half century of sustained *in*flation" would make inflation, even over periods of several decades, never and nowhere a monetary phenomenon.

Friedman suggests that Sims's model delivers its surprising results because it fails to adequately identify the Fed's monetary policy actions or the effects of those actions on the macroeconomy. If so, then the model's "implied irrelevance of monetary policy" for the postwar inflation translates further into irrelevance for assessing monetary policy's role in causing or cushioning business cycles. One indication that Sims's postwar policy rule does not accurately represent Fed actions, Friedman argues, is the difference between the Sims model's policy prescriptions for the Depression era and John Taylor's policy rule prescriptions for the same period. Friedman finds that Taylor's rule would imply nominal interest rates "an order of magnitude more negative than what Sims reports," casting some doubt on how well Sims's policy rule reflects all of postwar Fed behavior.

Finally, Friedman notes that the assumption that Fed policy can be characterized by one unchanging rule over the entire postwar period is implausible. He asks, "Are we really to equate Paul Volcker's tough stance against inflation with the see-no-evil regime of Arthur Burns?" While Friedman recognizes that Sims tests for a shift in monetary policy in 1979, Sims does so by testing for a shift in all 279 of his model's parameters. Friedman notes that Sims could have more narrowly focused this test to detect only shifts in the parameters that summarize monetary policy.

## FINANCIAL MARKETS AND BUSINESS CYCLES: LESSONS FROM AROUND THE WORLD

A panel composed of Rudiger Dornbusch, Maurice Obstfeld, and Avinash Persaud analyzed recent financial market crises, most notably the turmoil in Asia, and drew lessons on how to reduce the likelihood and severity of future crises. Generally speaking, the panelists agreed more on why the crises occurred than on what should be done to prevent future crises.

Dornbusch believes that recent financial crises in Asia, Russia, and Mexico differed from most preceding crises because they centered on capital markets rather than on the balance of payments. Both types of crises often are associated with currency crises as well, but the vulnerability or risk imposed on an economy by a capital market crisis is fundamentally different. He explains that financial systems experiencing a capital market crisis exhibit five characteristics: (1) borrowing short and lending long generates a *mismatching of maturities* between liabilities and assets; (2) borrowing in foreign currency units and lending in domestic currency units generates a *mismatching of denominations;* (3) borrowing to carry assets exposed to large fluctuations in price generates *market risk;* (4) high risk exposure throughout a country generates a *national credit risk;* and (5) the central bank is weakened by *gambling away foreign exchange reserves.*

According to Dornbusch, the capital market crisis in Asia made the regional economy vulnerable, or at risk, to adverse external factors. And two such factors happened. First, "Japan went into the tank." Just as the Japanese economy was starting to show signs of emerging from several years of sluggish growth, the Japanese government tightened fiscal policy and the economy slumped again. This time the weakened economy exposed underlying banking problems that exacerbated the situation so much that the Japanese economy eventually began to contract. Because Japan is the largest economy in the region and the leader in regional export and import markets, the Japanese slump put stress on the foreign trade structure of the entire region, which is characterized by extensive export and import linkages.

A second adverse factor was the sharp depreciation of the yen vis-à-vis the U.S. dollar, "leaving the dollar peggers high and dry." Asian economies that were dependent on robust exports to Japan but had pegged their currencies to the dollar suddenly found their exports priced too high, in yen terms. Export demand fell sharply among Asian trading partners, and almost overnight domestic economies throughout the region began experiencing severe contractions. Together these adverse external factors turned vulnerable economies into collapsing economies. Thus, Dornbusch attributes the Asian economic downturn to a confluence of capital market vulnerability and adverse external factors.

Obstfeld also believes that the primary source of economic vulnerability in recent financial crises was capital markets, but he emphasizes shifts in expectations as the central factor driving the economic fluctuations. He notes that "exogenous fluctuations in capital flows have become a dominant business cycle shock" for developing countries in the modern era, and that similar financial crises were quite common prior to World War II.

Obstfeld describes two main types of crises—exchange rate (currency) crises, and national solvency crises—and explains that although they can occur separately, they often "interact in explosive ways." The main linkage between them is self-fulfilling expectations. An economy with a weak and vulnerable capital market can avoid crisis so long as there is no expectation of one. But when expectations change, the desirable but tenuous equilibrium will give way abruptly to a crisis. A sudden new expectation of currency depreciation can

start the process rolling, once speculators perceive the threat that public debt will be paid through inflation. He cites Indonesia as an example of this phenomenon.

In Persaud's view, moral hazard and inadequate oversight were key factors in generating the underlying capital market vulnerability. "Moral hazard [induced by International Monetary Fund bailouts] . . . probably played a role in the exponential rise in foreign bank lending to Emerging Asia," and "crony capitalism" may have further "impaired the proper allocation of resources." Furthermore, Asia's economic success was "unbalanced" in the sense that lending went toward overinvestment that was concentrated in a limited number of sectors. Inadequate supervision and unreliable information about this worsening capital situation allowed the rise in risky lending and overinvestment to go unchecked until it was too late.

Persaud also cites the weakened Japanese economy and depreciating yen as important factors, but he identifies the collapse of the Thai baht on July 2, 1997 as the "trigger" that set off the Asian crisis. The effect of this trigger was amplified as investors suddenly realized new or mispriced risks in the region and greatly reduced their "appetites for risk"; this led to widespread and simultaneous capital outflows from the region.

A key factor contributing to this capital flight, says Persaud, was the sudden discovery that domestic corporate investment positions were highly concentrated. When the crisis emerged, heavyweight investors in the region discovered that their peers were also deeply vested in the same small number of collapsing Asian economies. Thus, these influential investors not only wanted to get out of Asia because of the inherent financial problems, they also wanted to get out first, because they knew that a massive capital outflow would dramatically reduce asset prices in the region.

The panelists generally agreed that unwise economic decisions had promoted an environment of vulnerability, and that Japan's economic weakness and other events turned a precarious situation into turmoil. However, their recommendations about how to respond to the current crisis, and how to prevent future crises, were notably different.

Dornbusch believes that the key to preventing future capital market crises is to control financial risk. He proposes using model-based value-at-risk ratings and disseminating "right thinking" within the international financial community regarding controlling and pricing such risk. Controlling capital flows themselves, however, is not appropriate. He advocates International Monetary Fund (IMF) inspections of financial market conditions during country consultations, but he is doubtful the IMF will become sufficiently forward-looking and preemptive, because IMF member countries will resist such changes. For this reason, he particularly opposes an Asian IMF. Dornbusch advocates moving toward regional currencies like the euro. Regarding the appropriate response to current developments, Dornbusch is adamant that tight money policies are required to restore financial stability; debt restructuring can be negotiated later. Fiscal policy is not a viable tool because of the fiscal deterioration associated with the recent crises.

Obstfeld asserts that "policy must counteract the severe capital-account shocks by creating a new expectational climate" that will restore confidence in these economies. He sees no economic prescription for this change "short of infeasibly extensive official financial support from abroad." In contrast to Dornbusch, Obstfeld concludes that fiscal expansion is the least risky policy prescription, particularly in Japan. Monetary expansion in Japan might also help, but it carries the risk of further yen devaluation and is insufficient until Japan resolves its banking problems. He ends by warning that monetary tightening now by the Federal Reserve and the new European Central Bank to fight domestic inflation "would be an error of perhaps historic proportions."

Persaud highlights the need to develop policies that "work with financial markets and not against them." He views many actual and proposed policies as counterproductive. Capital controls intended to curb outflows would implicitly curb much-needed inflows. Looking to the IMF for faster and more lucrative assistance is also unwise. He doubts that the IMF loans can keep pace with the magnitude of required private capital flows, and in any case further IMF assistance worsens the moral hazard problem.

Instead, Persaud wants an international financial system that permits countries access to an international pool of foreign exchange reserves if—and only if—they meet certain "selectivity criteria" intended to reflect sound and prudent financial operations. The criteria, which must be "public, clear, and transparent," would consider the extent of external debt, the productivity of capital inflows, the competitiveness of exchange rates, the soundness of government finances, and the openness of governance. Countries or financial institutions that do not meet these criteria should be allowed to fail. Indeed, Persaud believes that selective assistance is a critical requirement for eliminating moral hazard.

## PRODUCTION, TECHNOLOGY, AND BUSINESS CYCLES

Susanto Basu tackles another of the most contentious questions among modern macroeconomists: Do fluctuations in technological change or productivity growth actually cause business cycle fluctuations? Some prominent neoclassical macroeconomists assert not only that the answer is yes, but that technology change is the *primary* determinant of such fluctuations. This assertion is contested by macroeconomists like Basu who adhere to the Keynesian tradition of emphasizing fluctuations in aggregate demand as the primary contributor to business cycles. Because these two views of the sources of business cycles lead to radically different macroeconomic models and prescriptions for government policy, resolution of this debate is critical.

Basu argues that neoclassical economists have misinterpreted the link between technological change and business cycles by misusing the standard measure of technological change: the Solow residual, named after M.I.T. economist Robert Solow. Solow's methodology is simple: measure the growth of output; subtract the appropriately weighted growth of all observable inputs such as labor, capital, and materials; and the difference, or residual, is an estimate of unobserved technological change. Economists use this sensible but indirect measure because they do not have direct data measures of technological change.

Thus far, most attempts to construct Solow residuals with conventional data on inputs yield a measure that is positively correlated with output, giving rise to the claim that technological changes cause business cycles. But Basu argues the Solow residual was only intended to estimate the long-run impact of technology on the economy, not the cyclical impact. He notes that Solow warned long ago that his measure would be spuriously correlated with output and the business cycle because firms adjust to fluctuations in demand by varying the rates at which they utilize capital and labor.

Basu has developed a new measure of technological change that adjusts for features that could lead to an excessively positive correlation between technological change and output. Basu's methodology, developed in earlier research with John Fernald and Miles Kimball (hencef[illegible]h the BFK technology measure), adjusts for four factors: (1) variable utilization of ca[illegible] and labor; (2) variable worker effort; (3) imperfect competition and other special a[illegible]antages firms may have in production; and (4) different characteristics of firms acros[illegible]ustries. In other words, it adjusts for many of the demand-side features

Solow was concerned about. The BFK methodology requires relatively few controversial restrictions or assumptions; indeed, previous measures of technological change are special cases of it.

The salient and distinguishing feature of the new BFK technology measure is that it is essentially uncorrelated with output and the business cycle. Unlike the Solow residual, which is positively correlated with output and the business cycle, it exhibits no simple statistical evidence of causing business cycle fluctuations. Moreover, the BFK measure is much less variable than the Solow residual. Together, these features reduce, if not eliminate, the likelihood that unexpected technological changes cause business cycles. Basu shows that this conclusion holds up in simple statistical models of the production process.

Another potentially important characteristic exhibited by the BFK technology measure is that it suggests what all workers fear: that technological improvements reduce employment. At least initially, the BFK measure is very negatively correlated with factor inputs, such as labor and factor utilization. In other words, when firms improve their technical efficiency by installing the latest and greatest machines, they are able to produce the same output with fewer inputs, so they reduce costs by cutting their work force rather than reducing their prices and producing more. Only much later, as profits rise, do they expand their output and hire workers. This interpretation of the data stands in stark contrast to interpretations based on the conventional Solow residual, in which employment and other factor inputs rise with technological improvements.

In the second part of his investigation, Basu uses his technology measure to evaluate whether the dynamic properties of two state-of-the-art macroeconomic models match the postwar data. One is the real business cycle (RBC) model, which features technological change as the main source of business cycle fluctuations. It also assumes complete, competitive markets with fully adjustable prices. The other model is basically similar but introduces slowly adjusting or "sticky" prices. Sticky prices are a common feature of macroeconomic models that emphasize fluctuations in aggregate demand as the main source of business cycles.

The result of Basu's evaluation is quite discouraging for state-of-the-art macroeconomic models. He finds that neither the RBC nor the sticky price model generally fits the data very well. The RBC model, in particular, does not match the dynamic properties of the data, and it cannot reproduce the essentially zero correlation that exists between the BFK technological change and output or the negative correlation between factor inputs and output. These models also fail to reflect the generally sluggish response of output changes in the economy. Basu reports that the sticky price model is qualitatively better because it approximately reproduces these two correlations, although it does not do so well. The prognosis for these models becomes even bleaker when he evaluates the models with both technological change and various specifications of monetary policy.

Basu concludes that the defining cyclical feature of technological change is a short-run reduction in inputs and factor utilization, and that business cycle models face the challenge of reproducing that feature. At present, standard RBC and sticky price models cannot do the job, and variable factor utilization does not impart enough rigidity to generate sufficient sluggishness. He projects that the sticky-price models modified to include other sources of rigidities, "show some promise of being able to match the data, but clearly have a long way to go."

Mark Bils questions whether Basu's technology measure adjusts *too much* for the positive correlation between factor utilization and output. He hypothesizes that the proportions of capital and labor used in production are likely to be fixed in the very short run.

Thus, when capital utilization rises slightly, labor hours will rise in equal proportion. If so, total factor productivity should be positively correlated with output but labor productivity should be approximately uncorrelated with output. Bils finds exactly these correlations in data on detailed manufacturing industries. Because the BFK methodology infers movements in capital utilization from movements in materials prices, and because materials prices are more positively correlated with output than labor costs, Bils believes the BFK measure makes capital utilization more positively correlated with output than labor utilization is.

Other aspects of Basu's methodology make Bils skeptical of the results. He doubts that labor quality (effort) is positively correlated with output, as in the BFK measure, because there is evidence that workers hired during expansions are paid less and therefore of lower quality. Moreover, he thinks the relationship between effort and hours will vary depending on the stickiness of wages and the type of shock. Bils also argues that factor utilization will vary more if shocks are transitory rather than permanent. Basu's methodology relies more on variables associated with transitory shocks, so it may yield estimates of utilization that are too positively correlated with output.

Finally, Bils assesses the plausibility of price stickiness in two empirical exercises. One exercise is based on the theory that if prices are sticky, then firms with significant inventory holdings should be less likely to reduce inputs and output when technology increases, because they can inventory unsold output. He reports evidence that "labor hours are much less likely to decline for industries that hold significant inventories," but points out that this evidence does not conclusively determine the actual flexibility of prices. So in a second exercise he provides more direct evidence from models of relative prices. Prices are significantly negatively correlated with current total factor and labor productivity but not with past productivity, a relation Bils interprets as evidence that prices are not sticky.

Thomas Cooley is also cautious about interpreting Basu's results as evidence against the idea that technological change is an important source of business cycle fluctuations. Like Bils, Cooley has reservations about the methodology underlying the BFK technology measure, although he embraces Basu's finding that firms do not enjoy market power from technological advantages in production. In particular, he notes that the correlation of the BFK technology measure with output is sensitive to the exact form of the econometric methodology used to construct the measure and to the identifying assumptions of the modeling framework.

However, granting the validity of Basu's results, Cooley directs his critique at the logic of Basu's inferences about the implications for macroeconomic models. First, he questions Basu's conclusion that the results necessarily rule out RBC-type models. He argues that RBC models no longer rely on artificially sluggish technology shocks to obtain sluggish output responses. Sluggishness can arise from factor utilization as well as financial market imperfections, differences among firms, and other features. As for the RBC model's inability to generate a negative correlation between technology and factor inputs, he suspects that this result is not robust.

Cooley also questions whether the evidence should lead one to conclude that prices are sticky. Basu provides no direct evidence of sticky prices, and economic theory does not make clear predictions about the direction in which capital and labor should respond to technology changes. The response will depend, among other things, on the nature of the technology change, market structure, and the sensitivity of demand to prices. This point calls into question Basu's assertion that he does not need to consider the behavior of profits and product markets.

Cooley thinks Basu's results suggest that technological change is embodied in new capital investment—a characteristic absent from the BFK methodology. With technology embodied in capital, the short-run responses of output and factor inputs to technological change are different from those of a standard RBC model and are capable of yielding the patterns Basu finds in the data. Moreover, in this case the nature of depreciation matters for interpreting the effects of cyclical factor utilization.

## REALLOCATION, RESTRUCTURING, AND BUSINESS CYCLES

Scott Schuh and Robert Triest investigate the idea that business cycles might be caused by the shuffling of jobs as firms restructure the way they do business. New data produced during the past decade show that firms are continuously changing. Some expand and create jobs while others contract and destroy jobs. The pace of change is rapid; one in 10 jobs is newly created and one in 10 jobs newly destroyed in manufacturing each year. The sources of these ups and downs of particular firms include product demand and innovation, prices and wages, regional economic conditions, technological change, and other factors idiosyncratic to each firm, rather than factors common across all firms. Job creation and destruction together represent job reallocation, a measure of job turnover or churning in the economy.

Traditionally, macroeconomists looking at the labor market have ignored job reallocation and have focused solely on total employment growth (or the total unemployment rate). However, Schuh and Triest point out that a given rate of employment growth can occur with either low or high rates of job reallocation. More important, the intensity of job reallocation has significant consequences for unemployment, wage growth, and productivity growth.

For example, if changes alter the desired distribution of jobs across firms, industries, and regions, job reallocation must intensify to keep productive efficiency high. More intense reallocation usually means higher job destruction that forces many workers into unemployment. These unemployed workers lose any skills they had that were unique to their previous job (such as knowledge of firm operating procedures), have a hard time finding a comparable new job, and stay unemployed longer. Eventually they may have to accept a job entailing sizable reductions in their wages. Such issues are linked inherently to the determination of aggregate unemployment, wage growth, and productivity.

Schuh and Triest point out that job reallocation and the pace of restructuring rise markedly during recessions. Traditional macroeconomic models cannot explain why because they do not incorporate the phenomenon of job reallocation. But in light of the potentially negative economic consequences of job reallocation, it is important to know whether an identifiable connection exists between reallocation and business cycles, and whether the correlation between them is of no consequence and can continue to be ignored.

Schuh and Triest ask the following fundamental question: Does job reallocation cause business cycles, or do business cycles cause job reallocation? Evidence on job reallocation has sparked an interest in building theoretical models capable of explaining the observed patterns in the data, and they classify these theories into two types. One type stresses the role of factors that primarily determine the desired allocation of economic resources, such as workers, across firms. The other type stresses the role of aggregate factors, such as monetary policy, that primarily determine the overall level of economic activity. Both types of theories aim to explain why job reallocation rises during recessions. Yet both types of

theories tend to rely on vaguely defined aggregate and allocative "shocks" rather than observable variables.

Schuh and Triest argue that these theories do not and cannot answer their fundamental question, for two reasons. First, although the two-way classification of factors may be conceptually sensible, in practice the definitions of allocative and aggregate factors become hopelessly muddled. Second, these theories have little to say about what *causes* business cycles—that is, *why* they occur—because they focus more on *how* they occur.

Schuh and Triest present results from three empirical exercises that extend research by Schuh with Steven Davis and John Haltiwanger on job creation, destruction, and reallocation (henceforth referred to as DHS). One exercise analyzes the behavior of job reallocation during the 1990s using newly available data. A second exercise attempts to learn what kinds of plants destroy and reallocate jobs and how, in hope of discovering clues about the causes of recessions. The third exercise looks for evidence of causal relationships between job reallocation, the fundamental determinants of reallocation, and the business cycle. Each of these exercises uses data from the U.S. Bureau of the Census on individual manufacturing plants (the Longitudinal Research Database (LRD)).

The new data show that the 1990–91 recession was much less severe in manufacturing than preceding recessions, as evidenced by a relatively modest decline in employment. Nevertheless, job destruction and job reallocation both increased in a manner similar to that in previous recessions. The ensuing expansion was unusual in that job destruction and reallocation remained above average, rather than declining quickly after the recession. In addition, job creation experienced two large surges that were *not* preceded by surges in job destruction, as creation surges typically are. The authors interpret these surges as evidence of favorable allocative shocks, in contrast to the unfavorable allocative shocks of the 1970s and 1980s.

Regarding the nature of job creation and destruction, Schuh and Triest take a deeper look at two areas: (1) the magnitude, permanence, concentration, and cyclicality of job flows; and (2) the differences in job flows between larger, older, and higher-wage plants (henceforth, simply "large") and smaller, younger, lower-wage plants (henceforth, simply "small"). Previous DHS research concluded that job flows are large, permanent, and concentrated in a minority of plants with large employment changes. Also, large plants account for most of the increases in job destruction and reallocation during recessions. Together these DHS findings suggest that during recessions only a small fraction of really large plants experience really large and permanent rates of job destruction, and thus they imply that the cause of job destruction and recessions is related to large plants.

The Schuh and Triest findings significantly refine this DHS view. They find that small plants tend to have much higher rates of job creation and destruction than large plants, and that high rates of job creation and destruction—especially plant start-ups and shutdowns—are much more likely to be permanent. Thus, even though large plants account for most of the increase in job destruction during recessions, these large-plant job destruction rates are likely to be much smaller in percentage terms and less permanent. In fact, Schuh and Triest find that almost one-half of all jobs destroyed by plants experiencing relatively mild contractions are ultimately restored within five years. In other words, all plants are adversely affected by recessions but large plants appear to be more resilient than small plants, which expand and contract more dramatically and permanently.

Finally, Schuh and Triest uncover some evidence that suggests allocative factors cause business cycles. Their evidence is based on the premise that there are observable determinants of the allocation of jobs across firms, industries, and regions—prices, produc-

tivity, and investment—and that changes in those determinants cause job reallocation to increase, which in turn causes recessions. One key finding is that when relative prices and productivity growth across detailed industries change dramatically, job destruction and job reallocation also increase dramatically shortly afterward. Another key finding is that increases in job reallocation generally are *not* associated with increases in trend productivity and investment growth, as some recent theoretical models seem to imply.

Ricardo Caballero regards some of the Schuh-Triest results as "potentially promising," but he challenges two fundamental tenets. He questions the central premise that job reallocation is countercyclical, and he doubts that reallocation shocks actually cause fluctuations. In addition, he objects to the author's characterization and testing of theories of job reallocation.

Caballero contends that the term "job reallocation" is a misnomer. He does not dispute the fact that Schuh and Triest's measure of job reallocation is countercyclical. However, he argues that the main feature of job reallocation over time is a significant fluctuation in total destruction that is unconnected with the process of total job creation. Thus while individual jobs are destroyed and created at the plant level, thereby generating worker reallocation, it is what he calls a "dynamic fallacy of composition" to infer that a link exists between total job destruction and creation that could be characterized as total job "reallocation." Put another way, job "reallocation" would be higher if job destruction rose now and fell later while job creation stayed constant, but it would not be true in this case that job losers were reallocated to new jobs.

Caballero cites evidence from his own research that the surge in total job destruction during recessions is more than offset by a decline in destruction during the subsequent expansion. He calls this latter effect "chill," where job destruction falls below the rate associated with the "normal" underlying level of job turnover in the economy. He argues that it is important to understand that this chill can arise from market imperfections and produce technological sclerosis as a result of insufficient turnover. This argument contrasts with theories earlier this century that suggested that all job turnover is healthy for the economy.

Caballero believes "it is a large leap to claim that reallocation shocks are a substantial *source* of business cycles, at least in the United States," although he thinks they might be important elsewhere such as Eastern Europe, for example. He argues that plausible statistical models show that reallocation shocks are "substantially" less important than aggregate shocks, at least for net employment growth. He also demonstrates that such models can produce confusion about the relative importance of job reallocation, and asks whether the "fragile decomposition" of shocks as aggregate versus allocative is worthwhile, compared to focusing on observable shocks such as prices or interest rates.

In general, Caballero thinks it is a mistake at this point to focus on trying to discover whether or not reallocation shocks cause business cycles. Instead, effort should be directed toward the less debatable issue of whether "the churn [ongoing processes of creation and destruction] has a significant effect on the economy at *business cycle* frequencies."

Steven Davis shares the ambition of Schuh and Triest to develop new evidence on the connection between job reallocation and the business cycle. Indeed, he devotes a significant portion of his comments to explaining why this endeavor is important. But Davis, too, challenges the claim that reallocation activity is countercyclical, and he argues further that total job reallocation is inappropriate for this analysis. He also suggests a more effective methodology for summarizing the relationship between job flows and plant characteristics.

Davis provides a detailed description of the dynamic nature of job and worker flows and then advances several reasons why it is important to study these flows. First, "the ex-

tent to which the reallocation and matching process operates smoothly determines . . . the difference between successful and unsuccessful economic performance," with European unemployment serving as a prime example. Second, successful conduct of policy requires accounting for the reallocation and matching process. Third, recent modeling of reallocation frictions and heterogeneity makes it evident that aggregate shocks have allocative consequences, and shocks to factor demand can drive fluctuations in economic aggregates. Fourth, "models with reallocation frictions also help to address some well-recognized shortcomings in prevailing theories of the business cycle."

Davis believes that Schuh and Triest err in treating gross job reallocation "as equivalent to the intensity of reallocation activity." His criticism is that gross job reallocation does not account for the fact that movements in job creation and destruction merely may be achieving changes in total employment instead of reflecting a fundamental reallocation of labor across plants. Davis argues that the amount of job reallocation in excess of the change in total employment is a more suitable measure of reallocation intensity. He reports evidence that, unlike total job reallocation, excess job reallocation is uncorrelated with the business cycle.

## POLICY IMPLICATIONS

In the closing session, leading economists from the public and private sectors discussed the implications for government policies of the conference's analysis of the causes of recessions. Panelists focused especially on the important role of vulnerability in setting the stage for unanticipated or adverse events. Each argued that governments should implement policies to reduce the economy's vulnerability and exposure to risk, provide more and accurate information to private agents about the extent of risk, and—if necessary—aid the recovery of economies that plunge into crises.

Henry Kaufman believes that sweeping structural changes to financial markets in recent years have significantly altered the linkages between financial markets and the real economy. Among the developments he identifies are securitization, derivatives, globalization, and leveraged investing. Several themes pervade his analysis. First, global financial markets are becoming increasingly sophisticated and complete. Second, this maturation process increasingly makes financing available to borrowers who would not have been able to obtain it previously. Third, and a consequence of the first two points, financial markets are becoming increasingly volatile, as risk-taking becomes easier while accurate risk assessment becomes more difficult. Altogether, these changes increase the likelihood that financial market turbulence will make economies more vulnerable to shocks and recessions.

Kaufman believes the changes increase the difficulty and reduce the efficacy of monetary policy. Monetary policy is more difficult because traditional monetary factors—monetary aggregates, debt aggregates, and the like—have become less reliable indicators of the stance of monetary policy and the state of money markets. Monetary policy is less effective because increased availability and easier acquisition of credit mean that short-term interest rates must increase more to achieve the same real response. Furthermore, increased volatility in asset prices (wealth) leads to greater volatility in aggregate economic behavior. Thus, he argues, the Federal Reserve should take asset price developments explicitly into account in formulating monetary policy.

Internationally, Kaufman sees a need for increased supervision of financial markets. Paradoxically, he notes, when financial markets become deregulated and "freewheeling,"

the need for more accurate, timely, and complete information increases, particularly about the risks in which financial entities are engaging. He decries the poor job of oversight and information gathering done by official institutions thus far and proposes several reforms. In particular, he recommends a new body he calls a Board of Overseers of Major Institutions and Markets, which would set a code of conduct, supervise risk-taking, and harmonize capital requirements.

Kaufman also favors reforms to two international economic organizations. First, the IMF should be reorganized to specialize in a narrower set of core functions. The new IMF would continue to facilitate lending to countries in financial distress and to press for reform in government policies in these countries. But it would also be charged with rating the credit-worthiness of countries, by assessing economic and financial conditions, reviewing extant government policies, and demanding remedial action where needed. Kaufman also argues that the G-7 must be restructured to account for the European Monetary Union and its euro currency.

Martin Zimmerman provides perspective from one of the largest and most cyclical components of the U.S. economy: the automobile industry. He explains how the auto industry, specifically Ford Motor Company, views the unfolding of a recession—how consumers postpone their car purchases, how auto makers respond to weakening sales, and how interest rate policy is an important determinant of the economic fortunes of the auto industry. But ultimately he argues against the central theme of the conference. That is, Zimmerman believes it is impossible to go "Beyond Shocks."

The economy is always subject to shocks, according to Zimmerman. For the auto industry, a shock is anything that causes consumers to suddenly alter their normal plans to purchase new cars. Zimmerman tells the story of how the 1990–91 recession unfolded. As late as June 1990, economic forecasters were predicting confidently that there would be no recession, only a slowdown. But Iraq's invasion of Kuwait and the U.S. military response caused a precipitous drop in consumer confidence and sales of cars to consumers. The shock of the Kuwait invasion, like all shocks, by definition was not forecastable, says Zimmerman (an assessment that was not well-received by his employers, he adds wryly).

Although shocks are pervasive, the central question is whether the shocks will tip the economy over into recession. Here, he asserts that not all shocks do, in fact, trigger recessions. The economy must already be vulnerable when the shocks hit. Absent this vulnerability, the economy may be able to withstand shocks. Likewise, absent shocks, vulnerability may never result in a recession.

What is the role of policy in a world of vulnerability and inevitable shocks? Zimmerman notes that every precipitous drop in auto sales has been associated with an increase in interest rates, so he tends to associate monetary tightening with the emergence of economic vulnerability (weak growth). But because not every increase in interest rates was followed by a recession, he surmises that a shock is required to turn vulnerability into recession. He asserts that monetary policy cannot prevent shocks because they are inherently unpredictable. Instead, policy should minimize vulnerability of the economy.

Agustin Carstens contributes a view of recessions and policy from the perspective of emerging economies such as Mexico. He identifies five characteristics of business cycles in emerging economies that distinguish them from business cycles in industrialized economies. First, business cycles in emerging countries are closely synchronized with the fortunes of industrialized countries: "When the United States gets a cold, Mexico gets pneumonia." Second, business cycles are more volatile in emerging economies. Third, emerging economies are susceptible to additional sources of volatility, such as terms of

trade fluctuations. Fourth, and more recently, increasing globalization of markets has encouraged massive capital flows into emerging countries like Mexico. But these capital flows are very unstable, so emerging countries can experience sudden and massive capital outflows that devastate their economies. Finally, emerging economies have to deal with exchange-rate regimes and their failures.

These characteristics force emerging economies to adopt very different policies to deal with business cycles. Industrialized countries, as leaders of the world economic engine, follow policies designed to manage aggregate demand so as to achieve low inflation and full employment. Such policies are countercyclical. In contrast, emerging countries follow policies designed to avoid or mitigate economic crises that break out there, often because industrialized countries are slumping and reducing their demand for emerging country exports. One essential goal of these policies is to reestablish the credibility of emerging economies, especially the credibility of their currencies and financial markets. Often this means reestablishing the credibility of governments that have made bad policy decisions. These types of policies, then, are usually procyclical.

Carstens offers four specific policy recommendations for emerging economies to help them to reduce vulnerability and follow a more stable path. First, they must reduce their vulnerability to changes in the international prices of exports, by adopting more open trade and investment regimes. Second, they should allow market determination of interest and exchange rates so these rates can accomplish their purpose of absorbing shocks. Third, they must ensure the robustness of their financial institutions to macroeconomic fluctuations. Fourth, they should push forward with structural changes in order to achieve central bank autonomy, privatization of production, labor market flexibility, and reduced dependence on foreign saving. In each case, more complex policies are required beyond the traditional demand management schemes followed by industrialized countries, Carstens notes.

Michael Mussa, as a leading official at the International Monetary Fund, offered an informed, practical—and oftentimes contrarian—view of the conference papers, the conventional wisdom about the ongoing global economic crises, and recent criticisms of international policy responses to the crises.

Mussa infers from Sims's paper that systematic monetary policy *does* have a significant, positive effect on the real economy, despite Sims's claim to the contrary. He says Sims understates the effect of monetary policy, citing Sims's own results showing that industrial output would have been nearly one-fifth higher if the Fed had followed modern monetary policies during the Great Depression. He also points out that Sims omits the positive role monetary policy can play in avoiding banking and financial panics by subsidizing and reforming weak banks, and by reassuring depositors that their accounts were safe. Had Sims accounted for this, and for the fact that fiscal policy should have been more aggressive, one-half to three-quarters of the impact of the Great Depression could have been avoided.

Mussa finds the two long historical analyses of business cycles to be inherently valuable. He particularly agrees with Temin's premise that recessions "have a multiplicity of causes," although he doubts that it is possible—or useful—to try to quantitatively separate causes into different categories of influence. Like Romer, Mussa believes that Temin underestimates the contribution of monetary policy to recessions. However, Mussa is cautious about the quality of older economic data and what we can reliably infer from them, particularly data for countries other than the United States.

Regarding the paper by Schuh and Triest on labor reallocation and business cycles, Mussa is "skeptical that labor reallocation is itself an independent cause of most U.S. business cycles." He suggests that the authors focus more on the relationship between labor reallocation and the NAIRU (non-accelerating-inflation rate of unemployment). Regarding the central issue addressed in Basu's paper, Mussa believes that "the notion that adverse downward movements in total technology cause recessions [because workers don't work as hard] is just plain silly. This is the theory according to which the 1930s should be known not as the Great Depression but as the Great Vacation."

Mussa then turned to a discussion of current economic developments and the appropriateness of policy. On the domestic economy, Mussa likens recent monetary policy performance to the movie, "As Good As It Gets." Aside from some minor quibbles, Mussa judges U.S. monetary policy management during the last decade to be "remarkable" by any standard. But he notes that it has been "very good management with very good luck." Moreover, he warns, to say that monetary policy has been as good as it gets implies that monetary policy is better than it is normally expected to be—in other words, it is likely to get worse, not better. Ultimately, the monetary authority cannot avoid all recessions; it can only be expected to avoid "big" ones.

On the international situation, Mussa likens catastrophic economic events such as the Great Depression and the current worldwide financial crisis to the movie "Titanic." What caused the Titanic to sink, he asks? Perhaps an exogenous shock (the iceberg), he quips. But it was more than that. Errors in the design and operation of the ship, inadequate preparation for the sinking, and other factors all contributed. In the same way, the current financial crisis has many complex causes and contributing factors.

However, reasons Mussa, the *real* tragedy of the Titanic was not that it sank and 1,500 lives were lost, but that *800 of the Titanic passengers were saved that day!* Clearly this policy mistake discouraged shipbuilders from spending money on improving designs and shipping lines from bearing the cost of conducting safe navigation of future cruises across the Atlantic. The Titanic rescue demonstrated that entrepreneurs in the shipping industry didn't need to worry about safety—they knew that the government would be there to save them from their imprudence!

Mussa employs this tongue-in-cheek argumentation to rebut those who argue that moral hazard problems should prevent the international community from responding to the current financial crisis. Despite moral hazard problems, saving 800 Titantic passengers *was* the right thing to do. And despite clear moral hazard problems, Mussa says the IMF attempts to rescue Korea and other besieged economies *is* the right thing to do. He argues that IMF support is not a gift but a loan, and that the IMF's earlier financial support of Mexico has been validated by Mexico's successful servicing of IMF debt.

## CONCLUSION

In the end, most participants agreed that the business cycle is *not* dead but is likely here to stay. No one championed the ideas that a "new," recession-proof economy has emerged, that unanticipated adverse economic events have stopped buffeting the economy, or that government policy has become so adroit that it can offset every dip in the aggregate economy. If anything, the mere mention of these ideas drew disdainful remarks, and even served as "proof" that the ideas were without merit. Indeed, the general premise among partici-

pants was that the right question was *when,* not *if,* the next recession occurs, what will have caused it? The consensus answer is it is likely to be not one but many things, with government policy and vulnerability playing important—but still not fully understood—roles.

Most participants also agreed that policymakers in a world continually subject to business cycles should adopt certain goals to improve their ability to deal with fluctuations. First, policymakers must learn how to recognize and address the economy's vulnerability to disruptions and unanticipated events. Second, policy institutions should conduct and support research that shows the contribution of deliberate actions of economic agents to economic fluctuations. Finally, and most important, policymakers should understand that they cannot prevent every recession, but they should concentrate their efforts on averting The Big Ones, such as the Great Depression.

## NOTES

1. See Burns and Mitchell (1946, p. 3), Lucas (1981, p. 217), and Sargent (1979, p. 215).
2. This definition was taken from the NBER's web address, http://www.nber.org/cycles.html.
3. An important exception is Long and Plosser (1983), which does allow for multiple sectors. Their model economy is straightforward to analyze because they adopt several key simplifying

assumptions. For example, they assume the entire stock of capital in each sector wears out within three months. However, these assumptions make the model ill-suited for quantitative, empirical analysis. It took many years before economists undertook a systematic empirical analysis of versions of the Long and Plosser model without the key simplifying assumptions (see Horvath [1998a, b]).

4. Employment data are taken from DRI Basic Economics database. The hours worked data are indexes of aggregate weekly hours of production or nonsupervisory workers on private nonagricultural payrolls by industry. The data on numbers of workers are workers on nonagricultural payrolls, by industry. All data are monthly and seasonally adjusted and cover 1964:Q1–95:Q3.
5. Other studies of this question include Baxter (1996), Cooper and Haltiwanger (1990), Hornstein and Praschnik (1997), Huffman and Wynne (1998), and Murphy, Shleifer, and Vishny (1989).
6. Our statistic is the regression $R^2$ obtained by regressing the business cycle component of that series on the business cycle component of total hours worked, at lags 0, 1, and $-1$. We allow next month's employment and the previous month's employment to enter this relationship because we do not want our measure of comovement to be low just because a variable may be out of phase with total private hours worked by only one month. If we did not include these lags, our regression $R^2$ would coincide exactly with the square correlation referred to in the text. We construct our statistic as follows. Let $y_t$ denote the business cycle component of a given sector's employment. Let $x_t$ denote the corresponding measure of total hours worked. We consider the regression of $y_t$ on $x_t$, $x_{t-1}$, and $x_{t+1}$, $y_t = \hat{\alpha}_0 x_t + \hat{\alpha}_1 x_{t-1} + \hat{\alpha}_2 x_{t+1} + \varepsilon_t$, where $\hat{\alpha}_t$ represents the estimated coefficients. Then, the $R^2$s reported in the table are $var\,(\hat{\alpha}_0 x_t + \hat{\alpha}_1 x_{t-1} + \hat{\alpha}_2 x_{t+1})/var\,(y_t)$.
7. Table 1 shows the volatility in each of these data series.
8. The correlation between $y_t$ and $y_{it}$ is $corr\,(y_t, y_{it}) = Cov\,(y_t, y_{it})/[Var\,(y_t)Var\,(y_{it})]^{1/2}$. But, $Cov\,(y_t, y_{it}) = \sigma^2$ and $Var\,(y_t) = 2\sigma^2$, $Var\,(y_{it}) = \sigma^2$. Substituting these results into the formula, we get $corr\,(y_t, y_{it}) = 1/\sqrt{2} \simeq 0.71$.
9. Suppose $y_t = y_{1t} + \ldots + y_{nt}$. The logic of the previous note leads to $corr\,(y_t, y_{it}) = 1/\sqrt{n}$. With $n = 33$, this is 0.17, after rounding.
10. The midpoints are $-0.35$, $-0.25$, $-0.15$, . . ., 0.85, 0.95. In each case, the interval has length 0.1 and extends 0.05 above and below the midpoint.
11. Real business cycle theory has evolved considerably in recent years and now encompasses a wide variety of conceptions of the economy. The definition proposed by Prescott (1991, p. 3) reflects this: "Real business cycle theory is the application of general equilibrium theory to the quantitative analysis of business cycle fluctuations."
12. This section and the next one draw heavily on work by Christiano and Fisher (1998).
13. Some might want to dismiss the notion of a technology shock that affects all firms simultaneously as too preposterous to deserve consideration. Such a person may find it more plausible to think of technology shocks as things that are idiosyncratic to individual firms. Most of the examples of technology shocks given in the text certainly suggest this. This is the line that Lucas took when he dismissed the idea that a technology shock might be the aggregate shock needed to account for business cycles. He argued that, although technology shocks are no doubt important at the firm level, they could not be important for economy-wide aggregate output: He expected that firms affected by positive productivity shocks would be balanced by firms experiencing negative shocks. Work of Shleifer (1986) and Dupor (1998) suggests that the Lucas reason for dismissing technology shocks as an important impulse to business cycles may be premature. These researchers emphasize the distinction between the time that a new technological idea arrives in the firm, and the time the firm implements it. Consistent with Lucas's intuition, the exact timing of arrival of ideas may well be idiosyncratic at the firm level. In this case, the economy-wide average rate of arrival of new ideas would be constant: Firms discovering ideas for new products or labor-saving ways to produce output would be balanced by firms experiencing no progress or even regress. What Shleifer and Dupor emphasize, however, is that it is not the arrival of new ideas *per se* that shifts up production functions. Rather, it is the imple-

mentation of the new ideas that does this. They point out that there may well be plausible mechanisms in an economy which lead firms to implement new, technology-shifting ideas at the same time. These mechanisms involve "strategic complementarities," which are discussed further below.

14. See, for example, Benhabib, Rogerson, and Wright (1991).
15. Formally, this is what we have in mind. A standard real business cycle model, with unit elasticity of substitution in production between capital and labor, implies that the value of the output of the sector producing consumption goods, measured in utility units, is proportional to the value of the labor used in that sector, also measured in utility units. The value of the output of the consumption sector is the product of the total output of that sector, $Y$, and the marginal utility of consumption, $u_c$. The value of the labor used in the sector producing consumption goods is the product of the labor used in producing consumption goods, $L_c$, and the marginal utility of leisure, $u_l$. Thus,

$$\alpha Y u_c = u_l L_c.$$

This is just a rearrangement of the usual static efficiency condition that specifies that the marginal product of labor in producing the output of the consumption sector, $\alpha Y/L_c$, must equal the marginal rate of substitution between consumption and leisure, $u_l/u_c$. Note that if the term on the left of the equality falls ("the value of the output of the sector producing consumption goods falls") and $u_l$ rises ("the marginal utility of leisure rises"), then $L_c$ must fall.

16. The inability of the standard real business cycle model to produce comovement is surprisingly robust. Standard specifications of that model hold that the marginal rate of substitution between consumption and leisure is $\psi C/(1 - L_c - L_t)^{\xi}$, where $L_c$ is employment in the consumption sector, $L_i$ is employment in the investment good sector, and $1 - L_c - L_i$ is leisure. Also, $\psi$ and $\xi$ are non-negative constants. In Hansen's (1985) indivisible labor model, $\xi = 0$. In his divisible labor model, $\xi = 1$. The standard model assumes a Cobb–Douglas production function, so that the marginal product of labor is proportional to average labor productivity in the consumption good producing sector. Equality between the marginal product of labor and the marginal rate of substitution between consumption and leisure implies:

$$\alpha \frac{C}{L_c} = \frac{\psi C}{(1 - L_c - L_i)^{\xi}}.$$

Cancelling consumption on the two sides and rearranging, we get

$$\frac{\alpha}{\psi}(1 - L_c - L_i)^{\xi} = L_c.$$

From this it is easy to see that if, for whatever reason, $L_i$ or $L_c$ moves, then the other variable *must* move in the opposite direction. This demonstration summarizes a discussion in Benhabib, Rogerson, and Wright (1991) and in Murphy, Shleifer, and Vishny (1989). The result holds for the entire class of utility functions identified by King, Plosser, and Rebelo (1988) as being consistent with balanced growth. However, the same cannot be said for the entire class of production functions consistent with balanced growth. In particular, the result does *not* hold for production functions in which the elasticity of substitution between capital and labor differs from unity. We demonstrate this in technical appendix 2. We also show, however, that for plausibly parameterized versions of the standard real business cycle model, departures from unit elasticity of substitution in production do not help the model reproduce comovement.

17. One paper that is often mentioned in the comovement literature is Huffman and Wynne (1998). However, their focus is primarily on comovement in investment and output. They largely abstract from comovement in employment by making assumptions that make labor in the consumption sector essentially constant. They specify that the elasticity of substitution between labor and capital in the consumption sector is nearly unity, and that $\xi = 0$. The argument in note 16 explains why their model has the implication that $L_c$ is essentially constant.

18. Suppose $L_x$ is the third use of time. Then the equation in note 16 is modified as follows:

$$\frac{\alpha}{\xi}(1 - L_c - L_i - L_x)^{\xi} = L_c.$$

Evidently, now it is possible for both $L_c$ and $L_i$ to be procyclical, as long as $L_x$ is sufficiently countercyclical.

19. Closely related to this is their recommendation that economists work with the following utility function in consumption and leisure: $u\,[c - \psi_0 L^{1+\psi}/(1 + \psi)]$, where $\psi$, $\psi_0 > 0$ and $u$ is a concave, increasing utility function. The marginal rate of substitution between consumption and leisure with this utility function is $\psi_0 L^{\psi}$. Substituting this into the employment condition in note 16 results in

$$\alpha \frac{C}{L_c} = \psi_0 (L_c + L_i)^{\psi}.$$

The argument in that note that $L_c$ and $L_i$ cannot move in the same direction does not work with this utility function.

20. Baxter's model is a convenient vehicle for illustrating an issue that has to be confronted in macroeconomic models generally. The text provides an illustration of Baxter's assumption that durable goods and market goods are substitutes. However, it is just as easy to think of examples in which they are complements. Consider a car, for example. Ownership of a car makes it more attractive to go out on long road trips that require purchasing market goods like hotel and restaurant services. This suggests that cars and market goods are complements. A moment's further thought about this example suggests that most household durables actually cannot be neatly labeled as either complements or substitutes for market consumption. For example, an automobile is also a substitute for market goods because it reduces the need for market services like cab, train, and airplane rides. Similarly, consider the biggest household durable of all, the home. It substitutes for hotel and restaurant services and complements market goods such as party goods, telephone services, and food. Thus, intuition is ultimately not a good guide to assessing Baxter's assumption about the substitutability of durables and market goods. Ultimately, this must be assessed through careful econometric work to determine whether, *on average,* market goods and durables are more like substitutes or complements.

21. Consider the limiting case of perfect substitutability, so that consumption is $C + D$, where $C$ is market consumption and $D$ is the service flow from the stock of home durables. With log utility, the marginal utility of market consumption is $1/(C + D)$. Suppose $D$ is fixed. Then a given jump in $C$ reduces marginal utility by less, the larger is $D$.

22. Remarks in note 20 about Baxter's work are obviously relevant here too. Intuition is a very confusing guide, at best, regarding the plausibility of Benhabib, Rogerson, and Wright's assumption that the elasticity of substitution between home-produced and market-produced goods is high. The parameter must be estimated econometrically. This was done in Rupert, Rogerson, and Wright (1995), who report, based on data from the *Panel Study on Income Dynamics,* that the elasticity of substitution indeed is high.

23. Because the model predicts that consumption rises in a boom, the high degree of substitutability between home and market goods causes the marginal value of home goods to drop in a boom. This in turn causes a drop in the value of home durables, leading households to reduce their purchases of new durables. This implication is strongly counterfactual, however, since durables are in fact highly procyclical. Interestingly, Baxter's (1996) model seems to avoid this tension. In particular, her model generates comovement between employment in the consumption and investment industries and simultaneously implies that durable goods purchases are procyclical.

24. Boldrin, Christiano, and Fisher (1995) adapt the habit persistence specification of preferences proposed in Constantinides (1990) and Sundaresan (1989).

25. See Kocherlakota (1996) for a recent review. Although habit persistence helps to account for

the observed average of the premium in equity over risk-free debt, it does not account well for the volatility of these variables. For a further discussion, see Boldrin, Christiano, and Fisher (1997) and Heaton (1995).

26. See Constantinides (1990) and Sundaresan (1989) for more evidence on the plausibility of habit persistence preferences.
27. In the Hornstein and Praschnik (1997) modification, the output of the consumption sector is $C + m$, where $m$ is intermediate goods sent to the investment good sector. Suppose the marginal utility of market consumption is $1/C$. Then, the value of the output of the consumption sector is $(C + m)/C = 1 + m/C$. Note that this jumps with a rise in $C$ as long as $m$ rises by a greater percentage than $C$. With $m/C$ sufficiently procyclical, it is possible for employment in the investment and consumption good sectors to move up and down together over the cycle.
28. We are very grateful for instructions and advice from Mike Kouparitsas on how to analyze the input–output data.
29. We do not have an index of hours worked for this sector. Instead, we used LHAG, which is Citibase's mnemonic for number of persons employed in the agricultural industry. We obtained a measure of comovement for this variable in the same way as for the other variables.
30. The least squares regression line through the data in figure 6 is $\rho_{h,y} = 0.48 + 1.35I_c$. Thus, if a sector was not connected to the investment sector at all (that is, $I_c = 0$), employment in that sector would still exhibit substantial procyclicality (that is, $\rho_{h,y} = 0.48$).
31. Such an exercise could be pursued by building on the models in Long and Plosser (1983) and Horvath (1998a, b). To our knowledge, comovement in the sense studied in this article has not been investigated in these models.
32. A slightly different mechanism, whereby a firm's expectation that other firms will be inactive leads all firms to be inactive was analyzed by Shleifer (1986) and Dupor (1998) and summarized in note 13.
33. For example, Benhabib and Farmer (1994, 1996) incorporate strategic complementarities by way of an externality in the production function. Because their production function is of the Cobb–Douglas form, the argument in note 16 applies to these models too. In particular, in these models, employment in the production of consumption and investment goods must move in opposite directions over the business cycle.
34. The literature on the potential for expectations to be self-fulfilling is large. Influential early papers include Azariadis (1981), Bryant (1983), Cass and Shell (1983), Cooper and John (1988), Diamond (1982), Farmer and Woodford (1984), Shleifer (1986), and Woodford (1986, 1987, 1988, 1991). More recent contributions include Benhabib and Farmer (1994, 1996), Christiano and Harrison (1998), Cooper and Haltiwanger (1990, 1996), Farmer and Guo (1994), Gali (1994), and Schmitt-Grohe (1997).
35. An example of a negative externality is the pollution that is generated as a byproduct of a manufacturing process.
36. For an analysis of the case where there are information externalities and timing *is* under the control of managers, see Chamley and Gale (1994). They find, as one might expect, that there is a tendency to delay decisions under these circumstances.
37. We are grateful to Henry Siu for pointing this out to us.
38. The example is similarly sensitive to the assumption that people view the signals they receive as equally reliable to the signals received by others. It is possible that, in practice, the type of individual making investment decisions has greater confidence in her ability to interpret signals than her counterparts at other firms. This is the implication of empirical evidence that suggests that these types of people are overly confident in their own abilities. See Daniel, Hirshleifer, and Subrahmanyam (1998), and the references therein for further discussion. According to them, (p. 5–6): "Evidence of overconfidence has been found in several contexts. Examples include psychologists, physicians and nurses, engineers, attorneys, negotiators, entrepreneurs, managers, investment bankers, and market professionals such as security analysts and economic forecast-

ers. Further, some evidence suggests that experts tend to be more overconfident than relatively inexperienced individuals."

39. A small subset of the literature on information externalities includes Banerjee (1992), Bikhchandani, Hirshleifer, and Welch (1994), Caplin and Leahy (1994), and Chamley and Gale (1994).
40. See Romer (1996) for a review.
41. Let $e(w)$ be the amount of effort a worker expends per hour, given the hourly wage rate, $w$. The efficiency wage is the value of $w$ that maximizes $e(w)/w$. One type of $e$ function that guarantees that this has a maximum for $0 < w < \infty$ is one in which $e$, when expressed as a function of $w$, has an $S$ shape: convex for $w$ near zero and turning concave for larger values of $w$ (see Romer, 1996). The optimal $e(w)/w$ is the slope of the ray drawn from the origin, tangent to the concave part of the $e$ function. At the optimum, the elasticity of effort with respect to the wage is unity, that is, $e'(w)w/e(w) = 1$. Optimality requires that, when evaluated at the efficiency wage, the second derivative of $e$ with respect to $w$, is negative.
42. The algebra underlying this analysis is simple. Let the production function be $f(e(w)L, K, z)$, where $eL$ is the total amount of effort expended in $L$ hours of work, $z$ is a shock to technology, and $K$ is the stock of capital. We assume that the derivative of $f$ in its first argument is positive and strictly decreasing in $eL$ and increasing in $z$. Revenues net of labor costs are $f(e(w)L, K, z) - wL$. The firm maximizes this with respect to $w$ and $L$. It is convenient, however, to adopt a change of variables, $X = wl$, and let the firm choose $X$ and $w$ instead. Then, the revenue function is

$$f\left(\frac{e(w)}{w}X,K,z\right) - X.$$

Evidently, maximizing this with respect to $w$ is equivalent to maximizing effort per dollar cost, $e(w)/w$ with respect to $w$. For a further discussion of this maximization problem, see the previous note. Maximization with respect to $X$ implies:

$$f_1(eL,K,z)e = w,$$

that is, the marginal product of labor must equal the wage rate.

43. The marginal product of labor curve in Figure 7 graphs $f_1(e(w^*)L, K, z)e(w^*)$ as a function of $L$, holding $K$ fixed. Here, $w^*$ is the efficiency wage rate. The curve marked marginal product of labor' graphs $f_1(e(w^*)L,K,\tilde{z})e(w^*)$ for $\tilde{z} > z$.
44. These observations motivate why efficiency wage theory is sometimes viewed as a way to fix another set of counterfactual implications of the standard real business cycle model: that wages tend to fluctuate too much and employment too little over the business cycle.
45. This argument implicitly assumes that the stock of capital used by a firm, once put in place, cannot be shifted to another firm. The assumption guarantees that a positive technology shock which drives up the marginal productivity of labor curve, *must* be accompanied by a rise in employment if marginal productivity is to remain unchanged. If capital were mobile between sectors, this could even be accomplished with a *fall* in labor, as long as capital in that sector fell by an even greater percentage. The standard real business cycle model assumes that capital is freely mobile between sectors. Thus, the intuition in this article is based on *two* modifications to the real business cycle model: incorporation of efficiency wages and sectoral immobility of capital. The second of these is not sufficient to produce business cycle comovement. This is because the argument in note 16 holds even if capital is immobile between sectors.
46. In addition to verifying the logical coherence of efficiency wage theory as an explanation of comovement, there are two empirical issues to be investigated. How hard is it to monitor worker effort? If it can be monitored easily, then efficiency wage theory is irrelevant. Also, if the penalty for being fired for shirking is enormous, workers will behave as if they are being monitored continuously, and once again the theory becomes irrelevant. For a further discussion of these issues, see Alexopoulos (1998).

47. We stress that the intuition developed here relies on *two* assumptions—efficiency wages and sectorally immobile capital.
48. To be precise, suppose $e(w, D)$ is the effort supplied by workers when the wage rate is $w$ and unemployment duration is $D$. At the efficiency wage, $e_{11}(w, D) < 0$. Also, we assume $e_{12}(w, D) = 0$. Totally differentiating the first order condition for the efficiency wage, $we_1(w, D)/w = 1$, with respect to $w$ and $D$, and imposing the restrictions on $e_{12}$ and $e_{11}$ yields the result, $dw/dD < 0$.
49. In the literature, what we have called the worker's effort function, $e$, is referred to as the "incentive compatibility constraint."
50. Alexopoulos and Gomme have reported to us privately that their models are only partially consistent with business cycle comovement. In both cases, employment in the consumption and investment sectors is positively correlated, but investment in these two sectors is negatively correlated. However, both models assume that capital can be transferred instantaneously across sectors in response to a shock. The analysis here suggests that sectoral capital immobility may be important for obtaining comovement.
51. For an introduction to the literature on sticky prices and wages, see Romer (1996). To see why countercyclical markups might help, recall the key equation in note 16, used to show why hours worked making consumption goods and hours worked making investment goods in a standard real business cycle model must move in opposite directions. A version of that model with market power, for example, the model of Rotemberg and Woodford (1992), implies that it is the ratio of the marginal product of labor to the markup that must equal the marginal rate of substitution between consumption and leisure. That is, that equation must be modified as follows:

$$\frac{\alpha}{\mu}\frac{C}{L_c} = \frac{\psi C}{(1 - L_c - L_i)^{\xi}},$$

where $\mu$ is the markup of price over marginal cost. Cancelling consumption on the two sides and rearranging, we get

$$\frac{\alpha}{\psi}(1 - L_c - L_i)^{\xi} = \mu L_c.$$

Suppose a boom occurs, driving up $L_i$. If $\mu$ falls, as in the Rotemberg and Woodford model, then it is possible for $L_c$ to rise too. (For another model with countercyclical markups see Gali [1994]). See Murphy, Shleifer and Vishny (1989) for a conjecture about how limited intersectoral labor mobility, together with credit market restrictions, may help account for comovement.

## NOTES

1. Note that $\sin(t\,\omega_{T/2}) = 0$ for all integers $t$. Since the right column of $X$ is zero in this case, $X$ is singular and so cannot be inverted. In practice, the last column of $X$ is replaced by a column of ones, to accommodate a non-zero sample mean in $x_t$. Under these conditions, the columns of $X$ are orthogonal, so that $X^{-1}Y$ is trivial to compute. In particular, for $j = 1, \ldots, T/2 - 1$:

$$a_j = \frac{2}{T}\sum_{t=1}^{T} \cos(\omega_j t)x_t,$$

$$b_j = \frac{2}{T}\sum_{t=1}^{T} \sin(\omega_j t)x_t.$$

Also,

$$a_{T/2} = \left[\sum_{t=1}^{T} \cos(\omega_{T/2} t)x_t\right]/T$$

$$b_{T/2} = \left[\sum_{t=1}^{T} x_t\right]/T.$$

2. To gain further intuition into the relationship between equations 2 and 3, it is useful to recall the simplest definition of an integral, the Riemann integral. Thus, let $f(y)$ be a function, with domain $\underline{y} \leq y \leq \bar{y}$. Let $y_j, j = 1, \ldots, M$ be a set of numbers that divide the domain into $M$ equally spaced parts. That is, $y_1 = \underline{y} + \Delta_M$, $y_2 = y_1 + \Delta_M, \ldots, y_M = y_{M-1} + \Delta_M$, where $\Delta_M = (\bar{y} - \underline{y})/M$. Note that $y_M = \bar{y}$. The integral of $f$ over its domain is written,

$$\int_{\underline{y}}^{\bar{y}} f(y)dy.$$

This is approximated by the sum of the areas of the $M$ $f(y_j)$ by $\Delta_M$ rectangles:

$$\sum_{j=1}^{M} f(y_j)\Delta_M.$$

The Riemann interpretation of the integral is that it is the limit of the above sums, as $M \to \infty$. The relationship between the above finite sum and the integral resembles that between equations 2 and 3 if we adopt $y_j = \omega_j = 2\pi j/T$, $\Delta_M = 2\pi/T$, $M = T/2$, $f(y_j) = a(\omega_j)\cos(\omega_j t) + b(\omega_j)\sin(\omega_j t)$, $a(\omega_j) = a_j T/2\pi$, $b(\omega_j) = b_j T/2\pi$.

3. Actually, the theory as we summarized it here technically does not accommodate nonstationary processes like random walks. Christiano and Fitzgerald (1998) discuss standard ways of extending the theory to this case. Also, optimizing the mean square error criterion, equation 7, requires a constant term in equation 8. See Christiano and Fitzgerald (1998) for more details.

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## NOTES

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## NOTES

1. Equivalently, higher quality goods of all kinds can be produced with the same amount of capital and labor. As described in more detail below, new models of endogenous growth have reduced forms, which have similar implications for growth accounting to those of models written in terms of exogenous disembodied technical change.
2. Examples of textbooks that emphasize the IS–LM model are Abel and Bernanke (1997), Gordon (1998), Hall and Taylor (1997), and Mankiw (1997).
3. For a survey of theories based on animal spirits, see Farmer (1993).
4. A good summary of this view is Prescott (1986). For a discussion of how this view can be used to explain the 1990–91 recession, see Hansen and Prescott (1993).
5. This section relies heavily on Christiano and Fitzgerald (1998, pp. 58–59).
6. This is the empirical counterpart to investment as it is usually defined in the real business cycle literature.
7. The aggregation in this table is identical to the aggregation used by the BEA, except for "residential," which is calculated as the chain-weighted aggregate of "residential structures and equipment" and "consumer durable." See Box 1 for the chain-weighting procedure.
8. For TPI and GDP, $y$, the nominal shares in the first row are $P_t^{TPI} q_t^{TPI} / (P_t^y q_t^y)$ and the real shares are $q_t^{TPI} / q_t^y$. Nominal and real shares for investment good $i$ in the other rows are given by $P_t^i q_t^i / (P_t^{TPI} q_t^{TPI})$ and the real shares are $q_t^i / q_t^{TPI}$.
9. In the notation used above, the black lines are (the natural logarithm of) $p_t^i$ for $i$ corresponding to the 20 types of investment listed in Table 1 over the period for which data are available.
10. Many of the trends evident in Figure 2 are not apparent in the NIPA fixed-weighted constant 1982 dollar and earlier NIPA data. In a very influential book, Gordon (1989) argued that the conventional BEA treatment of investment good quality severely underestimated the degree of quality change in investment goods. His analysis was the first to show that there is a substantial downward trend in the prices of PDE and CD. The BEA now incorporates many of the adjustments for quality change advocated by Gordon (1989).
11. The procedure used to extract the business cycle component of the relative price data involves the application of a linear filter. This, combined with the fact that this filter is applied to the natural logarithm of the relative prices, implies that the business cycle component of each relative price is the business cycle component of the relevant investment deflator minus the business cycle component of the consumption deflator.
12. For a comprehensive review of this literature, see Barro and Sala-i-Martin (1995).
13. The assumption of constant returns to scale is usually based on a replication argument. A fixed quantity of capital and labor applied to produce $x$ amount of some good can always be applied again to produce another $x$ of the good. That is, increasing the quantity of factors of production by some proportion changes the amount produced by the same proportion. This argument seems harder to apply in the case of technology. For example, suppose a group of researchers have discovered a new process for making steel. If another group of researchers make the same discovery, there is no net improvement in knowledge. In this case, there would be decreasing returns. On the other hand, fixed costs or advantages to having many researchers working on similar projects may mean that increasing returns to scale are important in the process of knowledge creation.
14. Greenwood et al. (1997) show how the research and development and human capital classes of models can be used to account for the evidence, if these activities have a disproportionate impact on the production of equipment compared with consumption goods. Two explanations they consider differ fundamentally from their basic story. They both involve a two-sector

interpretation of the evidence, in which equipment and consumption goods are produced in separate sectors (using separate production functions). In one case, the production functions have different factor shares, that is, the different goods require capital and labor in different proportions to produce a unit of the good. The authors conclude that the "prospect for explaining the relative price decline with a two-sector model based on differences in share parameters looks bleak, given the implausibly large differences required in the structure of production across sectors (p. 358)." The other explanation involves an externality in the production of investment goods. Specifically, the productivity of factors in the investment good sector is increasing in the quantity of investment goods along the lines described in Romer (1986). Greenwood et al. (1997) show that this explanation can, in principle, account for the trend evidence. However, this theory relies on an externality which is difficult to identify empirically. Some evidence on increasing returns to scale, which the production externality implies, is discussed below. Generally, there is little empirical support for this view.

15. The shape of the frontier can be justified by standard neoclassical assumptions about how goods are produced, in particular that they are produced using constant returns to scale production functions in labor and capital and that it is costly to transfer labor and/or capital across sectors producing consumption goods and sectors producing investment goods. Note that adjustment costs in the installation of investment goods affect the relative price of installed capacity, *not* the relative price of investment goods.
16. This discussion assumes that the shares of factors in production are identical in producing consumption and investment goods and/or that there are costs of adjusting factors of production across sectors. It is possible for the price of investment goods to be countercyclical in this type of model if the share of labor in production is greater in the consumption sector than in the investment goods sector. As long as factors of production are perfectly mobile across sectors (that is, there are no costs to shifting factors across sectors), an increase in technology lowers the price of investment goods in this case. Factor shares are difficult to measure, so assessing the plausibility of this possibility is difficult. However, the Greenwood et al. (1997) results for long-run trends suggest that the differences in factor shares required to reconcile the empirical evidence on prices with this explanation may be implausible. Also, it is implausible to assume that there are no costs of shifting factors of production across sectors.
17. This frontier does not necessarily reflect true technological possibilities, but takes into account the restrictions on individual decisionmaking, such as individuals not internalizing a production externality, such that the points on the frontier are consistent with optimizing behavior of producers.
18. The methodology is identical to that employed by Eichenbaum and Fisher (1998). This methodology uses four variables, in addition to the investment good quantity and price variables, in a vector autoregression, along with a dummy variable which takes on the value zero at all dates except 1950:Q3, 1965:Q1 and 1980:Q1, in which cases the variable equals unity. These dates correspond to the beginning of three large military buildups. The key identifying assumption is that these buildups were exogenous events. For further discussion, see Edelberg, Eichenbaum, and Fisher (1999). The four variables are the log level of time $t$ real *GDP,* the net three-month Treasury bill rate, the log of the Producer Price Index of crude fuel, and the log level of real defense purchases, $g_t$. Six lags were used. The plotted responses in Figure 12 correspond to the average response of the indicated variable across the three military buildup episodes, taking into account the endogenous variation in the variable.
19. See Edelberg, Eichenbaum, and Fisher (1999) for a discussion of how this evidence can be explained within the context of a standard neoclassical model.
20. Technically, I estimate a vector autoregression in the deflator for nondurables and services, real GDP, an index of changes in sensitive materials prices, the federal funds rate, plus the investment price and quantity I am interested in. All variables except the federal funds rate are first logged. The impulse response functions in Figure 13 correspond to an orthoganalized innovation in the federal funds rate. The orthoganalization procedure assumes the order of the

vector autoregression is the same as listed in the text and a triangular decomposition. Ordering is not important for the investment responses as long as standard assumptions are made about the variables that precede the federal funds rate in the ordering (see Christiano, Eichenbaum, and Evans, 1999). Finally, the standard errors are computed using the procedure described by Christiano, Eichenbaum, and Evans (1999).

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## NOTES

1. A fuller account of norms, with applications to collective action and bargaining problems, is found in Elster (1989).
2. This was written before the introduction of two-tiered wage systems in several American airlines.
3. I am indebted to Ottar Brox for this example.
4. The argument in Akerlof (1976, p. 610) seems to rest on the assumption that sanctions can go on forever, without losing any of their force. Anyone who violates any rule of caste, including anyone who fails to enforce the rules, automatically becomes an outcaste. Abreu (1988) offers a formal analysis built on a similar assumption. I know too little about the caste system to assess the validity of the assumption in this case, but I am confident that it is false in the cases

about which I have some knowledge. Sanctions tend to run out of steam at two or three removes from the original violation.

5. See also Ullmann-Margalit (1977), p. 60.
6. Note that the norm cannot be justified by individual "Tit for Tat" rationality: if I eat someone I have no reason to fear that he may eat me on a later occasion.
7. I am indebted to Amos Tversky for suggesting this to me as an example of social norms.
8. Turnbull (1972), p. 146. These strategies are universally employed. As I was completing this paper, I came across a passage in a crime novel (Engel, 1986, p. 155) making the same point: "I decided to make a fast getaway. I had done Pete a favour and it didn't pay to let him thank me for doing it. It was more negotiable the other way. I heard him calling after me but I kept going."
9. As participant-observer in a machine shop Roy (1952) found substantial losses due to deliberately suboptimal efforts.
10. Faia (1986) has a good discussion of the (severely limited) range of cases in which social selection arguments make good sense.

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## NOTES

1. See Arthur M. Okun, "Potential GNP: Its Measurement and Significance," American Statistical Association, *Proceedings of the Business and Economics Section,* 1962, pp. 98–103. Gross National Product (GNP) was the typical gauge of total output at the time Okun was writing. It measures the total output of U.S citizens, independent of the country in which production occurs. Gross Domestic Product (GDP), the measure we use today, represents total output produced in the United States, independent of what country's citizens own the resources used in production.
2. There is a sense in which the terminology used here is misleading and unfortunate. It is widely accepted that in the long run, inflation is a purely monetary phenomenon. In other words, inflation that persists when output is at its potential and unemployment is at its natural rate is solely attributable to monetary growth in excess of demand. Seen in this context, the trend inflation rate is wholly unconnected to the level of resource utilization in labor markets. Nonetheless, for purposes of this discussion, we will proceed using the conventional, though imprecise, language.
3. In his original work (footnote 1), Okun offered changes in GDP growth and the unemployment rate as empirical proxies for deviations from potential, or "natural," levels.
4. The actual estimated linear regression equation is 3.17 for the intercept and–1.93 for the slope.

5. This follows from a simple algebraic rearrangement of the Okun's law equation: Letting $u$ be the unemployment rate and $g$ be the growth rate of GDP, the equation can be expressed as

$$g = 3.2 - 2\Delta u$$
$$\Rightarrow g - 3.2 = 2\Delta u$$
$$\Rightarrow \Delta u = \frac{g - 3.2}{2}.$$

For $g = 4.2$, this implies $\Delta u = 1/2$.

6. This ignores the important possibility that capital services can adjust in the short run via fluctuations in capital's utilization rate. As a measurement issue, failure to control for variable capital utilization would lead us to ascribe too large a fraction of total output to factor productivity.

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## NOTES

1. For other studies of the Depression and many additional references, see Brunner 1981; Temin 1989, 1993; Eichengreen 1992; Calomiris 1993; Margo 1993; Romer 1993; Bernanke 1995; Bordo, Erceg, and Evans 1996; and Crucini and Kahn 1996.
2. The National Bureau of Economic Research (NBER) defines a *cyclical decline,* or *recession,* as a period of decline in output across many sectors of the economy which typically lasts at least

six months. Since the NBER uses a monthly frequency, we convert to a quarterly frequency for our comparison by considering a peak (trough) quarter to be the quarter with the highest (lowest) level of output within one quarter of the quarter that contains the month of the NBER peak (trough). We define the *recovery* as the time it takes for output to return to its previous peak.

3. Note that in the closed economy framework of the neoclassical growth model, savings equals investment.
4. We end our analysis in 1939 to avoid the effects of World War II.
5. We make the trend adjustment by dividing each variable by its long-run trend growth rate relative to the reference date. For example, we divide GNP in 1930 by 1.019. This number is 1 plus the average growth rate of 1.9 percent over the 1947–97 period and over the 1919–29 period. For 1931, we divide the variable by $1.019^2$, and so forth.
6. To obtain this measure, we divide per capita output in 1939 by per capita output in 1929 (0.89) and divide the result by $1.019^{10}$.
7. This point is first stressed in Hall 1978.
8. Kendrick's (1961) data for output are very similar to those in the NIPA.
9. Hours will be constant along the steady-state growth path if preferences and technology satisfy certain properties. See King, Plosser, and Rebelo 1988.
10. The average ratio of employment in 1939 to employment in 1929 was one in these countries, indicating that employment had recovered.
11. Cooley 1995 contains detailed discussions of computing the solution to the stochastic growth model.
12. Some researchers argue that there are many other forms of capital, such as organizational capital and human capital, and that the compensation of labor also includes the implicit compensation of these other types of capital. These researchers argue, therefore, that the true capital share is much higher, around two-thirds, and note that with this higher capital share, convergence in the neoclassical model is much slower. To see what a higher capital share would imply for the 1934–39 recovery, we conducted our recovery exercise assuming a capital share of two-thirds rather than one-third. While slower, the recovery was still much faster than in the data. This exercise predicted output at 90 percent of trend by 1936 and at 95 percent of trend by 1939.
13. Bernanke and Parkinson (1991) estimate returns to scale for some manufacturing industries during the Depression and also find evidence that productivity fell during this period. They attribute at least some of the decline to mismeasurement of capital input or increasing returns.
14. An extreme approach to evaluating the effects of idle capital on total factor productivity measurement is to assume that output is produced from a Leontief technology using capital and labor. Under this Leontief assumption, the percentage decline in capital services is equal to the percentage decline in labor services. Total hours drop 27.4 percent between 1929 and 1933. Under the Leontief assumption, total factor productivity in 1933 is about 7 percent below trend, compared to the 14 percent decline under the opposite extreme view that all capital is utilized. This adjustment from a 14 percent decline to a 7 percent decline is almost surely too large not only because it is based on a Leontief technology, but also because it does not take into account the possibility that the capital left idle during the decline was of lower quality than the capital kept in operation.
15. One reason that private investment may have fallen in the 1930s is because government investment was substituting for private investment; however, this seems unlikely. Government investment that might be a close substitute for private investment did not rise in the 1930s: government expenditures on durable goods and structures were 3 percent of output in 1929 and fluctuated between 3 percent and 4 percent of output during the 1930s.
16. To understand why a trade disruption would have such a small effect on output in a country with a small trade share, consider the following example. Assume that final goods are produced with both domestic ($Z$) and foreign ($M$) intermediate goods and that the prices of all goods are nor-

malized to one. Assuming an elasticity of substitution between home and foreign goods of one implies that the production for final goods, $Y$, is Cobb-Douglas, or

$$Y = Z^{\alpha}M^{1-\alpha}$$

where $\alpha$ is the share parameter for intermediate inputs. This assumption implies that with the level of domestic intermediate goods held fixed,

$$\%\Delta Y = (1 - \alpha)\%\Delta M.$$

That fact that U.S. imports were 4 percent of total output and U.S. exports 5 percent in 1929 suggests that the highest the cost share of inputs in production could have been is $0.04/0.95 \approx 0.04$. Hence, an extreme disruption in trade that led to an 80 percent drop in imports would lead to only a 3.2 percent drop in output. (See Crucini and Kahn 1996 for more on this issue.)

17. Note that the monetary base, which is the components of M1 controlled by the Federal Reserve, grew between 1929 and 1933.
18. In addition to Lucas and Rapping's (1969) findings and Fisher's (1933) debt-deflation view, we have other reasons to question the monetary shock view of the Depression. During the mid- and late-1930s, business investment remained more than 50 percent below its 1929 level despite short-term real interest rates (commercial paper) near zero and long-term real interest rates (Baa corporate bonds) at or below long-run averages. These observations suggest that some other factor was impeding the recovery.
19. Bernanke (1983) acknowledges the possibility of an endogenous response but argues that it was probably not important, since problems in financial intermediation tended to precede the decline in overall activity and because some of the bank failures seem to have been due to contagion or events unrelated to the overall downturn.
    Recent work by Calomiris and Mason (1997) raises questions about the view that bank runs reflected contagion and raises the possibility that productive, as well as unproductive, banks could be run. Calomiris and Mason analyze the bank panic in Chicago in June 1932 and find that most of the failures were among insolvent, or near-insolvent, banks.
20. To see how we derive the linear expression for $\hat{Y}$, note that if $Y = F(y_i, \ldots, y_n)$, then

$$dY = \sum_{i=1}^{n} F_i d_{yi}.$$

    Note also that if goods are produced competitively, then the price of each factor $i$ is given by its marginal product $F_i$. Hence, $\gamma_i = F_i y_i / Y$, and the result follows.
    Note that the fact that the cost shares didn't change very much is inconsistent with the notion that there was extremely low elasticity of substitution for this input and that the fall in this input was an important cause of the fall in output. For example, a Leontief production function in which $F(y_1, \ldots, y_n) = \min_i y_i$ implies that the cost share of input $y_i$ would go to one if that input was the input in short supply.
21. Cooper and Corbae (1997) develop an explicit model of a financial collapse with a high output equilibrium associated with high levels of intermediation services and a low output equilibrium associated with low levels of intermediation services and a sharp reduction in the size of the banking sector. Their model also implies that the ratio of total deposits to output is a measure of the available level of intermediation services.
22. Interest rates on Baa debt, which is considered by investment bankers to have higher default risk than these other debts, did begin to rise in late 1937 and 1938.
23. While Kendrick's (1961) data on aggregate hours are frequently used in macroeconomic analyses of the pre–World War II economy, we point out that the Bureau of Labor Statistics (BLS) did not estimate broad coverage of hours until the 1940s. Thus, Kendrick's data are most likely of lower quality than the more recent BLS data.
24. Decade-long money illusion is hard to reconcile with maximizing behavior. Regarding nominal contracts, we are unaware of any evidence that explicit long-term nominal wage contracts

were prevalent in the 1930s. This prevalence would seem unlikely, since only about 11 percent of the workforce was unionized in the early 1930s.

25. Alternative views in the literature combine a variety of shocks. Romer (1990, 1992) suggests that the 1929 stock market crash increased uncertainty, which led to a sharp decline in consumption. She argues that this shock, combined with monetary factors, is a key to understanding the 1930s. To assess Romer's view, which is based in part on the large drop in stock prices, we need a well-established theory of asset pricing. Existing theories of asset pricing, however, do not conform closely to the data. (See Grossman and Shiller 1981 or Mehra and Prescott 1985.) Given existing theory, a neoclassical evaluation of Romer's view is difficult.

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## NOTES

1. Kessel (1965) was the first to note the relation between the yield curve and future real economic activity.
2. Estrella and Hardouvelis (1991), Harvey (1989), and Haubrick and Dombrosky (1996) find the yield spread predicts real GDP growth in the United States, while Estrella and Hardouvelis (1991) and Estrella and Mishkin (1996) and Dueker (1997) find that the U.S. yield spread forecasts the probability of a U.S. recession. Studies which examine the predictive power of the yield spread in non-U.S. countries include Caporale (1994), Estrella and Mishkin (1995), Hu (1993), and Plosser and Rouwenhorst (1994).
3. Harvey (1988, 1989) presents a related explanation for the relation between the slope of the yield curve and future economic growth. Suppose, as above, bond market participants expect real income to rise in the future. The expectation of increased future income will reduce today's

demand for long-term bonds which pay off in the future. A decrease in the demand for the long-term bonds will cause the price of the bonds to fall, or their yield to rise. Thus, the yield curve steepens as long-term interest rates rise. If the expectations for economic growth are realized, a steepening of the yield curve will be associated with a future increase in real economic activity.

4. Because of the difficulties in interpreting data on East Germany prior to the unification of East and West Germany, the analysis focuses on West German economic growth only.
5. When possible, the interest rate data used averages of daily data over the quarter or month, depending upon whether quarterly or monthly forecasts are evaluated. Averaged data are used because it is more likely that measures of real economic activity are related to average yield spreads, rather than to a single end-of-month value.
6. In particular, Caporale (1994) examines the in-sample and out-of-sample forecast power of the yield spread in 13 countries, but restricts her forecast horizon to one year and her measure of real economic activity to real GDP. Estrella and Mishkin (1995) examine the predictive power of the yield spread in five countries, France, Germany, Italy, the United Kingdom, and the United States, over the 1973 to early 1995 period, and also examine the sensitivity of the empirical results to real GDP, industrial production, and unemployment measures of real activity, as well as to forecast horizons up to five years. They do not, however, examine the out-of-sample forecast power of the yield spread. Hu (1993) examines the in-sample and out-of-sample forecast power of the yield spread from the earliest data point possible to 1991 for the G-7 countries, but restricts his forecast horizon to one year. Finally, Plosser and Rouwenhorst (1994) examine in-sample yield spread forecasts for three countries, Germany, the United Kingdom, and the United States, between 1973 and 1988. They consider both real GDP and industrial production measures of real economic activity and forecast horizons of up to five years, but they restrict their forecasts to in-sample forecasts.
7. When the percent change in real GDP is the dependent variable, the long-term and short-term interest rates used to calculate the spread are the quarterly averages of monthly rates in that quarter. When industrial production or the unemployment rate is the dependent variable, the spread is calculated from daily averages of the long-term and short-term interest rates over the month.
8. Estimating this forecasting equation for $k = 1, 2$, or 3 years with quarterly or monthly data causes the error term to be serially correlated. Consequently, the standard errors from the estimation are corrected following Hansen (1982) and Newey and West (1987).
9. Due to data availability, the sample period for the Netherlands is 1977:1 to 1996:4.
10. The R-squares plotted are actually the R-bar squares from the regression, the R-square values adjusted for the degrees of freedom.
11. Prior to 1980, Japanese financial markets were heavily regulated and may not have reflected market expectations.
12. These average growth rates imply real GDP growth in year 2 will be 2.4 percent ($2.7 \times 2 - 3.0$), while real GDP growth in year 3 will be 1.8 percent ($2.4 \times 3 - 3.0 - 2.4$).
13. The results for the two-year and three-year forecasts are very similar.

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## NOTES

1. A.W. Phillips first noted such a relationship in 1958. His original study examined a temporary trade-off between changes in nominal wages and the unemployment rate in the United Kingdom over a period from 1861 to 1957.
2. The literature presents several versions of the birariate relationship between unemployment and inflation. For critical discussions consult, for example, Chang (1997), Espinosa and Russell (1997), and Staiger, Stock, and Watson (1997).
3. See, for example, Diebold (1998a) and Sims and Zha (1996) for detailed discussions.
4. The mathematical structure is similar to Sims and Zha (1998). See Box 1 for details.
5. Blue Chip Forecasts is a monthly publication based on a survey of a number of forecasters from different industries. The Blue Chip forecasts displayed in this article are the consensus forecasts.
6. Technically, these two sets of forecasts may not be statistically different when error bands are considered. Small samples such as the data after 1982 tend to give unreliable results due to erratic sampling errors, as found in, say, Cecchetti (1995). The fact that the model with only the post-1982 data delivers reasonable results may be due to recent developments in Bayesian

methods that deal with problems associated with low degrees of freedom (see Sims and Zha 1998 and also Box 1). This feature is still largely unexplored and deserves further research.

7. These sources can be various commercial firms, particular economic theories, institutional knowledge, or even ad hoc views.
8. All forecasts are made at the beginning of 1995. Although this article concentrates on inflation for simplicity of the analysis, forecasts of other macroeconomic variables such as output and unemployment are equally important for monetary policy. In particular: a number of economists believe that there is a short-term trade-off between inflation and output, especially when unexpected large shocks hit the economy (King 1997).
9. Similar to error bands of individual forecasts, error regions of joint forecasts can be constructed for any desired probability. Again, the discussion here focuses on two-thirds probability.
10. The forecasts displayed in Chart 10 are the 1998 averages of published figures in the *Wall Street Journal.*

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## NOTES

1. Under the Gold Reserve Act of 1934, the U.S. Treasury, through its Exchange Stabilization Fund (ESF), maintains primary responsibility for the nation's interventions. The Federal Reserve intervenes both as the ESF's agent and on its own behalf, typically splitting any transactions equally between the two accounts.
2. Almekinders (1995), Dominguez and Frankel (1993), and Edison (1993) provide useful surveys of exchange-market intervention.
3. This statement is based on a survey of "Treasury and Federal Reserve Foreign Exchange Operations." which appeared quarterly in the *Federal Reserve Bulletin* between October 1990 and June 1997.
4. The tests utilize only official U.S. intervention data because foreign data are unavailable.
5. I base this statement on official published summaries of "Treasury and Federal Reserve Foreign Exchange Operations" and news accounts of currency markets. Official data used in this paper terminate in December 1995.
6. The "Foreign Exchange" column of the *Wall Street Journal* made no mention of these interventions on the days they took place.
7. The author thanks an anonymous referee for comments about the random-walk hypothesis.
8. Merton (1981; proposition III. p. 384) shows this to be a necessary and sufficient condition for the forecast to have no value.
9. Ironically, an intervention that is consistently wrong also conveys useful information to the market. The market can profit by belting against the intervention: Buy when the Federal Reserve sells foreign exchange.

## NOTES

1. Under the Gold Reserve Act of 1934, the U.S. Treasury, through its Exchange Stabilization Fund (ESF), maintains primary responsibility for the nation's interventions. The Federal Reserve intervenes both as the ESF's agent and on its own behalf, typically splitting any transactions equally between the two accounts.
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## NOTES

1. For more on the Phillips curve, see the article by Robert King and Mark Watson. The 1999 article by Thomas Sargent contains a discussion of the breakdown of the Phillips curve in the context of monetary policy.
2. Currency and demand deposits, a significant portion of the money stock, pay no interest, but nonmonetary assets, such as Treasury bills and bonds, do. The higher interest rates are, the more interest income people forgo by holding currency and demand deposits, so they hold less money. If interest rates decline, people will hold more money.
3. The story is more complicated than we have made it seem. When the Fed increases the money supply, it does so by purchasing bonds in an open-market operation, which increases bank reserves. Banks then increase lending, which results in more money circulating in the economy. In addition, changes in the money supply are associated with changes in real activity, such as employment and output, at least in the short run.
4. The monetary base consists of the currency component of the money supply plus bank reserves.
5. There is an extensive literature on the instability of money demand. See the review article by Stephen Goldfeld and Daniel Sichel.
6. Michael Woodford's article has references to proposals that monetary policy be guided by commodity prices.
7. Some advocates for using commodity prices to gauge inflationary pressures came from within the Federal Reserve System. See the speeches by Federal Reserve Board governors Wayne Angell, Robert Heller, and Manuel Johnson. In general, the empirical evidence suggests that commodity prices are not very good predictors of inflation. See the article by Michael Woodford for a brief review of the literature and references.
8. Robert E. Lucas's 1977 article contains a nontechnical discussion of many of these points.
9. Much work has been done over the last 20 years on building better foundational models for policy analysis, for example, the paper by Eric Leeper and Christopher Sims, and the book edited by Thomas Cooley. These sources offer examples of what economists call stochastic, dynamic, general equilibrium models. One key difference between these newer models and older, large-scale statistical models is that the newer models have restrictions across equations that account for how people respond to perceived changes in monetary and fiscal policies. In addition, the new models are based explicitly on the utility and profit-maximizing behavior of households and firms.
10. We have in mind Taylor's rule and McCallum's rule. See the article by John Taylor and the one by Bennett McCallum for details.

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## FOOTNOTES

1. See Douglas Staiger, James Stock, and Mark Watson, "How Precise Are Estimates of the Natural Rate of Unemployment?" National Bureau of Economic Research, Working Paper No. 5477, March 1996. The author estimates NAIRU's current value at 6.1 percent. They also acknowledge that due to the difficulty of obtaining precise measurements, the actual figure may lie anywhere between 4.6 and 6.9 percent. NAIRU is also known as the natural rate of unemployment.
2. The Phillips curve postulates a trade-off between unemployment and inflation: Lower rates of unemployment are possible only with higher rates of inflation.
3. The *output gap* refers to the difference between actual and potential output. The Keynesian approach contends that a negative gap (where actual output exceeds potential output) would have inflationary consequences.
4. In technical language, the long-run Phillips curve is vertical at NAIRU.
5. Remember that under this framework, any inflation rate is sustainable in equilibrium as long as the public expects that rate to continue indefinitely.
6. For a very readable and useful survey of current practices among these countries, see Andrew G. Haldane, ed., *Targeting Inflation,* London: Bank of England, 1995.
7. For a more detailed discussion of the upward biases that may occur in measuring price changes (especially in the CPI), see Michael F. Bryan and Jagadeesh Gokhale, "The Consumer Price Index and National Saving," Federal Reserve Bank of Cleveland, *Economic Commentary,* October 15, 1995.

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1. John le Carré. *The Secret Pilgrim.* New York: Knopf, 1991, p. 321.

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## NOTES

1. The original manuscript of the essay is not known to be extract. In the Tracy W. McGregor Library, University of Virginia, is a transcript of about the first one-third of the article, which John C. Payne probably copied from the newspaper version of it.
2. Pledging on September 1, 1779, not to increase its $160 million of outstanding bills of credit by more than 25 percent, and that only in case of a dire emergency, the Continental Congress had John Jay draft a "Circular Address" to the states (adopted September 13) exhorting them to supply enough soldiers, money, and matériel to restore public credit and advance the common cause.

And yet, by March 18, 1780, the gloomy situation obliged Congress to authorize the states to issue new bills of credit and declare that the old continental issues would be redeemed at only one-fortieth of their face value (*Journals of the Continental Congress,* XV, 1052–62: XVL 262–67). Although in the prefatory note Madison declared that he wrote his essay during the six months intervening between these two actions by Congress, he probably could have narrowed the time to the period from late in December 1779 to early in March of the next year. In his brief third-person autobiography, written long afterward. Madison mentioned his election to Congress on December 14, 1779, and then added that "To prepare himself for this service, he employed an unavoidable detention from it in making himself acquainted with the state of Continental affairs and particularly that of the finances which, owing to the depreciation of the paper currency, was truly deplorable. The view he was led to take of the evil, and its causes, was put on paper, now to be found in several periodical publications, particularly Freneau's National Gazette." By "unavoidable detention" he most likely referred to his necessary preparations at Montpelier for his residence in Philadelphia and the heavy snow which delayed his departure for that city until March 6, 1780, or for some days after he had planned to begin the trip. The essay was printed as the fourth in Madison's series of seventeen politically tinged articles appearing in Freneau's newspaper late in President Washington's first term. Even though Madison may have revised his original manuscript before releasing it for publication, it deals with a problem which was much less acuse by 1791 than when he wrote the essay nearly twelve years earlier.

3. Madison accurately reflects the thought, but does not always quote the exact words of David Hume in his *Political Discourses* (Edinburgh, 1752), pp. 82–83.
4. The portion of the essay in the issue of the *National Gazette* for December 19, 1791, ends here. The remainder is in the issue of December 22, 1791.

† As the depreciation of our money has been ascribed to a wrong cause, so, it may be remarked, have effects been ascribed to the depreciation, which result from other causes. Money is the instrument by which men's wants are supplied, and many who possess it will part with it for that purpose, who would not gratify themselves at the expence of their visible property. Many also may acquire it, who have no visible property. By increasing the quantity of money therefore, you both increase the means of spending, and stimulate the desire to spend; and if the objects desired do not increase in proportion, their price must rise from the influence of the greater demand for them. Should the objects in demand happen, at the same juncture, as in the United States, to become scarcer, their prices must rise in a double proportion.

It is by this influence of an augmentation of money on demand, that we ought to account for that proportional level of money, in all countries, which Mr. Hume attributes to its direct influence on prices. When an augmentation of the national coin takes place, it may be supposed either, 1. not to augment demand at all; or, 2. to augment it so gradually that a proportional increase of industry will supply the objects of it; or, 3. to augment it so rapidly that the domestic market may prove inadequate, whilst the taste for distinction natural to wealth, inspires, at the same time, a preference for foreign luxuries. The first case can seldom happen. Were it to happen, no change in prices, nor any efflux of money, would ensue: unless indeed, it should be employed or loaned abroad. The superfluous portion would be either hoarded or turned into plate. The second case can occur only where the augmentation of money advances with a very slow and equable pace: and would be attended neither with a rise of prices, nor with a superfluity of money. The third is the only case, in which the plenty of money would occasion it to overflow into other countries. The insufficiency of the home market to satisfy the demand would be supplied from such countries as might afford the articles in demand: and the money would thus be drained off, till that and the demand excited by it, should fall to a proper level, and a balance be thereby restored between exports and imports. The principle on which Mr. Hume's theory, and that of Montesquieu's before him, is founded, is manifestly erroneous. He considers the money in every country as the representative of the whole circulating property and industry in the country; and thence concludes, that every variation in its quantity must increase or lessen the portion which represents the same portion of property and labor. The error lies in supposing, that because money serves to measure the

value of all things, it represents and is equal in value to all things. The circulating property in every country, according to its market rate far exceeds the amount of its money. At Athens oxen, at Rome sheep, were once used as a measure of the value of other things. It will hardly be supposed, they were therefore equal in value to all other things.

5. Madison's entire footnote is in italics in the *National Gazette.* In the last paragraph of the footnote, he refers to Book XXII of Montesquieu's *De l'esprit des lois,* first published in Geneva in 1748 and soon thereafter translated into English. Madison's daring in challenging the correctness of this redoubtable authority is noted by Paul Merrill Spurlin in his *Montesquieu in America, 1760–1801* (Baton Rogue, La. 1940) pp. 175–76.
6. See note 2.

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## SUGGESTED READING

For an overview of the Federal Reserve System and its functions, see:

*The Federal Reserve System: Purposes and Functions,* 8th ed. Washington, DC: Board of Governors, Federal Reserve System, December 1994.

*The Federal Reserve System in Brief.* Federal Reserve Bank of San Francisco.

## NOTES

1. The FOMC is the policy-making arm of the Federal Reserve System. It is composed of the seven members of the Board of Governors and five of the twelve district bank presidents, four of whom vote on a rotating basis, and the New York Federal Reserve Bank president, who is a permanent voting member. For a recent use of the FOMC transcripts as the basis for analyzing Fed actions, see Edison and Marquez (1998).
2. Meigs (1976) chronicles the contributions of D. C. Johns, the president of the Federal Reserve Bank of St. Louis, and Homer Jones, the director of research at St. Louis. Meigs also provides a brief discussion of Bryan's role in the developing debates that would later be centered on the Federal Reserve Bank of St. Louis.

3. The term cones comes from their construction. For example, supposing that the base period is the average value for the level of an aggregate in the fourth quarter of a year and assuming that this value is $100, if a 5 percent growth path is the policy objective for the year, then the average value for money in the fourth quarter of the following year would be $105. Allowing for a growth path somewhat higher (for instance, 7 percent) and lower (for instance, 3 percent) would give quarter-average values of $107 and $103, respectively. As shown below, connecting the base period value with the upper and lower ranges creates a cone of possible values.
4. Monetary policy is conducted through the Federal Reserve Bank of New York primarily by buying and selling government securities in the open market. This activity takes place through the Open Market Trading Desk, supervised by the manager of the desk.
5. Atkinson (1969) shows that the FOMC often switched between free reserves and looking to tone and feel during the 1950s and 1960s. Even though the FOMC officially used free reserves as the operating guide, Atkinson's evidence indicates that doing so did not reduce the variance of interest rates or lead to better control over reserves than proposals that used tone and feel as guidelines. For an early analysis of the problems associated with the use of free reserves, see Brunner and Meltzer (1964).
6. Although quotation marks appear, the minutes represent the FOMC Secretary's summary of the discussion and are not necessarily verbatim. Even so, FOMC members had the opportunity to correct the minutes before they entered the permanent record.
7. This notion of flexibility can be found throughout FOMC discussions. For example, compare Roosa's and Martin's comments to those of Chairman Paul Volcker at the December 20–21, 1982, meeting of the FOMC: "I think we're left with what could be termed an eclectic, pragmatic approach. It's going to involve some judgment as to which one of these [aggregate] measures we emphasize, or we may shift from time to time. . . . [W]e're going to have to make some judgments as to which one is more significant at any particular point in time against what nominal GNP is or what the goal is or what the real economy is doing and what prices are doing and all the rest. . . . [T]hat's the way the Federal Reserve used to operate, less elaborately, for years when policy by present standards looked pretty good" (FOMC 1982, 41).
8. The source of the quote is Hayes's testimony before the Joint Economic Committee in 1961.
9. It is likely that Bryan meant "Some Theoretical and Empirical Aspects of the Demand for Money" since there is no reference in the NBER list of publications to the former piece.
10. Thanks to Milton Friedman for making this correspondence available. Bryan's views on monetary policy and the effects of money probably reflect the fact that he received postgraduate training at the University of Chicago (see Box 1). This is the school often associated with Friedman and so-called monetarist economics. To get a feel for the opinion that many economists held of such views, the remarks of Richard Davis, an economist at the Federal Reserve Bank of New York in 1969, can be considered: "[T]he view that 'only money matters' or, perhaps more accurately, that 'mainly money matters' was the province of an obscure sect with headquarters in Chicago. For the most part, economists regarded this group—when they regarded it at all—as a mildly amusing, not quite respectable collection of eccentrics" (1969, 119).
11. In personal discussions, Jim Meigs relates that Bryan and Johns often met outside the FOMC meetings to discuss policy developments. Bryan, the professional economist, is likely to have influenced Johns, a lawyer by training, in matters of monetary policy.
12. The total-effective-reserves measure developed at Atlanta is similar to the St. Louis adjusted monetary base series less currency. Total effective reserves are measured by first calculating the average value for the ratio of required reserves to average deposits beginning in May 1958 through December 1959. May 1958 is used since it is the last time reserve requirements were changed. This ratio is 0.1152. For the period prior to May 1958, this ratio is divided by the monthly ratio of required reserves to deposits and the value of this term multiplied by actual reserves—in other words, $[0.1152/(R_r/D)] \times R$. From May 1958 onward, actual member bank reserves are used. Both reserve measures are then seasonally adjusted. This computation is out-

lined in the appendix to the January 26, 1960, FOMC meeting. This measure can be replicated using the data in Appendix D of Meigs (1962). For example, this author's trend estimate is that reserves increase, on average, $42.7 million per month compared with Bryan's reported estimate of $43 million per month.

13. Meigs (1976, 445) suggests that Bryan introduced the use of total effective reserves at the November 24 meeting of the FOMC. It was at the November 24 meeting that Bryan introduced the charts upon which his policy discussions actually had been based since August.
14. The following draws on Hetzel (1996). See also the related discussions in Meltzer (1991), Schwartz (1997), and Wheelock (1997).
15. The published record does not indicate whether Bryan preferred one base period over another. The fact that Bryan shows little affinity for selecting one base from which to measure changes in reserves causes base drift. For a discussion of this issue and how it influenced monetary policy in the 1970s, see Broaddus and Goodfriend (1984).
16. The notion that any attempt to make up the shortfall in one action could disrupt the market in undesirable ways was used during the 1979–82 period of monetary aggregate targeting. During that period, intermeeting deviations of the aggregates from targets were reduced gradually in order to prevent undue gyrations in interest rates. For an appraisal of policy actions during the 1979–82 period, see, among others, Hetzel (1982) and Poole (1982).
17. The FOMC turned its attention increasingly toward the external balance-of-payments problem as the 1960s unfolded. Bryan believed that monetary policy was not responsible for the problem and could do little to correct it. As he stated at the October 24, 1961, meeting, "for the System to try to correct the balance of payments situation by monetary manipulation [of the Treasury bill rate] struck him as not only absurd but dangerous" (FOMC 1961, 892). For a discussion of how these external events influenced monetary policy during the early 1960s, see, among others, Hetzel (1996), Meltzer (1991), and Schwartz (1997).
18. Bryan's distrust of free reserves deepened over time. By April 1963, for instance, he recognized that the "maintenance of a constant level of free reserves would permit indefinite expansion of the money supply and the financing of inflation" (FOMC 1963, 343). In September 1963 Bryan observed that the "free reserve figure might be a rather dangerous one to use for target purposes, since maintaining free reserves at any selected level would mean supplying all of the reserves demanded" (839). By January 7, 1964, he admonished the committee that policy "had been injecting reserves into the banking system at a rate . . . greater than sustainable in the long run without inflation" (FOMC 1964, 46). The inflationary record of the late 1960s proved his warning to be all too correct.
19. For a related discussion of this issue, see Wheelock (1998).

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## NOTES

1. See Cox (1992) for an excellent discussion of the practical relationship between the Federal Reserve and the U.S. Treasury. For an interesting description of seigniorage in medieval times, see Rolnick, Velde, and Weber (1994).
2. For reference, the United States raises, on average, about 2 percent of federal government expenditures through money creation.
3. After all the accounting is consolidated for the government and the central bank, the net change in the government's income state is that money creation amounts to a revenue source to cover various expenses.
4. Bryant and Wallace (1984) offer an explanation for the coexistence of government bonds and money. They argue that the two types of government paper effectively price discriminate between "rich" and "poor" households.

   As far as my assumption about one-period bonds is concerned, I could examine a more complicated maturity structure for government debt. Such generality would not alter the conclusions that I reach about seigniorage revenue, but it would mean that I would have to keep tabs on the entire distribution of government bonds and when each one matures.
5. The reduction in reported income can come either from effective avoidance or from people working less or acquiring less capital. Of course, the discussion describes what happens to the steady-state level of income.
6. There is no explicit interest on money. Consequently, its one-period rate of return is calculated as the ratio of the date $t$ price (the potential selling price) to the date $t-1$ price (the purchase price). Formally, this is the ratio of $v_t/v_{t-1}$. With $v_t = 1/p_t$, then simple substitution yields the expression for the gross real return on money.
7. Here, the reserve requirement pins down the fraction of a person's portfolio held in the form of money balances. This approach is qualitatively the same as one in which the reserve requirement pins down the bank's portfolio.
8. The data set is available from the author upon request.
9. Fischer is primarily interested in describing why countries maintain national currencies. Computing the seigniorage-to-GNP ratio demonstrates how important seigniorage is. The ratio represents the command over resources that a government obtains by creating money.
10. The income tax analog is the average marginal tax rate. See, for example, Seater (1985).
11. Historically, the U.S. reserve requirement structure was more convoluted. In the past, for example, it mattered whether the commercial bank was located in a Reserve Bank city or outside.
12. Interestingly, Fischer (1982) presents evidence that several governments have made substantial use of seigniorage. In Fischer's sample, which generally covers the period between 1960 and 1978, Argentina collected, on average, 6.2 percent of GNP through money creation.
13. This result does not bear directly on the relative importance of seigniorage revenue. Rather, it bears on the issue of variability within a country across time. In short, the reader gains a sense of how the countries in the sample rely on seigniorage over time.
14. The effect of a change in the reserve ratio, holding money growth constant, is given by the following derivative: $\partial z/\partial(R/D) = W/(1 + R/D)^2$, where $W = g/(1 + g)$. With $W > 0$, the expression says $z$ is increasing the reserve ratio. In addition, $\partial^2 z/\partial(R/D)^2 = (-2 \cdot W)/(1 + R/D)^3$, which is negative for $W > 0$.
15. To see this relationship, suppose the estimated regression is given by

$$S/Y = c_0 + \alpha z + \beta z^2.$$

For a country with a 1-percentage-point higher average $z$, an estimate of the change in $S/Y$ is $\alpha + 2\beta z$. Thus, a 1-percentage-point change in $z$ depends on the value of $z$.

16. In all regressions, the Newey–West procedure is applied to correct any potential bias in standard errors. In this particular application, heteroskedasticity is the chief worry.
17. Per capita real GDP comes from the Summers–Heston Penn World Tables. In addition, regressions are run using per capital real GDP for 1980 and 1994 as alternative measures of financial sophistication in case the 1965 GDP value suffers from some time-specific factors. The regressions are qualitatively the same as those reported in Table 2.
18. Three OECD countries in this sample—France, the Netherlands, and Norway—have $z$ values less than 0.0023. Using the method outlined in Fomby, Hill, and Johnson (1984, 58), one can compute the standard errors for the value of $z$ at which seigniorage reliance is minimized. With 90 percent confidence, the seigniorage-reliance minimizing value of $z$ is between 0.0022 and 0.0024.

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## NOTES

1. Technically, the United States was on a bimetallic (gold and silver) standard until 1900. Though it is true that the money supply was limited by the size of the Treasury's gold and silver holdings, there was considerable short-run variability in the money multiplier. See Cagan (1965) and Freidman and Schwartz (1963).
2. Major banking panics occurred in 1873, 1884, 1890, 1893, and 1907.
3. This latter understanding was viewed as part of the Fed's mission, although it is only implicitly, not explicitly, stated in the Federal Reserve Act of 1913 itself.
4. See Goodfriend (1988).
5. See Hawtrey (1938).
6. According to Friedman and Schwartz (1963) U.S. real net national product fell by more than one-third from 1929 to 1933, implicit prices of goods and services fell by more than one-quarter, and wholesale prices by more than one-third. More than one-fifth of the commercial banks in the United States holding nearly one-tenth of the deposits closed because of financial difficulties. As a result of the sharp contraction in economic activity, the unemployment rate peaked at over 20 percent in 1932–33, and remained above 10 percent for the remainder of the decade.
7. The Fed had already recognized inflation as a problem on three occasions prior to the mid-1960s: in the aftermath of World War II, during the Korean War and the period of the 1951 Fed-Treasury Accord, and again in the mid-1950s. See footnote 12.
8. Under the leadership of Benjamin Strong, Governor of the Federal Reserve Bank of New York, the Fed made price stability a priority briefly in the 1920s. See Hetzel (1985).
9. See, for example, Bronfenbrenner and Holzman (1963) and Friedman (1987).
10. Estimates in Lucas (1994) imply that the economization of money balances that occurred at a rate of inflation of 5 percent per year (associated with a short-term nominal interest rate of about 6 percent) wasted about 1 percent of U.S. GDP. The payment of interest on transactions deposits in recent years raises money balances and reduces this welfare cost somewhat. The bulk of the welfare gain to reducing inflation is probably realized at a slightly positive inflation rate. See Wolman (1997).
11. Feldstein (1996) reports that the net present value of the welfare gain of shifting from 2 percent inflation per year to price stability forever is about 30 percent of the current level of GDP.
12. Friedman (1964, 1972, and 1984) discusses go-stop policy. Romer and Romer (1989) document that since World War II the Fed tightened monetary policy decisively to fight inflation on six occasions beginning, respectively, in October 1947, September 1955, December 1968, April 1974, August 1978, and October 1979. The unemployment rate rose sharply after each policy shock. Only two significant increases in unemployment were not preceded by Fed action to fight inflation. One occurred in 1954 after the Korean War and the second occurred in 1961, after the Fed tightened monetary policy to improve the international balance of payments.
13. The monthly average 30-year bond rate rose from around 8 percent in early 1978 to peak above 14 percent in the fall of 1981. The long bond rate was near 13 percent as late as the summer of 1984.
14. See Cook (1989).
15. See, for instance, Friedman (1987), Poole (1978), and Sargent (1986).
16. See McCallum and Goodfriend (1987).
17. The public's target ratio of money to expenditure may exhibit a trend at times in response to, say, rising interest rates or technical progress in the payments system. For instance, the ratio of money to expenditure will trend downward if money provides transaction services more efficiently over time. In that case, the money growth rate consistent with price stability will be below the growth of physical product.
18. See the preceding note.
19. Electronic private substitutes for government currency have become feasible recently. See Lacker (1996).

20. See Cagan (1965).
21. There have been exceptions, however. For instance, a new deposit type known as the negotiable order of withdrawal (NOW) account was introduced in the late '70s and early '80s as part of the deregulation of the prohibition of interest on checkable deposits. NOW accounts were interest-earning substitutes for demand deposits and so were immediately included in the Fed's M1 measure of the basic money supply for purposes of targeting and control. See Broaddus and Goodfriend (1984).
22. For instance, see Lucas (1988) and Meltzer (1963) on the long-run stability of the demand for M1.
23. See Heller (1966) and Shultz and Aliber (1966).
24. See Kosters (1975).
25. Government fiscal concerns are the driving force behind high inflations. See Sargent (1986).
26. See Schreft (1990).
27. See Phillips (1958).
28. See Heller (1966) and Tobin (1972).
29. See Fischer (1994), pp. 267–68.
30. King and Watson (1994), for example, report a significant negative correlation between unemployment and inflation over the business cycle.
31. Barro and Gordon (1983), Fellner (1976), Sargent (1986), and Taylor (1982) contain early discussions of credibility as it relates to monetary policy. Persson and Tabellini (1994) contains a recent survey of research on the role of credibility in monetary and fiscal policy. The new large-scale Federal Reserve Board macroeconomic model is designed to take account of different degrees of credibility in policy simulations. See "A Guide to FRB/US" (1996).
32. What happens is this: In the first instance households and businesses attempt to exchange financial assets for money. Such actions, however, cannot satisfy the aggregate excess demand for money directly. They drive asset prices down and interest rates up until the interest sensitive components of aggregate expenditure grow slowly enough to eliminate the excess demand for money. As the disinflation gains credibility, wage and price inflation slows, and real aggregate demand rebounds until the higher unemployment is eliminated.

    Ball (1994) shows that a perfectly credible disinflation need have no adverse effects on employment even in a model with considerable contractual inertia in the price level.
33. The Fed did not explicitly assert its responsibility for inflation in the initial announcements of its disinflationary policy. However, by emphasizing the key role played by money growth in the inflation process, and by announcing a change in operating procedures to emphasize the control of money, the Fed *implicitly* acknowledged its responsibility for inflation. See *Federal Reserve Bulletin* (November 1979), pp. 830–32.
34. The Fed took short-term rates from around 11 percent in September 1979 to around 17 percent in April 1980. This was the most aggressive series of actions the Fed has ever taken in so short a time, although the roughly 5 percent increase in short rates from January to September of 1973 was almost as large. See Goodfriend (1993).
35. The collapse of confidence in U.S. monetary policy in 1979 and 1980 was extraordinary. The price of gold rose from around $275 per ounce in June 1979 to peak at about $850 per ounce in January 1980, and it averaged over $600 per ounce as late as November 1980. Evidence of a weakening economy caused the Fed to pause in its aggressive tightening in early 1980. But with short rates relatively steady, the 30-year rate jumped sharply by around 2 percentage points between December and February, signaling a huge jump in long-term inflation expectations. The collapse of confidence in early 1980 was caused in part by the ongoing oil price shock and the Soviet invasion of Afghanistan in December 1979. But the Fed's hesitation to proceed with its tightening at the first sign of a weakening economy probably also played a role. In any case, the Fed responded with an unprecedented 3 percentage point increase in short rates in March, taking them to around 17 percent. See Goodfriend (1993).
36. After making its disinflationary policy commitment in October 1979, the Fed let the growth of

effective M1 overshoot its target range in 1980 and the inflation rate continued to rise, peaking at over 10 percent in the fourth quarter. Then, in sharp contrast to the preceding four years, effective M1 actually undershot its target range in 1981. Effective M1 grew around 4.6 percentage points slower in 1981 than its average annual growth over the preceding five years. Further, the actual 2 percent shortfall in M1 from the midpoint of its 1981 target was built into the 1982 target path. See Broaddus and Goodfriend (1984).

The unemployment rate rose from around 6 percent in 1978 to average nearly 10 percent in the recession year of 1982.

37. Simple policy rule specifications studied with models estimated on historical data can be of great practical value in benchmarking actual policy decisions. McCallum (1988) and Taylor (1993) present two rules, respectively, that are particularly useful in this regard. McCallum models the monetary base (currency plus bank reserves) as the Fed's policy instrument, and has it responding to a moving average of base velocity and departures of nominal GDP from a target path. Taylor models the real short-term interest rate (the market interest rate minus expected inflation) as the policy instrument, and has it responding to inflation and the gap between actual and potential GDP.

    Each specification has advantages and disadvantages. Taylor's rule matches more closely the way the Fed thinks of itself as operating. But McCallum's rule makes clear that the ultimate power of the Fed over the economy derives from its monopoly on the monetary base. McCallum's rule has the advantage that it could still be used if disinflation happened to push the market short rate to zero, or if inflation expectations became excessively volatile. In either situation the Fed might be unable to use the real short rate as its policy instrument.

38. See Board of Governors "Monetary Policy Report to Congress" (1994, 1995, and 1996).

39. In 1995, Senator Connie Mack introduced a bill that would make low inflation the primary goal of monetary policy. In 1989, Fed Chairman Alan Greenspan testified in favor of a prior resolution that would have mandated a price stability objective for the Fed. Academics as diverse as Blinder (1995), Fischer (1994), and Friedman (1962) all agree that the Fed should be given some sort of mandate for low inflation. The remarkable convergence of professional thinking in favor of a mandate was evident at the Federal Reserve Bank of Kansas City's August 1996 conference on price stability. See *Achieving Price Stability* (1996).

    Inflation targeting is employed by a number of central banks around the world. See Leiderman and Svensson (1995).

40. Rudebusch and Wilcox (1994) report empirical evidence on inflation and productivity growth. Dotsey and Ireland (1996) study the question in a quantitative, theoretical model.

41. Oil prices rose from around $3 to $12 a barrel during the 1973/74 oil price shock, and from about $15 to over $35 in 1979/80.

42. See Thurow (1994). By successfully keeping inflation in check, preemptive policy actions *necessarily* appear to be busting ghosts. So the appearance of ghost busting is a consequence of good monetary policy.

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## NOTES

1. The *M*1 money stock consists of currency, checkable deposits (including both non-interest-bearing demand deposits and interest-bearing NOW accounts) and travelers checks; its value as of June 1987 was $747 billion. *M*2 consists of *M*1 plus a much larger quantity of savings-type accounts, including ordinary passbook accounts and certificates of deposit (in amounts up to $100,000), money market deposit accounts and money market mutual funds (both of which can have limited checking facilities), and overnight repurchase agreements and Eurodollars; its June 1987 value was $2.8 trillion. *M*3 consists of *M*2 plus institutionally oriented instruments like certificates of deposit in amounts over $10,000 and money market mutual funds used by institutional investors, as well as repurchase agreements and Eurodollars extending beyond overnight; its June 1987 value was $3.6 trillion.
2. See, for example, De Rosa and Stern (1977) and Lombra and Moran (1980).
3. The official *M*1 target range for 1979 was 5–8 percent.
4. Increased short-run volatility of short-term interest rates, as a result of no longer accommodating temporary disturbances affecting money demand, is a straightforward implication of Poole's (1970) analysis of the money growth target strategy for monetary policy. Whether long-term interest rates should be expected to be more or less volatile is a more complicated question, however, involving changing risk factors and expectations of future inflation and interest rates.
5. The 1969 legislation under which the Board acted was quite far reaching, empowering the Federal Reserve Board, whenever explicitly authorized by the President, to "prohibit or limit any extensions of credit under any circumstances the Board deems appropriate." In 1980 the Board

proceeded under this authority to impose special reserve-type requirements on increases in certain kinds of consumer credit by all lenders (including non-banks), on increases in deposits at money market mutual funds, and on increases in non-deposit liabilities at banks that were not members of the Federal Reserve System.

6. In 1983 the stated target range for *M*2 growth covered only part of the year.
7. The standard reference to state first is the contrast between the findings in Goldfeld (1973) and Goldfeld (1976). The most widely read studies done at the time by the Federal Reserve's own staff include Enzler et al. (1976), Porter et al. (1979), and Simpson and Porter (1980).
8. I owe the analogy to William Bennett.
9. The specific results cited here are from Goldfeld and Sichel (forthcoming), which also provides an extensive survey. Roley (1985) also showed the results of experimenting with a wide variety of alternative specifications.
10. See, for example, the differing results reported in Friedman (1986), Eichenbaum and Singleton (1986), and Stock and Watson (1987).
11. Friedman made the some prediction more forcefully in writings directed at broader audiences. In a column in the September 26, 1983 issue of *Newsweek,* for example, Friedman wrote, "Inflation has not yet accelerated. That will come next year, since it generally takes about two years for monetary acceleration to work its way through to inflation . . . The monetary explosion from July 1982 to July 1983 leaves no satisfactory way out of our present situation . . . The result is bound to be renewed stagflation—recession accompanied by *rising* inflation and high interest rates." A lengthy interview in the March 19, 1984, issue of *Fortune* indicated that Friedman ". . . also sees a strong possibility that by the end of [1984] inflation could reach an annual rate as high as 9%."
12. There are several obvious problems with attempting to measure the relevant concept of credit in this way. One is simply that the available data measure long-term debts at par value rather than at market prices (or some equivalent for nonmarketable debts). Another is that, although the category of "nonfinancial" borrowers excludes any entity explicitly set up as a financial intermediary, there is inevitably some degree of double-counting due to what amounts to financial intermediation carried out by ordinary businesses and even individuals. Whether this problem is more or less severe than comparable problems affecting the monetary aggregates—for example, the apparently widespread use of U.S. currency in black markets around the world, or even in the United States for a variety of purposes not related to familiar theories of demand for money—is an empirical question.
13. The one exception is the farm sector.
14. For the five years 1978–82, the simple correlations among the fourth-quarter-over-fourth-quarter growth rates of the major M's were each *negative:* –.53 between *M*1 and *M*2, –.57 between *M*1 and *M*3, and –.12 between *M*2 and *M*3.
15. A "point year" of unemployment is one percentage point of unemployment in excess of the rate that corresponds to "full employment," maintained for one year. Some writers—for example, Fischer (1985)—have focused on real output rather than unemployment, and have argued on that basis that the post-1980 disinflation involved smaller costs than Okun's survey implied. The focus of the evidence that Okun surveyed was the inflation-unemployment relationship, however. His translation of the cost estimate into foregone real output simply relied on the usual three-for-one "Okun's Law" relation, which has not held up during the 1980s.
16. See, for example, Sachs (1985) for an analysis of the importance of the dollar's appreciation in the U.S. disinflation.
17. See Solomon (1986) for a review of the nineteenth century experience.
18. The official accounts include numerous obvious mismeasurements, but there is no ground for claiming that their sum is very different from zero. The largest adjustments in favor of the United States in a set of true accounts would be the revaluation of U.S. gold stocks, and of the net of U.S. direct investment abroad and foreign direct investment in the United States, to current market values. The largest adjustments against the United States would be the revaluation

to market value of U.S. banks' loans to developing countries, and allowance for the accumulation over time of each year's "errors and omissions" flow.

19. These data are from Scholl (1987), Table 1.
20. The effect is analogous to what is sometimes claimed along the lines that open market purchases would lead investors to sell long-term bonds out of fear that the resulting increase in money growth would bring higher inflation. Market experience in the United States has not borne out this earlier line of reasoning, but there appears to be more evidence to support the effect operating via exchange rates.
21. See Wallich (1984) for a description in different but equivalent terms.
22. See, for example, the descriptions given by Brunner and Meltzer (1964) and Guttentag (1966).

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## NOTES

1. A more thorough discussion of the issues presented here can be found in Lawrence J. Christiano and Terry J. Fitzgerald, "Understanding the Fiscal Theory of the Price Level," Federal Reserve Bank of Cleveland, *Economic Review,* vol. 36, no. 2 (2000 Quarter 2), pp. 3–38.
2. In this *Commentary,* we assume that complete price stability is desirable. Some research suggests this may not be the case—some price variability may be desirable. In fact, one argument in the fiscal theory literature is that it may generate an optimal degree of price instability. See Christiano and Fitzgerald (2000) for a discussion of this point.
3. This discussion is based on the classic analysis in Thomas Sargent and Neil Wallace, "Some Unpleasant Monetarist Arithmetic," Federal Reserve Bank of Minneapolis, *Quarterly Review,* vol. 5, no. 3 (1981), pp. 1–17.
4. Here we assume the economy is on the "right" side of the Laffer curve, where seignorage is an increasing function of the inflation rate.
5. The Microsoft example is taken from John Cochrane, "Money as Stock: Price Level Determination with No Money Demand," National Bureau of Economic Research, Working Paper no. 7498, January 2000.
6. We follow Sargent and Wallace in thinking of the game of chicken as reflecting that the actions of the fiscal authority can force, as a matter of feasibility, the monetary authority to increase the money supply. Under the fiscal theory, the fiscal authority's actions may also affect the actions of the monetary authority, but this is a matter of the monetary authority's preferences and not feasibility. For example, the monetary authority may want to swerve in our example, even though it is feasible not to, because it may not like the outcomes when it does not swerve. Fleshing this out requires specifying the preferences and objectives of the monetary and fiscal authorities.
7. This result is due to Michael Woodford.
8. Exploding debt is not envisioned under the fiscal theory. The idea is that as long as there is absolutely no doubt about the government's commitment to not adjusting policy in the face of exploding debt, prices will respond so that the debt does not explode in the first place.
9. John Cochrane argues that the fiscal theory can explain the behavior of inflation over the entire postwar period in "A Frictionless View of U.S. Inflation," in Ben S. Bernanke and Julio Rotemberg, eds., *NBER Macroeconomics Annual,* Cambridge, Mass.: MIT Press, 1998. In a comment on that article, Michael Woodford indicates the fiscal theory may provide a good explanation for the 1970s, but he is more skeptical that it characterizes the 1980s and 1990s, in part for the reasons given in this *Commentary.*

## NOTES

1. See Bank for International Settlements, *Central Bank Survey of Foreign Exchange and Derivatives Market Activity.* Basle: BIS, May 1996; and International Monetary Fund, *Direction of Trade Statistics Yearbook, 1997.* Washington, D.C.: IMF, 1997, p. 2.
2. See Kenneth A. Froot and Kenneth Rogoff, "Perspectives on PPP and Long-Run Real Exchange Rates," in Gene M. Grossman and Kenneth Rogoff, eds., *Handbook of International Economics,* vol. 3, part 2. Amsterdam: North-Holland, 1995, pp. 1647–88.
3. The price indexes used to calculate PPP usually include traded and nontraded goods. Deviations between the prices of these goods within a single country can affect calculated values of the real exchange rate.
4. The balance of payments, as presented in table 1, records international transactions on a nominal basis. I assume throughout this section that all transactions are measured on a real (constant-price) basis.
5. See Jeffrey A. Frankel and Andrew K. Rose, "Empirical Research on Nominal Exchange Rates," in Gene M. Grossman and Kenneth Rogoff, eds., *Handbook of International Economics,* vol. 3, part 2. Amsterdam: North-Holland, 1995, pp. 1689–729.
6. See Gregory P. Hopper, "What Determines the Exchange Rate: Economic Factors or Market Sentiment?" Federal Reserve Bank of Philadelphia, *Business Review* (September/October 1997), pp. 17–29.

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## NOTES

1. Table 1 shows that the cross-country mean of inflation exceeded the median for each decade. This property reflects the skewing of inflation rates to the right, as shown in Figure 1. That is, there are a number of outliers with positive inflation rates of large magnitude, but none with negative inflation rates of high magnitude. Because this skewness increased in the 1980s, the mean inflation rate rose from the 1970s to the 1980s, although the median rate declined.
2. See, for example, Okun (1971) and Logue and Willett (1976).
3. See, for example, Barro (1996).
4. The actual rate is slightly higher because the observed growth rates are averages over periods of 10 or 5 years. See Barro and Sala+Martin (1995, p. 81).
5. Human capital is measured as the overall estimated effect from the levels of school attainment and the log of life expectancy.
6. This estimate is similar to that reported by Fischer (1993, Table 9). For earlier estimates of inflation variables in cross-country regressions, see Kormendi and Meguire (1985) and Grier and Tullock (1989).
7. The residual is computed from the regression system that includes all of the variables, including the inflation rate. But the contribution from the inflation rate is left out to compute the variable on the vertical axis in the scatter diagram. The residual has also been normalized to have a zero mean.
8. This system includes on the right-hand side standard deviations of inflation measured for the periods 1965–75, 1975–85, and 1985–90. These variables are also included with the instruments.
9. Bade and Parkin (1982); Grilli, Masciandaro, and Tabellini (1991); Cukierman (1992); and Alesina and Summers (1993).
10. Cukierman's (1992, chapter 20) results concur with this finding, especially for samples that go beyond a small number of developed countries, the kind of sample used in most of the literature on central bank independence.
11. Cukierman et al. (1993) use as instruments the turnover rate of bank governors and the average number of changes in bank leadership that occur within six months of a change in government. These measures of actual bank independence have substantial explanatory power for inflation but would not tend to be exogenous with respect to growth.
12. I have carried out SUR estimation of a panel system with the inflation rate as the dependent variable (for 1965–75, 1975–85, and 1985–90), where the independent variables are lagged inflation and the other instrumental variables used in Table 2. The estimated coefficient of lagged inflation is 0.74 (0.06). The only other coefficients that reach marginal significance are for log (GDP), 0.037 (0.019); the blackmarket premium, 0.059 (0.033); the change in the terms of trade, −0.40 (0.22); and the rule-of-law index, −0.009 (0.005). The $R^2$ values for the three periods are 0.55, 0.24, and 0.37.
13. For discussions of the CFA Franc zone, see Boughton (forthcoming) and Clement (1994). The zone maintained a fixed exchange rate with the French Franc for 45 years until the devaluation

from 50 to 100 CFA Francs per French Franc in January 1994. At the time of the devaluation, the zone covered 14 African countries grouped around three central banks: the West African Monetary Union of Benin. Burkina Faso. Ivory Coast. Mali. Niger. Senegal. and logo; a group of central African countries consisting of Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, and Gabon; and the Comoros. Some original members of the zone left to establish independent currencies—Djibouti in 1949, Guinea in 1958, Mali in 1962 (until it rejoined in 1984), Madagascar in 1963, Mauritania in 1973, and the Comoros in 1981 (to set up its own form of CFA franc). Equatorial Guinea, which joined in 1985, is the only member that is not a former colony of France (and not French speaking).

14. See Schwartz (1993).
15. The seven in the sample are Barbados, Dominican Republic (attributed to France rather than to Spain; see the notes to Table 5), Guyana, Haiti, Jamaica, Suriname, and Trinidad and Tobago. Five other former British colonies in Latin America that are not in this sample—Bahamas, Belize, Grenada, St. Lucia, and St. Vincent—experienced the relatively low average inflation rate of 6.9 percent from 1970 to 1990.
16. These four are Angola, Cape Verde, Guinea-Bissau, and Mozambique. Data are unavailable for Cape Verde and Guinea-Bissau in the 1960s (prior to independence). The figures for Angola in the 1980s are rough estimates.
17. I have carried out SUR estimation of a panel system with the inflation rate as the dependent variable (for 1965–75, 1975–85, and 1985–90), where the independent variables are the two colony dummies and the other instrumental variables—mainly lagged variables—used in Table 2. This system excludes lagged inflation (see footnote 12). The estimated coefficient on the Spain-Portugal colonial dummy is 0.14 (0.03) and that on the dummy for other colonies is 0.11 (0.05). The $R^2$ values are 0.38 for 1965–75, 0.14 for 1975–85, and 0.10 for 1985–90. Thus, inflation is difficult to explain, especially if most contemporaneous variables and lagged inflation are excluded as regressors. Two variables that are sometimes suggested as determinants of inflation—trade openness (measured by lagged ratios of exports and imports to GDP) and country size (measured by log of population)—are insignificant if added to the system. Years since independence also has no explanatory power for inflation. This result may arise because the former colonies of Spain and Portugal in Latin America became independent at roughly the same time.
18. See, for example, the results in Barro 1991.
19. In the model, the fall in the growth rate by 0.2 percent to 0.3 percent per year applies on impact in response to a permanent increase in the inflation rate. The growth rate would also decrease for a long time thereafter, but the magnitude of this decrease diminishes toward zero as the economy converges back to its (unchanged) long-run growth rate. Hence, in the very long run, the effect of higher inflation is a path with a permanently lower level of output, not a reduced growth rate. The numerical estimates for the reduced level of output after 30 years take account of these dynamic effects. The calculation depends on the economy's rate of convergence to its long-term growth rate (assumed, based on the empirical estimates, to be 2 percent to 3 percent per year). Also, the computations unrealistically neglect any responses of the other explanatory variables, such as the human-capital measures and the fertility rate.

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## NOTES

1. This explanation has been articulated in a number of recent papers. See, for example, Azariadis and Smith (1996), Boyd and Smith (1998), and Schreft and Smith (1998 and 1994).
2. The same phenomena we report here occur in the presence of a costly state verification problem (Boyd and Smith forthcoming), or in a model where spatial separation and limited communication affect the financial system (Schreft and Smith 1998 and 1997).
3. In particular, in the absence of financial market frictions, our model reduces to one in which higher rates of inflation (easier monetary policy) stimulates real output growth. This occurs in a variety of monetary growth models: see Mundell (1965); Tobin (1965); Diamond (1965); or especially Azariadis (1993) (for an exposition); Sidrauski (1967); and Shell, Sidrauski, and Stiglitz (1969).
4. See Azariadis and Drazen (1990) for one of the original theoretical expositions of development traps.
5. If $\rho \geq 0$, our analysis is a special case of that in Azanadis and Smith (forthcoming). We therefore restrict attention here to $\rho < 0$. The assumption that $\rho < 0$ holds implies that the elasticity of substitution between capital and labor is less than unity. Empirical evidence supports such a supposition.
6. It is easy to verify that this assumption implies no real loss of generality.
7. This assumption implies that all capital investment must be externally financed, as will soon be apparent. This provides the link between financial market conditions and capital formation that is at the heart of our analysis.
8. Risk neutrality implies that there are no potential gains from the use of lotteries in the presence of private information.
9. The hallmark of models of credit rationing based on adverse selection or moral hazard is that different agents have different probabilities of loan repayment and hence regard the interest rate dimensions of a loan contract differently. See, for instance, Stiglitz and Weiss (1981) or Bencivenga and Smith (1993). Ours is the simplest possible version of such a scenario: Type 2 agents repay loans with probability one, while type 1 agents default with the same probability. Matters are somewhat different in models of credit rationing based on a costly state verification problem in financial markets. See, for instance, Williamson (1986 and 1987) and Labadie (1995). We will discuss such models briefly in the conclusion.
10. For models of informational frictions that do generate debt and equity claims, see Boot and Thakor (1993), Dewatripont and Tirole (1994), Chang (1986), or Boyd and Smith (1995a and b).
11. For a canonical adverse selection model, see Rothschild and Stiglitz (1976).
12. It is easy to verify that nondissembling type 1 agents will not wish to borrow if $R_{t+1} \geq \max(r_{t+1}, x)$. This condition will hold in equilibrium.
13. See Rothschild and Stiglitz (1976), or in this specific context, Azariadis and Smith (1996).
14. See equation 6.
15. An additional requirement of equilibrium is that intermediaries perceive no incentive to "pool" dissembling type 1 agents with type 2 agents and to charge an interest rate that compensates for the defaults by dissembling type 1 agents. Azariadis and Smith (forthcoming) show that there is no such incentive if $f'(k_{t+1}) \leq r_{t+1}/(1 - \lambda)$ holds for all $t$.
16. See, for example, Diamond (1965), Tirole (1985), or Azariadis (1993, chapter 26.2).
17. See, for instance, Diamond (1965), Tirole (1985), or Azariadis (1993, chapter 26.2).
18. In this analysis, inflation is inversely related to the return on real balances and hence to the return on savings. However, the intuition underlying our results is not dependent on real balances

earning the same real return as other savings instruments. Higher inflation will also reduce the return on savings in economies where nominal interest rate ceilings bind or where binding reserve requirements subject intermediaries to inflationary taxation. Binding interest rate ceilings and reserve requirements are very common in developing countries and are hardly unknown in the United States. Finally, our empirical results do support the notion that higher inflation does reduce the real returns received by investors (see the section on some empirical evidence).

19. Clearly $1/x > (1 - \lambda)/\lambda x$ can hold only if $\lambda > 0.5$. Equation a4 obviously implies this.
20. Equation 32 holds if and only if equation A19 holds, as established in the Appendix section on the existence of steady-state equilibria. Thus A19 gives a primitive condition under which Case 1 obtains.
21. The Appendix section that covers Result 6 proves that there are at most two intersections and that there are exactly two intersections in this particular case.
22. The existence of two saddles is possible because dynamical equilibria follow different laws of motion depending on whether a Walrasian regime or a regime of credit rationing pertains.
23. Except, possibly, for their initial capital stocks.
24. Strictly speaking, in any steady state with credit rationing, it is necessary that intermediaries perceive no arbitrage opportunities associated with "pooling" type 2 and dissembling type 1 agents (see footnote 11). The Appendix establishes that intermediaries perceive no such incentive, for any value of $\sigma \in [\underline{\sigma}, \bar{\sigma}]$, so long as $-\rho/x \leq \sigma^{-2}$ and $\underline{\sigma}^2 \geq (1 - \lambda)\,\hat{\sigma}^2$ both are satisfied.
25. For both outcomes to be consistent with positive levels of real balances, it is necessary that $(1 - \lambda)/x\lambda < \sigma^-$ holds. The Appendix establishes that $(1 - \lambda)/x\lambda < \sigma^-$ holds if either equations A27 or A28 and A29 are satisfied.
26. However, increases in $\sigma$ can still result in a reduction in the steady-state capital stock if they induce transitions from the Walrasian to the credit rationing regime. The current analysis provides no guidance as to when such transitions might or might not occur.
27. Obviously we are assuming here that $\sigma_c > \bar{\sigma}$.
28. As we have seen, this is true along either branch of the steady-state equilibrium correspondence if $\sigma < \bar{\sigma}$. The statement in the text does require some qualification, though. In particular, as noted above, if higher inflation causes the economy to shift from the Walrasian to the credit rationed equilibrium for $\sigma < \bar{\sigma}$. then an increase in the inflation rate can cause long-run output to fall.
29. Data sources are listed in the Appendix.
30. We also ran the regressions reported without removing the sample means. This led to no differences in results.
31. Boudoukh and Richardson (1993), using a much longer time series, also find that higher rates of inflation have reduced real stock market returns in the United States and in the United Kingdom.
32. Further evidence on this point appears in Boyd, Levine, and Smith (1995).
33. See Boyd, Levine, and Smith (1995).

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## NOTES

1. Gordon Matthews, "Brace Yourself: 10 Out of 10 Economists Expect Fed Hike," *American Banker,* May 19, 1997.
2. Art Pine, "Wary Fed Decides against Interest Rate Hike for Now," *Los Angeles Times,* May 21, 1997.
3. "Potential" GDP growth is typically taken to be synonymous with "long-run average" GDP growth. Economists often refer to this as the "steady-state" rate.
4. In equilibrium, supply equals demand. More specifically, we are describing a condition in which prices rise precisely because money would be in excess supply if they didn't.
5. More detailed accounts of the simple, and thoroughly standard, theory discussed in this section can be found in almost any introductory economics textbook. See, for example, Alan Stockman, *Introduction to Economics,* Fort Worth: Dryden Press, 1996, chapter 27.
6. A simple example clarifies the distinction between nominal and real variables. Suppose that the money supply consists solely of dollar bills. The nominal supply of money would then just be the number of dollar bills in circulation. The real money supply would be the nominal stock ex-

pressed in terms of "purchasing power": How many units of goods and services can be purchased with the stock of money? For example, suppose that the stock of money, $M$, is \$5 million, and the price level, $P$, is 2. Because the price level is the number of units of money required to purchase one unit of output, the real stock of money (in units of output) is $5/2 = 2.5$.

7. This statement—which implicitly invokes the economist's standard "all-else-equal" clause—is not meant to minimize the difficulties inherent in controlling the money supply.
8. To be a bit more precise, opportunity cost is typically measured as the difference between the return on short-term Treasury securities and a measure of the return on a particular monetary aggregate, such as M2. For a recent discussion of the operational relationship between money and opportunity cost, see John B. Carlson and Benjamin D. Keen, "M2 Growth in 1995: A Return to Normalcy?" Federal Reserve Bank of Cleveland, *Economic Commentary,* December 1995.
9. There is another possible source for rising interest rates: rising expectations of inflation. The role of inflation expectations can significantly complicate the simple theory presented here and make things difficult indeed for monetary policymakers.
10. For a more complete discussion of Okun's law, see David Altig, Terry Fitzgerald, and Peter Rupert, "Okun's Law Revisited: Should We Worry about Low Unemployment?" Federal Reserve Bank of Cleveland, *Economic Commentary,* May 15, 1997.

## NOTES

1. For a comprehensive discussion of the rationale for and features of inflation targets, see Bernanke, Laubach, Mishkin, and Posen.
2. See Kahn for a summary of views about how central bankers should define price stability for monetary policy purposes.
3. Proponents counter that inflation targets merely keep discretionary policy actions consistent with long-run goals and therefore do not prevent policymakers from countering short-run disturbances (Bernanke and Mishkin, 1997).
4. This does not imply that central banks that do not have inflation targets are not accountable. For example, in the United States, the Federal Reserve Board of Governors is required to submit a report on the economy and the conduct of monetary policy twice a year to Congress. In addition, the Chairman of the Federal Reserve Board of Governors is called to testify on the report before the Senate Committee on Banking, Housing, and Urban Affairs, and the House Committee on Banking and Financial Services.
5. For a discussion of the effects of oil prices on inflation see Kahn and Hampton.
6. Evidence on whether inflation targets have increased credibility and therefore reduced the cost of disinflation is inconclusive (Johnson).
7. Some countries, such as Sweden, set an initial target that remains in place today.
8. Credit services represent the consumer cost of repaying debt and therefore fluctuate with interest rates.
9. The bank monitors a variety of indicators to help its policy decisions. The main focus is on estimates of excess demand or supply in goods and labor markets. Other variables, such as the growth rates of monetary aggregates, credit, total spending, and wage settlements, are used as additional guides for policy decisions (Freedman 1995a).
10. The Chancellor has changed the interpretation of targets three times: In October 1992 (range between 1 percent and 4 percent), June 1995 (at or below 2.5 percent, acknowledging that shocks can make inflation move between 1 percent and 4 percent), and June 1997 (2.5 percent, acknowledging that shocks can make inflation move plus or minus 1 percent). The targets are valid from the announcement date onward.

11. The bank typically publishes a short-term forecast and an approximately two-year-ahead forecast. The forecasting horizon has been extended some recently.
12. Prior to the bank's operational independence in May 1997, the Governor met with the Chancellor on a monthly basis.
13. The bank uses several measures of underlying inflation in its analysis. They are used as indicators of inflationary pressures, not as official targets. The "headline" CPI is regarded as the most transparent and unambiguous measure of inflation, which gives it a more objective appeal than other measures, and makes it more suitable for a target (Andersson and Berg; Sveriges Riksbank, March 1998).
14. The output gap measures the divergence of actual production from what is considered its potential level.
15. The Riksbank uses the repo rate (rate at which it agrees to repurchase securities), the lending rate, and the deposit rate for monetary policy purposes (Sveriges Riksbank 1997).
16. The Bank introduced the inflation report initially in October 1993 under the title "Inflation and Inflation Expectations in Sweden," which was published three rather than four times a year (Almeida and Goodhart, Andersson and Berg).
17. For Canada and the UK, the interest rate used as the "official" rate is the rate monitored or controlled by the central bank. For Sweden, the 3-month interest rate was used as a proxy for an official rate because data on official rates were not available. In New Zealand, the discount rate—which moved closely with the 3-month rate over the part of the sample that the 3-month rate was available—was used as a proxy for the official rate because it was the only short-term rate available for the entire sample.
18. In addition, to the extent inflation rose in the period before the introduction of inflation targets, real rates may have been kept too low.
19. This result might be explained by a forward looking monetary policy focused on inflation targets if the unemployment rate helped predict future inflation but other variables did not. Surprisingly, in all countries except New Zealand, the coefficients on lagged inflation were insignificant (and sometimes negative) in the inflation targeting period.
20. Because in Sweden there appears to be a break in the unemployment series in the early 1990s, the regressions were also run using industrial production in place of unemployment. However, in these alternative regressions, industrial production also came in insignificant in both the before and after periods.
21. In New Zealand, the breakpoint also corresponds to the granting of operational independence to the Bank of New Zealand.
22. The UK targeted exchange rates during only part of the sample period before the introduction of inflation targets. Prior to the use of exchange rate targets, the Bank of England targeted various monetary aggregates.
23. When industrial production is substituted for unemployment in the Swedish "before" regression, the Swedish official rate is also persistently over-predicted.
24. It is not clear why the policy reaction function indicates that policy was tightened in Canada in the before period in response to an exchange rate appreciation.

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## NOTES

1. See, for example, Sargent (1982, 1983), Taylor (1982), and Fischer (1986).
2. This idea is the basis for many game theoretic models of credibility in monetary policy. See, for example, Barro and Gordon (1983), Backus and Driffill (1985a,b), Barro (1986), and Cukierman and Meltzer (1986). For an excellent survey of this literature, see Blackburn and Christensen (1989).
3. See Shapiro (1994) for an analysis of the relative success of Federal Reserve attempts to reduce inflation following seven postwar dates marking the start of an explicit disinflationary policy, as identified by Romer and Romer (1989, 1994).
4. For details on monetary policy in the early 1980s, see Friedman (1984). Blanchard (1984). Hetzel (1986), and Goodfriend (1993, 1997).
5. The crucial importance of the fiscal regime in determining the credibility of disinflationary policies is emphasized by Sargent (1982, 1983, 1986). For applications of this idea, see Flood and Garber (1980) and Ruge-Murcia (1995).
6. Other research that applies Bayesian learning to models of monetary policy includes Taylor (1975), Flood and Garber (1980), Backus and Driffill (1985a,b), Barro (1986), Lewis (1989), Baxter (1989), Bertocchi and Spagat (1993), Gagnon (1997), and Andolfatto and Gomme (1997). For related models with least squares learning, see Friedman (1979), Fuhrer and Hooker (1993), and Sargent (1998).
7. We take the starting date of the Volcker disinflation to be October 6, 1979, which coincides with Fed's announcement of a new operating procedure for targeting nonborrowed reserves. This starting date is consistent with the findings of Romer and Romer (1989), who use evidence from the minutes of Federal Open Market Committee meetings to identify October 1979 as a date when the Federal Reserve decided to undertake an explicit disinflationary policy.
8. The approximate dates of these episodes are: (1) December 1979 to February 1980, (2) December 1980 to October 1981, and (3) May 1983 to June 1984.
9. We do not explicitly link the supply shock $\varepsilon_{\pi t}$ to the real price of oil. Fuhrer and Moore (1995a, footnote 15) report that oil prices are uncorrelated with the residuals of their contracting equation, suggesting that their omission does not affect the model's performance. See Bernanke, Gertler, and Watson (1997) for an empirical study of the potential links between oil prices and monetary policy.
10. See Roberts (1997).
11. King and Watson (1994) document the robust negative correlation between inflation and unemployment at business cycle frequencies.

12. The policy rule is similar to one proposed by Taylor (1993), which takes the form: $r_t = (\bar{\rho} + \pi_t) + \alpha_\pi (\pi_t - \bar{\pi}) + \alpha_y \bar{y}_t$, where $\bar{\rho}$ is the steady-state real interest rate. The Taylor rule uses $\bar{\rho} = 0.02$, $\alpha_x = \alpha_y = 0.5$, and $\bar{\pi} = 0.02$. See Taylor (1998) and Judd and Rudebusch (1998) for historical analyses of how policy rules of this form fit U.S. interest rate data.
13. Cukierman and Meltzer (1986) develop a model in which the central bank intentionally adopts an imprecise monetary control process in order to obscure its preferences, and thereby exploit a more favorable output-inflation trade-off.
14. In going from (4) to (5) we have applied the law of iterated mathematical expectations.
15. Since $\bar{u}$ is independent of $\pi_t$, it can be interpreted as the "Natural Rate of Unemployment."
16. It is straightforward to append a money demand equation that determines how much money the Fed must supply in order to achieve the value of $r_t$ given by (3). This would have no effect on the model's dynamics.
17. Evidence that the public perceived the statement in this way can be found in published newspaper reports of the time. See, for example, "Fed Takes Strong Steps to Restrain Inflation, Shifts Monetary Tactic," *The Wall Street Journal,* October 8, 1979, p. 1.
18. See, for example, Walsh (1988).
19. See Svensson (1997) and Ball (1997) for analyses of "efficient" monetary policy rules that minimize a discounted weighted-sum of the variances of inflation and output.
20. See Sargent (1998) for a model that seeks to endogenize the rise and fall of U.S. inflation.
21. See Gagnon (1997) for a univariate model of inflation that relaxes both of the foregoing assumptions.
22. Our solution procedure is described in Section II.
23. The history of inflation *does* influence credibility, however, because it is incorporated into agents' prior beliefs, which are summarized by $P_{t-1}$ in (10).
24. See Ruge-Murcia (1995) for a model where credibility is inferred using joint observations on fiscal and monetary variables.
25. See Anderson (1958), Chapter 6.
26. This property will obtain when the ratios $\left(\int_{-\infty}^{\pi} \ell(z)dz\right)/\left(\int_{-\infty}^{\pi} h(z)dz\right)$ and $(\ell(\pi))/(h(\pi))$ are monotonically decreasing in $\pi$.
27. A similar effect obtains in the models of Fisher (1986), Ireland (1995), King (1996), Bomfim and Rudebusch (1997), and Bomfim, et al. (1997). In these models, credibility is determined by a backward-looking, linear updating rule. In contrast, Ball (1995) models credibility using a purely time-dependent probability measure.
28. We use the Matlab programs developed by Fuhrer and Moore (1995b), as modified to reflect the differences in our model specification and data.
29. The values $\bar{\pi}^H = 0.06$ and $\bar{\pi}^L = 0.03$ are very close to those used by Fuhrer (1996, figure IIb) to help reconcile the pure expectations theory of the term structure with U.S. nominal interest rate data.
30. For studies that explore disinflation dynamics in models subject to stochastic shocks, see Meyer and Webster (1982), Orphanides, et al. (1997), and Bomfim and Rudebusch (1997).
31. The steady states associated with the two reaction functions both exhibit the well-known saddle point property.
32. In contrast, Taylor (1975), Meyer and Webster (1982), Baxter (1989), and Andolfatto and Gomme (1997), among others, consider Bayesian learning models in which agents' expectations do not affect the evolution of the variables they form expectations about. Hence, convergence follows from standard results on the asymptotic properties of estimators.
33. Marcet and Sargent (1989) develop an analytical framework for proving the convergence of "self-referential" models in which the evolution of an endogenous variable is governed by an adaptive learning process.
34. A similar view is put forth by Mankiw (1994), who shows that forecasts made by the Council of Economic Advisers in January 1981 predicted a gradual and moderate decline in the inflation rate, in contrast to the rapid and pronounced disinflation that actually occurred under Fed Chairman Volcker.

35. The Hardouvelis-Barnhart measure of credibility is inversely proportional to the response of commodity prices (such as gold and silver) to unanticipated changes in the M1 money stock.
36. For the parameter values we employ, the model's dynamical system exhibits complex eigenvalues which give rise to damped oscillatory behavior.
37. In the words of Fed Chairman Volcker. "Inflation feeds in part on itself, so part of the job of returning to a more stable and more productive economy must be to break the grip of inflationary expectations." See Volcker (1979), pp. 888–889.
38. Since $r_t$ rises and $\bar{y}_t$ falls, a traditional Keynesian money demand equation with a predetermined price level would imply a contraction of the nominal money stock.
39. See Akhtar (1995) for a survey of the enormous empirical literature on this subject.
40. For a related discussion, see Taylor (1980, section IV).
41. See Gagnon (1996) for some cross-country evidence that inflation expectations exhibit a "long memory" of past inflation.
42. See Romer and Romer (1997) for a discussion regarding the merits of legislated rules and other institutional arrangements for the conduct of monetary policy.

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## NOTES

1. This focus on consumer price inflation stems from the belief that monetary policy can have no effect on real variables over the long run. It is closely akin to the monetarism that Milton Friedman and his colleagues forcefully and eloquently espoused in the 1960s and 1970s in that both offer a relatively straightforward, rules-based approach to policy. While monetarism's simplicity had great appeal, innovation in the financial services industry during the 1980s (for example, the development of money market and sweep accounts and the resulting blurring of distinctions between bank and nonbank financial institutions) increased the variability of velocity and made the monetarist approach impractical for policy purposes. Kindleberger (1978) links monetarism, in turn, to the Currency School of the early 1800s. Thus, the current focus on the consumer price index draws on a long legacy.
2. For example, Stanley Fischer (1996) has suggested that "long-run price stability should be the primary goal of the central bank, with the promotion of full employment and growth being permitted to the extent that they do not conflict with the primary goal." And Goodhart and Viñals (1994) have documented that price stability has become the central bank's primary objective throughout Europe, Canada, and Australia/New Zealand. But, of course, many economists disagree with this prescription, recommending instead that central banks look at both prices and output or at nominal GDP. Moreover, as noted in the text, most statutes that require the monetary authorities to follow an inflation target contain an escape clause in the event that major supply shocks have a severe impact on employment and growth.
3. For example, in 1995 Michael Bruno, then chief economist of the World Bank, wrote, "Very low inflation is again becoming the norm, not only in the industrial world but also in developing regions." After discussing stabilization strategies, like fiscal retrenchment, exchange rate pegs, currency boards, and wage freezes, he argues that "getting inflation down to single digits is important . . . for long-term growth reasons" and cautions that "the upward bias of inflationary persistence argues for keeping the inflation genie tightly in the bottle" (Bruno 1995). In the opening of its May 1997 *World Economic Outlook,* the International Monetary Fund approvingly sees "few signs of the tensions and imbalances that usually foreshadow significant downturns in the business cycle: global inflation remains subdued, and commitments

to reasonable price stability are perhaps stronger than at any other time in the postwar era . . ." (The same overview warns of potential dangers posed by fragile banking systems exposed to large foreign exchange risk by large and possibly unsustainable capital inflows.) Later, the IMF writes, "In Chile, the most *successful* economy in (Latin America), inflation fell to a 36-year low of 6 1/2 percent . . ." (italics added). Rudiger Dornbusch has also described Chile's approach as "exemplary" as it brought annual inflation down from 30 percent in the mid 1980s to 7 percent in the mid 1990s—in part because "the central bank has refused to overreach and squeeze inflation down to the fashionable 2 percent of the industrialized countries." He contrasts Chile with Mexico where he sees "exaggerated emphasis put on inflation, exaggerated urgency to get to 2 percent, dangerous imperviousness to overvaluation." He concludes, "The right message is that inflation must come down and that there is never room for complacency; that is not the same as inflation reduction first, growth later" (Dornbusch 1996).

4. *The Economic Growth and Price Stability Act of 1997* was sponsored by Florida Senator Connie Mack. The bill proposed that an explicit numerical definition of price stability be established, and that the promotion of long-term price stability, so defined, should be the sole mandate of the Federal Reserve System.
5. As of mid 1998, Hong Kong, Malaysia, Indonesia, Thailand, South Korea, and Japan report that their economies have been shrinking since the beginning of the year, Japan by a stunning annual rate of 5.3 percent in the first quarter. Those East Asian economies that managed to maintain some momentum, Taiwan and Singapore, have nonetheless slowed as well. The Philippines economy now has a negative growth rate.
6. Many investors and policymakers—both monetary and supervisory—apparently ignored other, less standard signs of trouble, like soaring ratios of foreign-currency debt to GDP and questionable levels of investment in certain asset markets and industrial sectors. The fact that these countries did not display the symptoms—rapid inflation and large fiscal deficits and "excessive" consumption relative to GDP—seen in the Latin American economies on the brink of their crises was seemingly reassuring.
7. This article uses the term "inflation" to connote consumer price inflation. Price inflation in asset markets will always be referred to as "asset-price inflation."
8. Like any major supply shock, a sharp shift in oil prices pushes employment and price trends in opposite directions, creating a dilemma for monetary policy. But in the 1970s, U.S. inflation probably contributed to the oil exporters' decision to raise prices. Although the precipitating event for the first increase was the Arab-Israeli War, oil is priced in dollars and rising U.S. inflation in the early 1970s had contributed to a nominal depreciation of the dollar and a decline in the value of oil revenues in world markets. The second increase also followed an extended period of rising U.S. inflation and nominal dollar depreciation.
9. In this article, asset prices refer to prices of land, real estate, financial assets such as stocks and bonds, and, on some occasions, the price of foreign currency in terms of domestic currency. Purchases of such assets are often motivated by hopes of capital gains.
10. *The New York Times* of October 22, 1929 reported "Fisher Says Prices of Stocks Are Low: Quotations Have Not Caught Up with Real Values as Yet, He Declares," page 24, col. 1. See also Carosso (1970), pages 300–302.
11. Rising real land prices in the 1970s may reflect the fact that the baby boom cohort began forming households at that time; however, for much of the period, prices for farm properties were rising faster than prices for nonfarm, noncorporate land. The boom in prices for farm land may have been linked to the unusually sharp and temporary rise in prices for foodstuffs in the early years of the decade.
12. The G-7 consists of the United States, Japan, Germany, France, Italy, the United Kingdom, and Canada.
13. The modest pickup in Japanese inflation from 1989 to 1991 reflects several developments, including some one-time factors: the Japanese introduced a consumption tax in 1989; the al-

ready low unemployment rate fell even lower, from 2.8 percent in 1987 to 2.1 percent in 1990; the yen weakened a bit in 1989 and 1990 before resuming its rise in 1991; and bad weather conditions in 1990 and 1991 aggravated the impact of the 1990 oil price increase sparked by the Gulf War. (Japan is highly dependent on imported oil.) (Government of Japan 1998.)

14. For example, chapter four of the IMF's May 1998 *World Economic Outlook* examines indicators of vulnerability to financial crises in 50 advanced and emerging market countries from 1975 to 1997. It finds that "typically, in the lead-up to a currency crisis, the economy is overheated: inflation is relatively high, the real exchange rate is appreciated, the current account deficit has widened, domestic credit had been growing at a rapid pace, and asset prices have often been inflated" (IMF May 1998, page 96).
15. Paul Krugman, Nouriel Roubini, and other commentators in the fundamentals camp argue that the crisis reflected excessive investment fueled, first, by international speculation that drove regional asset values to unrealistic levels, and second, by an East Asian variant of crony capitalism that directed investment to unproductive ends (Krugman 1998). Krugman has further argued that East Asia's spectacular economic growth since the 1960s was based on an accelerated use of the inputs of labor and capital rather than on the absorption of new technology. So, by the 1990s, the pace of the region's growth was likely to slow as diminishing returns set in (Krugman 1994).

    Jeffrey Sachs and Steven Radelet espouse a contrary view, arguing that IMF errors caused a crisis that was, at base, avoidable. After the initial devaluation of the baht in mid 1997, the IMF effectively yelled "fire" by announcing that severe shortcomings in East Asian financial markets would require fundamental restructuring; thus alerted, investors began to run for the exits. But the fundamentals of East Asian economies were sound, in this view, and any vulnerabilities in such sectors as finance or real estate would have been manageable in the absence of the IMF spooking private investors (Radelet and Sachs 1998a, b).
16. Because earnings have been so weak, in recent years P/E ratios have at times surpassed levels seen in the heady days of the late 1980s, even though stock prices are down substantially.
17. Commercial land prices in the six largest cities quadrupled between 1985 and 1989; residential and industrial land prices rose only slightly less rapidly. Prices peaked in 1991 and plummeted in 1992. They then continued to fall steadily. As of late 1997, commercial land prices had almost completely retraced their earlier run-up and were back to levels of 12 years earlier. As for land prices in the smaller cities, the index of commercial land values for 200-plus cities was down "only" 40 percent from its peak, as compared to the 75 percent decline suffered in the largest cities (Japan Real Estate Institute 1998).
18. Remarkably, however, the fraction of GDP devoted to residential investment in Japan surpasses that in the United States, despite the U.S. penchant for large and comparatively luxurious dwellings and the faster U.S. population growth.
19. Starting with a revision of the *Foreign Exchange Control Law* in 1980, Japanese nonbank firms gained increased access to foreign banks and foreign and domestic bond and equity markets, thereby reducing their dependence on the Japanese banks. Until then, financial regulations had ensured that the Japanese banks were the primary beneficiaries of Japan's high savings rate. But the increased competition spurred by financial deregulation broke the banks' cartel. (See Weinstein and Yafey 1998.)
20. See Bank for International Settlements, *67th Annual Report,* page 105.
21. Interest rate deregulation followed the following schedule: November 1991, deposits maturing in three or more years and corporate bonds maturing in two years; November 1993, loans (except government loans) and deposits maturing in two or more years; December 1994, deposits maturing in one or more years; in July 1995, deposits maturing in more than six months and less than one year; and in November 1995, demand deposits of three or more months (W.A. Park 1996).

22. The percentage of securities in banks' assets rose from 19.6 percent in 1990 to 32.4 percent in 1995. Trust accounts, where risky real estate investments could be held without regulatory oversight, also grew as a share of bank assets, from 17.9 percent in 1990 to 34.5 percent in 1995 (W.A. Park 1996).
23. As of 1994, the only restriction on such borrowing was that over half of the loans must have an initial maturity of more than three years. In May of 1995, in an effort to stem domestic investment growth financed by foreign-currency borrowing through domestic banks, the government tightened some of the access regulations, but with little impact on overall borrowing levels (*OECD Economic Survey, Korea,* 1995–1996, p. 136).
24. While improved accounting and disclosure standards are essential to preventing *future* crises, the transition to new standards can be difficult when the slate is not clean. As better information has become available in Asia, it has often alerted investors to the poor quality of credits already extended.
25. The IMF has recently recategorized Hong Kong, South Korea, Singapore, and Taiwan (as well as Israel) as "advanced" countries because their per capita incomes and industrial structures put them on a par with the members of the OECD.
26. Singapore, in contrast, had achieved even higher levels of investment spending in the early 1980s, with almost 50 percent of GDP devoted to capital formation. As this earlier episode ended with a sharp economic downturn and a scaling back of investment's share, it does not provide much support for the sustainability of such spending.
27. Divergence is calculated as $[(X_t - X_{t-3}) - (C_t - C_{t-3})]/E_t$ where $X_t$ is export employment, $C_t$ is employment in construction and $E_t$ is total employment, all in year t. Browne's original analysis looked at the growth in employment in both construction and real estate relative to the growth in export employment. Figure 8 shows only construction employment in order to be comparable with the Asian data, which generally include real estate in another employment category.
28. Effective exchange rates are inflation-adjusted averages of exchange rates for a country's important trading partners.
29. Businesses may also respond to an appreciating exchange rate by increasing foreign direct investment overseas. If so, the resulting shift in labor demand will dampen wage costs and, indirectly, consumer prices in the appreciating country.
30. In time, through wealth and credit channel effects, rising asset prices are likely to lead to somewhat higher prices for the goods and services measured by the consumer price index.
31. European integration has spurred considerable restructuring and increased competition in Europe's financial services sector. These forces may also have encouraged the surge in European lending to emerging markets.
32. Topics of debate include preferred exchange rate regimes, the need for restrictions on short-term capital inflows, the proper approach to financial deregulation and liberalization, and the best response to a combined currency/banking crisis.
33. Mishkin and Posen (1997) explore some of these issues in four countries that have adopted numerical inflation targets for monetary policy, New Zealand, Canada, the United Kingdom, and Germany.

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## NOTES

1. The response of the exchange rate to these different capacity utilization rates is usually left rather unclear in these arguments. Exchange rate movements should moderate any effects on domestic inflation. In fact, inflation rates routinely vary across countries, as do changes in these rates, with exchange rate movements helping to offset these differences.
2. Most of the conclusions in this paper do not depend on which price measure is used, however. The exceptions will be discussed as they arise.
3. The GDP deflator does not include imports directly. The effect of import prices on both U.S. input costs and U.S. export prices, which are included in the deflator, might produce some reaction of the deflator to foreign capacity utilization. However, this effect would be much less direct than the effect on CPI inflation.
4. Examples of this theoretical discussion can be found in Baldwin (1988) and Dixit (1989).
5. Empirical studies of pass-through can be found in Feenstra, Gagnon, and Knetter (1996), Gagnon and Knetter (1995), and Froot and Klemperer (1989), for example.
6. Many countries in Europe have operated well below full employment through most of the 1980s and 1990s. As a result, such estimates of potential output in these countries will tend to be biased down.
7. One drawback to a simple Phillips curve is that other forces besides each country's domestic capacity could affect inflation, such as oil price shocks or the sources investigated in this paper, import prices.
8. Data on unemployment and inflation rates for some of the currently important exporters to the United States, such as Mexico and China, are unreliable or unavailable for much of the sample. These countries were also much smaller exporters to the United States in the early part of the 1971–96 sample.
9. The data show that with more than 90 percent certainty the unemployment rate in France is an important determinant of its domestic inflation.

10. In fact, examining different specifications for the Phillips curve, such as estimates including oil price shocks, did not significantly alter the estimates of the NAIRUs, even though their inclusion often helped lower the standard errors.
11. Non-oil import prices could also depend on lagged prices and should depend on the exchange rate. Which prices to use—lagged import prices or lagged trade-weighted foreign prices, for example—is unclear. Both of these price measures were also included in this standard specification, along with the trade-weighted value of the dollar, with no effect on the results.
12. Note that any effect of import prices on U.S. capacity will be captured in the estimation through the unemployment rate. Also, Nixon and Nixoff are dummy variables capturing the quarters when wage and price controls were instituted and released.
13. A specification that examined relative price shocks, both import price inflation and oil import price inflation relative to U.S. inflation, was also tested. The results were identical.
14. The shares were based on total U.S. imports from these six countries, so they always summed to one. As a result, there is no trend in the foreign excess capacity variable due to any possible trend in the weights, although this share appeared to be relatively constant around 50 percent.
15. A longer sample was used when estimating the foreign NAIRUs since the import weights were not needed. The longer sample provides more information about each country's NAIRU.
16. The significance is unaffected by the number of lags of foreign capacity included in the equation. Since two lags of the trade-weighted foreign capacity variable are included, the log likelihood ratio testing whether we can reject that the coefficients on the foreign capacity are equal to zero is distributed as a chi-square with two degrees of freedom. The critical value for this ratio is 7.38. Its actual value is 2.8, providing little support that the coefficients are different from zero. In general, this result holds for other inflation measures. For the preferred specification of the chain GDP deflator, the total CPI, core PPI, and the deflator on personal consumption expenditures, foreign capacity has no statistically significant effect. Only for total PPI does foreign capacity appear significant. However, there is little evidence of a robust relationship between these foreign capacity measures and U.S. inflation.
17. In column 3, U.S. inflation is estimated as a linear function of the U.S. unemployment rate and a nonlinear function of the trade-weighted foreign unemployment gap; as a result, the coefficients are not comparable. The linear form is maintained for the U.S. unemployment rate, as it appears to fit the data better.
18. The critical value for the significance of the coefficient on foreign capacity is 7.38, and the log likelihood ratio remains far below that value, at 3.8.
19. The NAIRUs of our six major trading partners were reestimated over the shorter sample because of the concerns that the NAIRUs in Europe rose substantially in the shorter period. Only the estimate of the NAIRU in Italy rose significantly. The results are identical when the NAIRU estimates from the longer sample are used.
20. The critical value for accepting the importance of foreign capacity utilization in U.S. inflation in the shorter sample is 7.38. The actual value of the log likelihood ratio is 6.26, rejecting that foreign capacity plays an important role in the determination of U.S. inflation. The rejection is stronger if the sample begins in 1980.
21. The log likelihood ratio is distributed as a chi-square with two degrees of freedom. Its critical value is 7.38, while the ratio's actual value is 4.08.
22. The log likelihood ratio is again distributed as a chi-square with two degrees of freedom. Its critical value remains 7.38, while its actual value over this shorter sample is 2.96.
23. All the import price inflation regressions were also estimated including the trade-weighted exchange rate. These results are less relevant for this study since it is the total derivative of import prices and foreign capacity utilization that we are concerned about, not its partial derivative holding the change in the exchange rate constant. However, when the exchange rate was included in the import price inflation regressions reported in the text, the foreign capacity variable was more apt to reveal a significant effect on U.S. import prices, although the effect was not very robust to different samples or specifications.

24. The results are identical over the sample examined in Tables 2, 3, and 4, however.
25. The constraint on the coefficients on the lagged price variables in the Phillips curve is invalid if a subcomponent of the index is run independently. However, as will be discussed later, the import deflator prices do differ from the consumer prices, so the import prices are not exactly a subcomponent. Furthermore, examining import price inflation relative to U.S. inflation has no effect on the results.
26. Since four lags of all the import price inflation indexes were examined, the likelihood ratio is distributed as a chi-square with four degrees of freedom, the critical value of which is 11.1. The actual value for the log likelihood ratio for the test of the significance of the coefficients on oil import price inflation is 16.02. The value of the likelihood ratio testing whether non-oil import price inflation adds to the Phillips curve is 6.52, well below the critical value of 11.1.
27. The tests in Table 5 were performed with other measures of U.S. inflation. The results examining total CPI and the deflator for consumer expenditures were consistent with the results above; a specification with a statistically selected lag length of past inflation rates always rejects the importance of non-oil import price inflation in these other consumer price measures. The importance of the non-oil import prices in the PPI is consistently rejected over various specifications and samples. Over some specifications, there is some evidence that non-oil import prices influenced inflation of the GDP deflators, both the fixed-weight and the chain-weighted deflators. Since GDP inflation measures include no imported goods directly, the result might appear surprising. However, the close correlation between export and import prices could explain the result. Even with the GDP deflators, the importance of non-oil import prices is not robust to different specifications of the lags in the prices used or the sample selected. Other inflation measures do not offer strong evidence of a relationship between non-oil import prices and U.S. inflation.

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## NOTES

1. The idea that value is fixed by labor effort, called the "labor theory of value," is now generally discredited by economists. Still, we make clear distinctions between a good's real cost and its money cost.
2. Western economists of the time were certainly aware of paper money. Chinese notes called "chao" were known to have been used as early as the ninth century (they were also said to have depreciated rapidly in value).
3. A common lament in the New World was that paper money was necessary because of a lack of metallic coins.
4. Some historians note that the decision to issue continental currency was made in the conventions that occurred prior to the establishment of the Continental Congress.
5. See Charles J. Bullock, *Essays on the Monetary History of the United States,* New York: Macmillan, 1990, pp. 64–5.
6. The French also issued a paper money—"assignats"—around the time of their Revolution, with a similar result: They, too, rapidly lost their purchasing power. The French experience with paper money gave rise to the saying, "After the paper money machine comes the guillotine."
7. Bank notes were taxed out of existence by an act of Congress in 1865.
8. This is the earliest reference to *inflation* in the Federal Reserve Bank of Cleveland's library. *The Oxford English Dictionary* shows the earliest reference to be from D. D. Barnard (1838): "The property pledge can have no tendency whatever to prevent an inflation of the currency."
9. *Gold and the Currency: Specie Better than Small Bills.* Boston: Evans and Plumber, 1855.

10. However, "sound money man" Horatio Seymour, the reluctant Democratic candidate for the presidency in 1868, is said to have indicated that if elected, he would not support the plan.
11. Similar in spirit are the following:

> . . . we must distinguish between inflation and the rise in prices. The one is not necessarily synonymous with the other . . . An alteration in the general price level accordingly means a change in the relation between goods on the one hand and money on the other. Obviously, however, such a change in the relation may be ascribable, in its origin, to either of the two elements, the goods or the money.
>
> —Edwin R. A. Seligman (1921)

> Either the rise in prices might be due to the scarcity of goods or it might be due to the superabundance of money, but as a matter of actual historical fact it is, so far as I know, universally true . . . that it is the change in the money that makes the changes in the value of the money, and not changes in the goods.
>
> —Irving Fisher

## NOTES

1. See, for example, Jones and Manuelli (1990), Barro (1991), and Rebelo (1991).
2. Fischer (1991).
3. Jones and Manuelli (1990) and Gomme (1991) are exceptions.
4. See, for example, Fischer (1993).
5. The cross-sectional average of the time-series average rates of per capita income growth in the Summers and Heston (1991) data is around 1.92 percent per year.
6. Some studies do not arrive at this conclusion. McCandless and Weber (1995) find no correlation between inflation and the growth rate of output. See also Levine and Renelt (1992).

7. See also Grier and Tullock (1989).
8. Although we do not study the relationship between inflation volatility and growth here [as does Gomme (1991), theoretically], empirical studies have found that more volatile monetary policies also have depressing effects on growth rates. See Kormendi and Meguire (1985), Fischer (1993), and Easterly et al. (1994). One must be careful interpreting this relationship, however, since there is a high correlation between the average inflation rate experienced over the period in a country and the volatility of the inflation rate. This correlation is reported to be 0.97 in Levine and Renelt (1992).
9. Although these are important differences, one must be careful in interpreting this evidence. As discussed in Levine and Renelt (1992), a high degree of multicollinearity exists between many of the regressors that authors include in these studies. Hence, most of the empirical findings are nonrobust in the Learner sense.
10. See Stockman (1981) and Cooley and Hansen (1989).
11. For a detailed development of the key issues, see Jones and Manuelli (1990) and Rebelo (1991).
12. See the Appendix for a description of the technologies and preferences.
13. See Rosen (1976).
14. See Benhabib and Perli (1994) and Ladron-de-Guevara, Ortigueira, and Santos (1994).
15. See Jones and Manuelli (1990) for details.
16. Chari, Christiano, and Eichenbaum (1995).
17. Chari, Christiano, and Kehoe (1994).
18. Chari, Christiano, and Kehoe (1991).
19. Jones, Manuelli, and Rossi (1993).
20. Chari, Christiano, and Kehoe (1994).
21. Jones, Manuelli, and Rossi (1993).
22. We run several experiments to test the robustness of our results to our choice of parameters. For these experiments, we use the Lucas model of growth along with the CIA in everything model of money demand. First, we estimate the length of a period using the Nilson Report's (1992) numbers on the fraction of transactions that are completed using cash. The Nilson Report does not say exactly what transactions are included in its measure of all transactions. We calibrate the model two different ways: We assume that transactions on $x_h$ are and are not included in the calculations. These calibrations produce estimates of the period length of 1.63 months and 1.02 months, respectively. In addition, we (as did Chari, Christiano, and Kehoe, 1994) try lowering our parameter that determines the elasticity of the labor supply $\psi$ to the level 2, while allowing the potential workday to vary. Finally, we change the elasticity of substitution between cash goods and credit goods from –0.83 to –0.2. None of these experiments results in a significant change in the growth effect of inflation. Details of these experiments are available from us upon request.
23. Economic Report of the President (1994).
24. Economic Report of the President (1994).
25. Porter (1993).
26. Economic Report of the President (1994).
27. See issues of the U.S. Department of Commerce's Survey of Current Business (1992).
28. For the purposes of calibration, our Ak model is a version of the Lucas model in which the labor supply is inelastic. This model has all the important qualitative features of the Ak model, but it allows labor share and investment rates to be chosen so as to be close to those seen in the U.S. time series. Chari, Jones, and Manuelli (forthcoming) has details.
29. For the CIA in everything versions of the models, we assume that all of $c_1$ and a fraction $\epsilon$ of the $c_2$ and $x_k$ expenditures used are subject to the CIA constraint. For the results presented in Table 1, we use $\varepsilon = 0.2$, since most investment transactions do not use cash directly. We experiment with increasing $\varepsilon$ over an appreciable range and, although the growth effects are larger with larger $\varepsilon$, they still fall short of the effect seen in the data. In the next section, we discuss a model in which cash is used indirectly for these transactions through the banking system.

30. See Greenwood and Smith (forthcoming) for a survey of the theoretical work in this area. For recent empirical work, see Roubini and Sal-i-Martin (1992), King and Levine (1993), and Ireland (1994).
31. Our model is similar to the one analyzed by Haslag (1994), but ours is more realistic along two dimensions. First, Haslag assumes that all capital must be intermediated through banks, while we allow the share of bank assets to be endogenous. Second, Haslag uses money only to meet reserve requirements, while we use money to facilitate consumption transactions as well. See also Valentinyi (1994).
32. Porter (1993).
33. For details, see Chari, Jones, and Manuelli (1995).

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## NOTES

1. The constant term for the second half is estimated to be just 0.06 lower than the first half, with a standard error of 0.26. The coefficient for the level of the unemployment rate is estimated to be very slightly smaller (0.005 higher, with a standard error of .0.18). The coefficient for the change is estimated to be stronger by 0.48 in the second half, with a standard error of 0.27.
2. The critical value of the F(4.80)-statistic at the 95 percent confidence level is 5.7.
3. A test of this constraint, not reported in Table 1, added CPI inflation to the regression. The estimated coefficient was–0.05 with a standard error of 0.04. In other words, the freely estimated sum of the inflation coefficients is 0.95 and is insignificantly different from 1.0.
4. Rising stock prices mean that employers do not have to contribute as much to fund their plans as they would otherwise.
5. At times changes have been made to the methodology used to measure the Consumer Price Index. In the early 1980s, for example, a switch was made to the calculation of the cost of home ownership, changing to a rental equivalence cost from an estimate of the cost of home purchase. Such changes are thought to have made the CPI a more accurate measure of "true" inflation. However, because the CPI is not revised historically to reflect these methodological enhancements, it does not provide a measure of inflation that is consistent over time.

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## NOTES

1. Dow Jones News Service, January 7, 1997.
2. Our analysis expands on results that we presented in two earlier papers. See Lown and Rich (1997a, 1997b).
3. Gordon (1996), however, obtains an estimate of 5.3 percent for the NAIRU starting in 1996.
4. Gordon's work (1970, 1975, 1977, 1982, 1990) is prominent in the literature on the estimation of the Phillips curve.
5. See King and Watson (1994), Tootell (1994), Fuhrer (1995), King, Stock, and Watson (1995), and Gordon (1996).
6. The estimation of "expectations-augmented" Phillips curves is the result of work by Phelps (1967) and Friedman (1968), who developed the natural rate hypothesis and drew the distinction between the short-run and long-run Phillips curve trade-off.
7. For detailed definitions and sources of data, see the Data Appendix.
8. The results are little affected when the unemployment rate instead of the output gap is used to measure aggregate demand pressure. Potential GDP measures the full-employment level of output or the output level at which there is no tendency for inflation to accelerate or decelerate. The level of potential GDP grows over time because of the increased availability of resources (land, labor force, capital stock, and the level of technology). Because potential GDP is not directly observable, several techniques have been developed to calculate estimates of the series. A complete review of these techniques and an evaluation of the alternative potential GDP series are

beyond the scope of this paper. As noted in the Data Appendix, we employ a staff estimate of potential GDP to construct the output gap variable.

9. Commodity prices and/or an exchange rate term have been used as supply shock variables in some price-inflation Phillips curve models. We do not include these terms in our specification, however, because we found their effects to be small and statistically insignificant. The absence of a strong link between commodity prices and inflation is consistent with evidence presented by Blomberg and Harris (1995), who document a recent decline in the predictive power of commodity prices for inflation.
10. We exclude the net negative real oil price change variable from equation 1 because the variable displays quantitatively and statistically insignificant effects.
11. The compensation growth Phillips curve described later in the text includes dummy variables to capture the effects from the imposition and relaxation of wage and price controls during the 1970s. We exclude these dummy variables from the traditional price-inflation Phillips curve because they were found to be statistically insignificant. Alternative dating schemes for the dummy variables (Gordon 1982) also proved to be unimportant in explaining the dynamics of inflation during the 1971–75 period.
12. This test yields an F-statistic, which is distributed asymptotically as $F$ with $(m, n-k)$ degrees of freedom under the null hypothesis. The values of $n$ and $n+m$ refer to the number of observations in the first subperiod and the total sample, respectively. The value of $k$ refers to the number of parameters in the model.
13. This test yields a likelihood ratio statistic, which is distributed asymptotically as chi-square with $k$ degrees of freedom under the null hypothesis.
14. We also looked for evidence of parameter instability using the CUSUM and CUSUMSQ tests proposed by Brown, Durbin, and Evans (1975). The tests are based on recursive residuals, with the CUSUM test primarily used to detect gradual structural change and the CUSUMSQ test used to detect sudden structural change. The tests provided no evidence of parameter instability.
15. The dynamic simulation yielded similar results for the 1994–96 period.
16. Meyer (1997) notes that the declines in computer prices and import prices over the current expansion may also be acting as temporary supply shocks helping to restrain inflationary pressures in the economy. Moreover, as an additional explanation for the inflation puzzle, he cites firms' inability to raise prices because of increased international competitive pressures. We do not address these factors in this paper and instead restrict our attention to the two explanations that concern labor market phenomena. Further, while our analysis is not exhaustive, we nevertheless believe that it is instructive to evaluate these explanations before considering alternative hypotheses.
17. Our focus on compensation growth is also motivated by the idea that the pricing decision of a firm should be based on a consideration of its total labor costs rather than the behavior of the wage and benefit components of these costs. In addition, the data preclude us from obtaining observations on wages and benefits separately over the full sample period. The employment cost index, which provides measures of wages and benefits, is only available beginning in 1980 for the nonfarm sector.
18. We modify the traditional price-inflation Phillips curve to include unit labor costs rather than compensation per hour because it is the behavior of compensation growth *relative* to productivity growth that is relevant for describing the dynamics of the inflation process. That is, greater productivity growth will act to offset the inflationary pressure on prices arising from an increase in compensation growth.
19. Note that our model does not allow us to examine whether a shift in the Federal Reserve's inflation fighting credibility has changed the inflation process by directly altering inflation expectations. Such an examination is beyond the scope of this paper and would involve estimating a separate equation for inflation expectations and including some measure of Federal Reserve credibility as an explanatory variable. Previous evidence, however, suggests that such

a shift has not taken place. Blanchard (1984) notes that similar types of Phillips curves remained stable even after the 1979 change in Federal Reserve operating procedures.

20. As the value of the test statistics in Table 2 indicates, the Chow tests fail to reject the null hypothesis of parameter stability at conventional significance levels. However, this result is not particularly informative because the Chow tests also failed to reject the null hypothesis of model stability for the traditional Phillips curve.
21. The increase in the forecasted value for inflation primarily reflects the influence of a change in the output gap and the oil price variable.
22. For definitions of the data and their sources, see the Data Appendix.
23. For example, we could follow the approach of Fuhrer (1995), who assumes a value of 6 percent for the NAIRU, and use the unemployment gap (the difference between the actual level of unemployment and the NAIRU) instead of the unemployment rate as an explanatory variable in equation 3. This approach, however, would not affect the regression results other than to change the estimated value of the constant term.
24. Fuhrer (1995) also finds an absence of significant rate-of-change effects for the unemployment rate in wage-inflation Phillips curve models.
25. The definition of the dummy variable is from Englander and Los (1983).

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## NOTES

1. The main advantage of the ECI over two other common compensation measures—the monthly average hourly earnings series (which excludes benefits) and the nonfarm business sector compensation measure—is that it controls for the impact of shifts in the mix of jobs by measuring wages and benefits for a fixed set of industries and occupations. It is also designed to remove the influence of changes in the volume of overtime worked on reported hourly compensation. One disadvantage of the ECI is that it does not adjust for changes in productivity growth; however, a related measure—unit labor costs—which does control for productivity changes, cannot be reliably decomposed into goods and services.
2. Over time, however, rents are influenced by *general* wage increases in the sense that the resulting higher consumer incomes boost the demand for housing.

   In the CPI, the cost of owner-occupied housing is expressed in terms of "owners' equivalent rent," meaning the imputed value of the services provided by the housing unit. In practice, the estimation of owners' equivalent rent is largely based on observed rents paid for comparable housing units in similar locations.
3. To be precise, the BLS (U.S. Department of Labor 1997, p. 170) defines a category's relative importance as the "share of total expenditures" for which the category would account "if quantities consumed were unaffected by changes in relative prices and actually remained constant [at the fixed 1982–84 weight]." Thus, over time, relative importance increases for categories in which prices are rising faster than the overall CPI and decreases for categories in which relative prices are falling. In January 1998, the BLS plans to introduce updated weights January 1998, the BLS plans to introduce updated weights reflecting 1993–95 spending patterns.
4. Specifically, we performed Granger-causality tests in which the seasonally adjusted change in the CPI for each quarter was regressed on lagged values for the quarterly change in the ECI, as well as its own lagged values, and then conducted an F-test for joint significance of the lagged ECI variables. In the case of goods using three lags, the F-statistic on the lagged ECI variables was .69, with a significance level of 56.4 percent. Tests using different numbers of lags yielded similar results.
5. For three lags, the F-statistic was 6.31, with a significance level of 0.1 percent.
6. The standard error of this estimate is 0.17 percentage point.
7. For two lags, the F-statistic for a link from labor-cost-sensitive services to labor-cost-sensitive goods was 4.98 (significance level 1.09 percent), with a .34 point cumulative impact (standard error .14). In the case of a link from services to all other items, the F-statistic was 5.42 (significance level .75 percent), with a cumulative impact of .40 point (standard error .22).

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## NOTES

1. See P. Passell, A Pulse that Lingers, *New York Times,* July 22, 1997, p. A1.
2. See A. Freedman, The New Look in Wage Policy and Employee Relations, Report No. 865, The Conference Board, 1985.
3. See D. I. Levine, Fairness, Markets, and Ability to Pay: Evidence from Compensation Executives, *American Economic Review,* vol. 83, no. 5 (December 1993), p. 1248.
4. The marginal physical product is the addition to output made by the last worker hired.
5. Several simplifications are implicit in this move from microeconomic wage determination to the aggregate relationship. Notably, both the price and marginal products must be correctly aggregated for the simple relationship to hold, yet the aggregate data series are not even intended for this purpose. For example, productivity is measured on an average, rather than a marginal, basis. These are reasons to examine how well the relationship performs using actual data over an extended period.
6. The FRBC chooses participants in each city as representative of the area's employers. Although the survey has been conducted annually, the month for which data are collected has changed several times since 1955. All data, including the CPI and productivity figures, refer to the period between the preceding survey and the one conducted that year. In most cases, this is a 12-month

span, but occasionally the interval is less or more than a year. How well do the CSS wages reflect national trends? The year-to-year changes usually follow the national pattern closely (when U.S. wage-change data are available), but characteristics specific to this region have also caused its wage levels to change relative to the nation's. In general, Cleveland, Cincinnati, and Pittsburgh are more urban, have more cyclically sensitive employment, and have undergone more industrial restructuring than the United States as a whole. Before the 1980s, wages in these three cities were higher than the national average, but now they are on par with the rest of the country.

7. This has resulted from increases in both mandated benefits (such as the employer's contribution to the Social Security fund and unemployment insurance premiums) and voluntary benefits (such as health care insurance and paid vacation days).
8. Occupations in which overtime is a standard, continuing feature of the compensation structure are assigned a rate that exceeds the base wage, on the basis of typical overtime levels within the occupation.

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## NOTES

1. With chain-weights, price indexes and quantity indexes are calculated separately for components of GDP and therefore the difference between nominal GDP and real GDP growth is only approximately equal to the change in the GDP price index. With fixed-weights, the GDP deflator is defined as the ratio of nominal to real GDP and hence the gap between nominal and real GDP growth rates is precisely equal to the growth rate in the GDP deflator.
2. See Barro (1996) and Eijffinger, Schaling, and Hoeberichts (1998).
3. See Bruno and Easterly (1996).
4. See Friedman and Schwartz (1963).
5. Despite M2's imperfections as a cyclical indicator, the Conference Board's monthly Leading Indicators Index includes M2 relative to the price level as one of its 10 components.

6. The faultiness of interest rates as measures of monetary policy in a non-inflationary environment was evaluated in Dewald (1963).
7. The analysis rests on the assumption that the real rate of interest equals the rate of growth of real GDP, when both series are averaged over a moderately long period of time. This condition arises in theoretical models in which consumers are Ricardian and the rate of time preference is zero. The condition that the real interest rate is equal to the real output growth rate arises in theory since real GDP growth is acting as a proxy for an equilibrium rate of return on investment. It would be appropriately expressed in per capita terms. Per capita GDP growth has slowed more than overall GDP growth over the period plotted on Figure 6. Therefore, current inflation credibility would have fallen even more relative to its level in the late 1950s and early 1960s than indicated on Figure 6, if per capita real GDP growth had been used to proxy the equilibrium rate of return on investment.

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## NOTES

1. The fifteen members of the EU are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the UK. All but four members are participating in the first round of EMU. Denmark, Sweden, and the UK are not participating for domestic political reasons; Greece failed to meet the convergence criteria laid down in the Maastricht Treaty but intends to join as soon as possible.
2. EMU countries' notes and coins will continue to circulate until 2002; however, they no longer exist as currencies in their own right but as nondecimal denominations of the euro. There are several reasons for the three-year transition before the euro acquires a physical form. First, it will take time to adapt the physical payments infrastructure in each of the participating countries to the new notes and coins. In 1995, there were some 3.15 million vending machines and 130,000 ATMs in the EU; such machines will have to be recalibrated to accept the new currency. Second is the magnitude of the task of replacing national currencies. Printing enough banknotes and minting enough coins to replace all the existing notes and coins will take time. In 1994, more than 12 billion banknotes and 70 billion coins circulated in the EU, with a combined weight of 300,000 metric tons. Minting of euro coins began in May 1998. Finally, the transition allows businesses and the general public to become familiar with the new currency before having to use it for all transactions. During the transition, the no-compulsion, no-prohibition principle governs the use of the euro.
3. For a recent analysis of the unemployment problem in Europe, see Ljunqvist and Sargent (1998).
4. For this article, the significance of the Committee of Governors is that the economic unit created to support the committee would subsequently form the cadre for the European Central Bank.
5. For a textbook review of the major issues, see De Grauwe (1997). See also Feldstein (1997) and Wyplosz (1997).
6. Actually, many features of the ESCB are modeled on Deutsche Bundesbank, which is modeled on the Federal Reserve System. See Deutsche Bundesbank (1995).
7. Maastricht Treaty Protocol (no. 3) on the Statute of the European System of Central Banks and of the European Central Bank, Article 12.1.
8. The FOMC in its current form, with the Board of Governors enjoying a permanent majority, did not come into being until 1935. When the Federal Reserve System was established in 1914, it was thought discount lending would be the primary tool of monetary policy, with individual Reserve Banks having considerable discretion to set discount rates. It was not until the 1920s that the potential of open market operations was discovered. In the spring of 1922 the Committee of Governors on Centralized Execution of Purchases and Sales by Federal Reserve Banks was established to coordinate the actions of the System. This committee was reconstituted as the Open Market Investment Committee (OMIC) in 1923, consisting of representatives of the Boston, New York, Philadelphia, Cleveland, and Chicago Reserve Banks, under the chairmanship of the New York Bank. The OMIC was disbanded in 1930 and reconstituted as the Open Market Policy Conference, composed of representatives from all twelve Reserve Banks. The Banking Act of 1933 established the FOMC, consisting of representatives of the twelve Reserve Banks and the seven Board of Governors members. The Banking Act of 1935 altered the FOMC's composition to give the seven Board members a vote in open market policy and, more importantly, reduce the representation of the Reserve Banks to five members. This gave the Board of Governors a permanent majority.
9. Federal Reserve Act, Section 4.20.
10. See, for example, the schematic diagrams of the informal power structure of the Federal Reserve System in any intermediate money and banking textbook.
11. Statute of the European System of Central Banks and of the European Central Bank, Articles 10 and 13.

12. Statute of the European System of Central Banks and of the European Central Bank, Article 13.
13. European Central Bank (1998b).
14. Federal Reserve Act, Section 10.1.
15. Article 2 of the treaty states that "the Community shall have as its task, by establishing a common market and an economic and monetary union and by implementing the common policies or activities referred to in Articles 3 and 3a, to promote throughout the Community a harmonious and balanced development of economic activities, sustainable and non-inflationary growth respecting the environment, a high degree of convergence of economic performance, a high level of employment and of social protection, the raising of the standard of living and quality of life, and economic and social cohesion and solidarity between the Member States." Article 3a of the treaty states: "A1. For the purposes set out in Article 2, the activities of the Member States and the Community shall include, as provided in this Treaty and in accordance with the timetable set out therein, the adoption of an economic policy which is based on the close coordination of the Member States' economic policies, on the internal market and on the definition of common objectives, and conducted in accordance with the principle of an open market economy with free competition. 2. Concurrently with the foregoing, and as provided in this Treaty and in accordance with the timetable and the procedures set out therein, these activities shall include the irrevocable fixing of exchange rates leading to the introduction of a single currency, the ECU [European currency unit], and the definition and conduct of a single monetary policy and exchange-rate policy the primary objective of both of which shall be to maintain price stability and, without prejudice to this objective, to support the general economic policies in the Community, in accordance with the principle of an open market economy with free competition. 3. These activities of the Member States and the Community shall entail compliance with the following guiding principles: stable prices, sound public finances and monetary conditions and a sustainable balance of payments."
16. Other provisions in the treaty further reinforce the mandate for price stability. First, Article 2 of the statute repeats Article 105 of the treaty. Article 2 of the treaty makes the promotion of non-inflationary growth one of the European Community's objectives. Article 3 of the treaty states that the primary objective of both monetary and exchange rate policy following the start of monetary union "shall be to maintain price stability." Article 3 of the treaty also states that achieving stable prices is one of the guiding principles of the Community.
17. Alesina and Grilli (1992) evaluate the political and economic independence of the ECB using the same criteria as other authors to construct quantitative indexes of central bank independence. They find that the ECB will enjoy the same degree of political and economic independence as the Bundesbank, which is somewhat more independent than the Fed.
18. Statute of the European System of Central Banks and of the European Central Bank, Article 14.2.
19. Posen (1993) is more sanguine about the ECB's prospects, arguing that it will have important political support from the European financial community.
20. Alesina and Grilli (1992) use the terms *political independence* and *economic independence* to refer to essentially the same things.
21. European Central Bank (1998a).
22. See, for example, Friedman and Schwartz (1963) and Timberlake (1993).
23. As Fischer (1994, 304) notes, "Monetary and exchange rate policies cannot be independent. Under floating rates, monetary policy affects the exchange rate. Thus the government cannot have control over exchange rate policy while the central bank has control over monetary policy. The government should have the authority to choose the exchange rate regime. If it chooses a fixed exchange rate regime, it has then essentially—though not completely—determined monetary policy. While a central bank can be more or less independent of the government in a fixed exchange rate regime, its independent ability to determine the rate of inflation and interest rates is sharply curtailed." See also Giovannini (1993).
24. See, for example, Ungerer (1997) and Gros and Thygesen (1998).

25. See, in particular, Buiter (1998a, 1998b).
26. Issing (1994) argues along these lines.
27. For analyses of inflation targeting as a strategy for monetary policy, see Haldane (1995), Leiderman and Svensson (1995), and Bernanke and Mishkin (1997).
28. See Goodfriend (1993).

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## NOTES

1. The Fed also sets the discount rate, which is the rate charged banks when they borrow reserves from the Fed, and required reserve ratios, that is, the percentage of their deposit liabilities that banks are required to hold in the form of vault cash or deposits at Federal Reserve Banks. Neither is changed frequently, however, and open market policy is the principal mechanism by which the Fed conducts monetary policy.
2. See Campbell (1995) for more detail about the term structure of interest rates and empirical evidence on the expectations hypothesis.
3. Thomas T. Vogel, *Wall Street Journal,* February 7, 1994, p. C1.
4. See Dotsey and DeVaro (1995) for empirical evidence suggesting that much of the disinflation of the early 1980s was unanticipated by the public.
5. See Pakko (1995) for a detailed description of FOMC policy moves during 1994 and Gavin (1996) for a discussion of policy moves during 1995.
6. Thornton (1996) finds that financial market volatility has been lower around the time of FOMC meeting dates since the policy of announcing federal funds rate changes was implemented.
7. Statement before the Joint Economic Committee, United States Congress, January 31, 1994. *Federal Reserve Bulletin* (March 1994, p. 233).
8. Joseph Liro, chief economist at S. G. Warburg, quoted by Thomas D. Laurencella and Laura Young, *Wall Street Journal,* February 1, 1994, p. C23.
9. John Lipsky, chief economist at Salomon Brothers, quoted by Thomas T. Vogel, *Wall Street Journal,* February 7, 1994, p. C19.
10. Dave Kansas, *Wall Street Journal,* May 17, 1994, p. C2.
11. *Federal Reserve Bulletin,* July 1994, p. 610.
12. David Wessel, *Wall Street Journal,* May 18, 1994, p. A3.

13. See, for example, Dave Kansas, *Wall Street Journal,* January 31, 1996, p. C1.
14. For example, see Dave Kansas, *Wall Street Journal,* February 15, 1996, p. C1.
15. Vogelstein and Jereski, *Wall Street Journal,* March 11, 1996, p. C1.

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## NOTES

1. For representative examples see Smith (1991), Kaufman (1995), Donaldson (1992), Bartholomew, Moe, and Whalen (1995), and Eichengreen and Portes (1991). See Benston and Kaufman (1995) for a review of the evidence on fragility.
2. Eichengreen and Portes (1991) require declines in real output for a true financial crisis to occur.
3. Before 1910, however, the most common yield curve in the United States was downward-sloping.
4. It is generally argued that the theory as put forth by Minsky is not a unified theory that yields testable hypotheses. See, for example, Sinai (1977), Lintner (1977), Mishkin (1991), and Schwartz (1986).
5. Minsky argues that the ability to intervene is directly correlated with the size of government: and big government, with its revenue capacity, has the resources to support, through fiscal and monetary policies, a longer run-up of leverage. Also, through its lender-of-last-resort capabilities, it can soften the landing during an exogenous shock period by supporting a gradual rather than precipitous liquidation of assets. It thereby avoids the corresponding collapse of credit, bank failures, and destruction of the money supply.
6. For other examples of models in this mode see Haubrich and King (1984), Cone (1983), Jacklin (1987), Wallace (1988), Bhattacharya and Gale (1987), Smith (1991), and Chari (1989).
7. In the Diamond and Dybvig (1983) model there is really no nonbank money in circulation. Individuals deposit a real consumption good in the bank in exchange for a deposit or warehouse receipt. This consumption good is close, but not identical, to specie.

   In early U.S. banking, it was not uncommon for notes issued by out-of-area banks to trade at discounts, which reflected several factors, including transportation and transaction costs, lack of information on the issuing bank, and uncertainties about the creditworthiness of the issuing bank. This lack of par clearance in no way affected the ability of state bank notes to function as money.
8. For discussions of the evidence on runs see Kaufman (1988) and Gorton (1987).
9. Because of the way the model is constructed, runs necessarily have an adverse impact on the real economy.
10. For a discussion of these early bank runs see Kaufman (1988) or Bryant (1980).
11. Clearinghouses and other banks in the region often provided temporary credit to institutions experiencing liquidity problems (see Kaufman 1988). Kaufman (1994) notes that bank capital ratios were substantially higher during this period than they were after deposit insurance was introduced.
12. Although Schwartz articulates this view, she clearly does not believe it is correct or that the policies designed to protect against the events are appropriate.
13. The exception is the panic of 1873.
14. As a robustness test, he also reruns the analysis using monthly data as Gorton does and gets similar results to those found by Gorton. He concludes that monthly data are too spaced out to provide a sharp test of the hypothesis.

15. A more complete test of the Gorton-Mishkin-Park hypothesis about information asymmetries would be provided by examining fund flows from individual solvent and insolvent institutions. Relying upon aggregate statistics can be only circumstantial, not conclusive.
16. The Roosevelt administration, following the declaration of the bank holiday on March 6, 1933, employed this same policy.
17. Smith (1991) does provide a model in which banks are permitted to hold funds at a Reserve City bank. Bhattacharya and Gale (1987) provide a model with geographically dispersed depositors and banks. Again, however, these models only look at the interdependence among banks through the interbank deposit markets.
18. See also the discussions in Haubrich (1990), Bordo (1986), and Williamson (1989). All emphasize the advantages over U.S. banks that banks in Canada and other countries that permitted branching had in weathering panics. Calomiris and Schweikart (1991) have explored in detail for the United States the effects that structure had on failure rates in different states with different branching statutes. They show that branch banks had both lower failure rates and in general paid lower premiums on their notes during the crisis of 1857 than banks in other parts of the country.
19. Specifically, the monetary base included gold coin, gold certificates backed 100 percent by gold, silver dollars, silver certificates, other small silver coins. U.S. notes and other Treasury fiat, and national bank notes. See Tallman and Moen (1993).
20. Tallman and Moen (1993) indicate that this uncertainty was greatly reduced with the discovery of large gold supplies in the late 1890s.

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## NOTES

1. This taxonomy was introduced by Frank Knight. See Risk, Uncertainty, and Profit. Chicago: University of Chicago Press, 1971 (1921).
2. Others describe the origins of crises by suggesting that an objective distribution of possible outcomes of investments includes a significant region of bad results. This region (sometimes referred to as the "fat tail" of the distribution) reflects the slight, but not negligible chance of simultaneous losses to many investors in a crises. Investors are shortsighted, however, in ignoring this region of possibilities when constructing portfolios and, therefore, surprised when it actually materializes.
3. Or they may not. Suppose, instead, that these governments heed the advice of those who would throw more sand in the gears of cross-border financing to discourage susceptibility to capital flight. A turnaround tax on capital withdrawn within a few months or a year of entering a country is a popular suggestion. The approach might work, just as capital controls seem to have worked for most nations during and after World War II, but at the cost of a less efficient global allocation of capital. If regulation were to be part of the reform process, it would make more sense to remove regulations that discourage long-term capital flows than to add regulations that discourage short-term capital flows.
4. An interesting exception has been proposed by Howell E. Jackson in "The Selective Incorporation of Foreign Legal Systems to Promote Nepal as an International Financial Services Center," forthcoming in an Oxford University Press symposium volume on regulatory reform. His suggestion is that firms be permitted to establish operations in Nepal if they agree to abide by their home countries' regulations and submit their Nepalese operations to their home countries' supervision.

## NOTES

1. Based on "cleanup" costs of $165 billion. Hellmann, Murdock, and Stiglitz (2000) recently put the figure at $180 billion or 3.2 percent.
2. Drawing upon information from *Standard and Poor's Sovereign Ratings Service* (issues June 1999, November 1999, and December 1999) and the World Bank, the costs (as a percent of GDP) of bank recapitalization were estimated to be Korea, 24 percent; Malaysia, 22 percent; Thailand, 35 percent; and Indonesia, 65 percent. Kaufman (1999, table 2) puts the range at 45 percent to 80 percent.
3. The 6 percent figure is from a January 27, 2000, press release of the Financial Supervisory Agency of Japan. Others place the figure even higher: Hellmann, Murdock, and Stiglitz (2000) say nonperforming loans may approach 25 percent of GDP.
4. The previous cost figures (for example, 20 percent to 65 percent resolution costs) are not measures of welfare loss; they are simply transfers between agents in the economy. But welfare losses are typically associated with these transfers as a result of market distortions and the resulting inefficiencies. For example, the International Monetary Fund estimates that crises-induced output losses (actual versus trend growth) have been in the range of 17–18 percent (see Kaufman, 1999, table 1). Additionally, there could be welfare losses on a regular ongoing basis (not just during the crisis) as inefficient investments are undertaken. Thus, losses associated exclusively with crises probably understate the true welfare costs.
5. For the two worst quarters of the Asian crisis the annualized rates of GDP decline were over 25 percent for Indonesia, Korea, Thailand, and Malaysia. In the U.S., over the 1929–33 period GNP decreased by nearly 50 percent—about 15 percent per year. While the declines in the Asian crisis were less persistent than the Great Depression, the rate of decline was comparable.
6. This is further discussed in Marshall (1998) and Dooley (1999).
7. The twin-crisis hypothesis is associated with Kaminsky and Reinhart (1999) and Burnside et al. (1999). It should be emphasized that this may not be the sole explanation of what occurred in the Asian crisis.
8. This is consistent with arguments that suboptimal investments were undertaken in the Asian crisis countries. For example, a standard measure of investment efficiency is the "incremental capital output ratio" (ICOR), defined as the ratio between the investment rate and the rate of output growth. Higher ICOR implies less efficient investment. Corsetti, Pesenti, and Roubini (1999) show that for most East Asian countries, ICOR increased sharply in 1993–96, relative to 1987–92. They also claim that a substantial fraction of the new investment was directed toward real estate, as opposed to increased manufacturing capacity. Indirect evidence that this real estate investment was inefficient comes from data on rental yields for commercial office buildings. The yields were quite low (and vacancy rates quite high) before the onset of the crisis. Also, the rate of nonperforming loans before the crisis was above 15 percent in Thailand, Korea, Indonesia, and Malaysia. In 1996, 20 of the 30 largest Korean conglomerates showed a rate of return on invested capital below the cost of capital. While certainly not definitive, these patterns are consistent with less prudence on the part of investors.
9. This figure (3.66 percent of GDP in 1999) and the general discussion that follows are based on Hervey and Kouparitsas (2000).
10. This increase in the current account could be associated with either the "wealth effect" from the financial side or from demand side effects resulting from the strong U.S. economy. Again, while

both are operative, the data appear consistent with the wealth effect having an impact as described here. While the U.S. current account has been in deficit during most of the 1990s, the biggest increase occurred during 1998 and 1999; a timing that is consistent with the Asian crisis. Additionally, if driven by increased demand for foreign goods by U.S. consumers, it would result in increases in domestic interest rates. If the deficit was driven by an increased supply of foreign capital to the U.S., it would result in decreases in rates. In fact, the recent acceleration in the current account deficit was associated with a fall in medium- and long-term U.S. interest rates. This is consistent with the wealth effect argument.

11. Controls were imposed in August–September 1998.
12. See Renaud, Zhang, and Koeberle (1998).
13. Baer and Mote (1992) present evidence showing the rate of loss per dollar of deposits in the 1980s exceeded that experienced during the Depression years.
14. Boyd and Rolnick (1998) argue that ". . . before 1933, banks held much more capital than they now do. In fact, from 1844 to 1900, average capital ratios exceeded 20 percent of assets. In recent years, the average has been around 6 percent." Indeed, steady bank capital declines after 1930 were a major reason for the introduction of explicit bank capital requirements in the early 1980s. For a discussion of bank capital trends, and a discussion of why reported capital levels after 1930 are actually overstated, see Kaufman (1992).
15. Examples of specific proposals include U.S. Shadow Financial Regulatory Committee (2000) and Evanoff and Wall (2000).
16. Examples of the evidence in Asia include 1) the fact that the relative stock market valuation of the banking sector in Thailand started to decline in mid-1994, and 2) the IMF was "warning" the Thai government of economic misalignments for over two years prior to the onslaught of the crisis; see Lissakers (1999). The U.S. empirical evidence on the market's ability to distinguish between banks is summarized in Kwast et al. (1999).
17. The difference between the behavior of uninsured depositors and subordinated debtholders is driven by their different maturity structures.
18. Detailed information for individual banks concerning loan customers, status of loans, past dues, and so forth, is accessible via the Central Bank of Argentina's website.
19. See, for example, Calomiris and Powell (2000). They also provide evidence that banks are responding to this increased market discipline. They find that banks that were in compliance with the requirement before the Asian crisis were stronger (lower default risk), had faster deposit growth, and paid lower deposit interest rates than the banks not in compliance.

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## NOTES

1. Linton Weeks and John Berry, "The Shy Wizard of Money: Fed's Enigmatic Greenspan Moves Easily in His Own World." *Washington Post,* March 24, 1997, sec. A.
2. Money is said to exhibit long-run *neutrality* if permanent changes in the level of the supply of money have no long-run effects on real interest rates or the growth rate of real output. In this case, the levels to which prices and other nominal variables will increase are postulated to vary one for one with changes in the level of the money supply. Similarly, an economy is said to display long-run superneutrality if permanent changes in the rate of growth of the money supply have no long-run effects on either real interest rates or the rate of output growth, and the rates of inflation and other nominal variables are postulated to vary one for one with changes in the rate of growth of the money supply.
3. If monetary policy has real effects only because of money illusion then it is likely these effects will be very limited in scale. On the other hand, if monetary policy derives its real effects from other sources, then its short-run effects may be relatively large. Thus, limited short-run real effects may go hand in hand with long-run superneutrality while deviations from long-run superneutrality may produce powerful short-run effects.

4. In particular, as stated, this description of the quantity theory is really more of an accounting identity than a theory that qualitatively relates money to relevant macroeconomic variables. An accounting identity does not specify what is a given in the analysis and how different variables will change as a result of alternative policy changes. A theory or model, on the other hand, is specific about what is assumed to be exogenous to the model as well as what is determined within it and how different variables react to exogenous changes. A number of complimentary assumptions were really necessary for this equation to spell the list of properties Fisher attached to the quantity theory.
5. For this explanation to make sense some additional assumptions are required. See Espinosa and Russell (1997) for an explanation of these assumptions.
6. For a detailed nontechnical description of Lucas's contribution see Espinosa and Russell (1997).
7. Of course, if fiscal and monetary policy interactions led not only to long-run output level changes but to output growth changes, the Tobin effect could be of more significance.
8. In principle, of course, there exists the possibility that such a swap of liabilities results in no effects either real or nominal, either in the short or long term (a case made by Wallace 1984 and Sargent and Smith 1987 but not reviewed here), but under most circumstances it will.
9. The debt-GDP ratio cannot continue to grow forever. Otherwise, at some point the debt would get so large relative to households income that it would be impossible for them to save enough to hold it.
10. This term seems to have been first used by Miller and Sargent (1984).
11. Thus, if the real interest rate is 2 percent higher than the real growth rate then each dollar of debt costs the government two cents each year, adjusted for inflation.

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## NOTES

1. This work is based on Cecchetti (1995).
2. I will not discuss the difference between price-level and inflation targeting. While this is a potentially important practical distinction, it is beyond the scope of this paper.
3. See, for example, discussions in Christiano, Eichenbaum, and Evans (1996a, 1996b) and Bernanke and Mihov (1995).
4. Most results are unaffected by the substitution of nonborrowed reserves, suggesting that the funds rate elasticity of reserve demand is relatively stable.
5. For a more detailed discussion, see section 4 of Cecchetti (1995).
6. This is the technique used in Cecchetti (1995).
7. The standard-error bands in the figure are constructed using the simple Taylor-series approximation:

$$F(\hat{\beta}) \approx F(\beta) + \frac{dF(\beta)}{d\beta}\Big|_{\beta=\hat{\beta}} (\hat{\beta} - \beta),$$

where $F$ is any differentiable function. The variance of $F$ ($\beta$^) follows immediately as

$$E[F(\hat{\beta}) - F(\beta)]^2 \approx \left[\frac{dF(\beta)}{d\beta}\Big|_{\beta=\hat{\beta}}\right]^2 Var(\hat{\beta}).$$

Here, we can think of the estimated impulse response functions, the $\hat{A}_{ij}$'s, as functions of the estimated reduced-form VAR coefficients, the elements of $\hat{R}(L)$. Given the estimated variance of these coefficient estimates, the variance of the $\hat{A}_{ij}$'s can be computed by numerical differentiation.
8. Feldstein and Stock (1994) examine an identical experiment, but without parameter uncertainty.
9. Because the model is estimated in logs, the minimum MSE of the nominal-income policy minimized the MSE of the sum of the log of industrial production and the log of the CPI.
10. Performing the calculations in this way ignores a number of elements. In particular, there is no guarantee that the policy rules generated from the artificial experiment of one unit shock in one $\varepsilon_{jk}$ at a time will be robust to sequences of shocks in all the $\varepsilon_{jk}$'s simultaneously. One clear reason for this is that it ignores the covariance of estimated coefficients both within and across the elements of the $\hat{A}_{ij}(L)$'s.
11. As one would expect, these large policy innovations result in less stable real output, highlighting that the ultimate issue in policymaking is still the relative weight of prices and output in the objective function.

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## ENDNOTES

1. We have investigated the robustness of our findings along a large number of dimensions: omitting the trend; including lagged as well as contemporaneous changes in unemployment and inflation; considering longer sample periods (which requires us to not distinguish between anticipated and unanticipated inflation); allowing the effects of inflation as well as unemployment to change in 1983; and estimating the regressions in levels rather than changes (and including the lagged dependent variable on the right-hand side). In all cases, the qualitative picture is the same: there is a strong relationship between unemployment and poverty, and no clear relationship between inflation and poverty. In two of the variants (omitting the trend and including lags), there is a modest tendency for increases in inflation to be associated with increases in poverty. But the coefficients on inflation are never significantly different from zero.
2. We have investigated the robustness of the results for the distribution of income along the same dimensions that we examined the results for poverty. These results support our findings that unemployment has no systematic impact on the distribution of income, and that inflation may narrow it slightly.
3. The two most important components of our other financial assets category are certificates of deposit and the survey's residual category (which includes loans, future proceeds, royalties, futures, nonpublic stock, deferred compensation, oil/gas/mineral investment, cash not elsewhere classified).
4. As Deininger and Squire describe, the inequality measures for some countries are based on spending rather than income. We adjust these observations as suggested by Deininger and Squire to make them comparable to the income-based measures. Specifically, we add 6.6 points to the spending-based Gini coefficients, and we subtract 1.2 percentage points from the spending-based figures for the share of the poorest fifth of the population.
5. We use Summers and Heston's definitions of the continents.

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## NOTES

1. In most previous studies using an interest-rate-based measure of monetary policy, a short-term money market rate (the three-month or one-year Treasury bill rate) is used. Most of those studies surveyed recently in Akhtar (1995) find significant and large effects of short rates on long rates. In those studies the long-run response of nominal long rates ranges from about 22 to 66 basis points for every one percentage point change in nominal short rates. However, there is considerable skepticism about the reliability and interpretation of those effects. One main reason for such skepticism is even though monetary policy has its strongest effect on a short-term money market rate, the latter is also influenced by nonmonetary forces. Hence changes in short rates do not necessarily reflect changes in the stance of monetary policy.

   There are a few other empirical studies that use the federal funds rate as a measure of monetary policy. But most of those studies examine the effect of policy on the long rate in a bivariable framework. In such studies the estimated impact of policy on the long rate is quantitatively modest and temporally unstable (see Akhtar 1995, Table 3). An exception is the recent work in Mehra (1994) which uses a multivariable framework and finds a significant effect of the real funds rate on the long rate. However, Mehra (1994) does not investigate the robustness of those results to alternative specifications or to different sample periods.
2. Recent research has shown that the federal funds rate is a good indicator of the stance of monetary policy (Bernanke and Blinder 1992; Bernanke and Mihov 1995).
3. In this chapter near-term effects refer to responses of the bond rate to recent past values of the funds rate spread. The immediate effect is the response to the one-period lagged value of the spread and the near-term effect is the cumulative response to all such past values. What I call the near-term effect is sometimes referred to as the long-run effect in previous studies. As indicated later, I use the long-run effect to measure the effect that arises from the existence of equilibrium or trending relationships among nonstationary variables.

4. The discussion in this section draws heavily from Goodfriend (1993).
5. This lag arises not because financial markets adjust slowly but rather because funds rate strategy puts considerable persistence in the funds rate. Such a lag can also arise if the bond rate depends upon anticipated policy moves which in turn are influenced partly by current and past values of the policy variable.
6. This framework differs somewhat from the ones used in Goodfriend (1993) and Mehra (1994). Goodfriend describes interactions between the bond rate and the funds rate, taking into account the behavior of actual inflation and real growth, whereas in Mehra (1994) the deficit also is included. That work, however, indicates that the deficit variable is not a significant determinant of the bond rate once we control for the influences of inflation and real growth. Hence the deficit variable is excluded from the work here. I use the output gap rather than real growth as a measure of the state of the economy because the bond rate appears more strongly correlated with the former than with the latter. The qualitative nature of results, however, is the same whether the output gap or real growth is used as a measure of the state of the economy. Moreover, I do examine the sensitivity of results to some changes in specification in the subsection entitled "Additional Empirical Results."
7. The concept of weak exogeneity is introduced by Engle et al. (1983). The hypothesis that inflation is weakly exogenous with respect to the parameters of the cointegrating vector simply means that inferences on such parameters can be efficiently carried out without specifying the marginal distribution of inflation. More intuitively, inflation in equation (2) could be considered predetermined in analyzing the response of the bond rate to inflation.
8. This test is proposed in Johansen (1992).
9. I get similar results if instead the consumer price index or the GDP deflator is used to measure actual inflation (see the subsection entitled "Additional Empirical Results").

   In a couple of recent studies (Hoelscher 1986; Mehra 1994) the Livingston survey data on one-year-ahead inflationary expectations are used to measure long-run anticipated inflation. The results in Mehra (1994), however, indicate that the near-term impact of the funds rate on the bond rate remains significant if one-year-ahead expected inflation (Livingston) data are substituted for actual inflation in the empirical work (see Mehra 1994, Table 4). That result continues to hold in this article also (see the subsection entitled "Additional Empirical Results").
10. These tests are described in Mehra (1994).
11. This can be shown as follows. Assume, for example, the level of the bond rate is related to inflation and the funds rate spread as in

$$BR_t = a_0 + a_1\dot{p}_t + a_2(NFR - b_1\dot{p})_t + V_t, \tag{a}$$

   where the stationary component is $a_0 + a_2(NFR - b_1\dot{p})_t$ and the nonstationary component is $a_1\dot{p}_t$. The error-correction regression is

$$\Delta BR_t = \lambda_1 V_{t-1} + \sum_{s=1}^{n} (\text{other lagged differences of variables}) + \epsilon_t, \tag{b}$$

   where $\lambda_1$ is negative. Substituting for $V_{t-1}$ from (a) into (b) yields (c):

$$\Delta BR_t = \lambda_1 BR_{t-1} - \lambda_1 a_1 \dot{p}_{t-1} - \lambda_1 a_2 (NFR - b_1\dot{p})_{t-1} + \textit{other terms}. \tag{c}$$

   Equation (c) can be estimated and $a_2$ can be recovered as $\lambda_1 a_2/\lambda_1$, which is the minus of the coefficient on $(NFR - b_1\dot{p})_{t-1}$ divided by the coefficient on $BR_{t-1}$. The coefficient $a_2$ then measures the near-term response of the bond rate to the funds rate spread. I do not label $a_2$ as measuring the long-run effect because the spread is stationary. The long run is defined as the period over which trend relationships emerge. In the long run the funds rate spread $(NFR - \dot{p})$ is constant.
12. In estimated short-run regressions the coefficients that appear on lagged differences of the bond rate are very small. If we ignore those coefficients, then the short-run equation (c) given in foot-

note 11 can be expressed as

$$BR_t = \frac{-\lambda 1 a 1}{1-(1+\lambda 1)L}\dot{p}_{t-1} + \frac{\lambda_2}{1-(1+\lambda_1)L}(NFR-\dot{p})_{t-1} + other\ terms,$$

where $L$ is the lag operator and where $\lambda_2$ is $-\lambda_1 a_2$. The coefficients ($w_i$) that appear on lagged levels of $NFR - \dot{p}$ are then of the form $\lambda_2, \lambda_2(1+\lambda_1), \lambda_2(1+\lambda_1)^2$, etc. The mean lag then can be calculated as follows:

$$Mean\ Lag = \sum_{i=1}^{\infty} w_i\, i / \sum_{i=1}^{\infty} w_i$$

$$= \frac{1}{(1-1-\lambda_1)^2} \times \frac{1}{\lambda_2 \frac{1}{1-1\lambda_1}} = -\frac{\lambda_1}{\lambda_1^2} = -\frac{1}{\lambda_1}.$$

13. This is confirmed by results of the formal Chow test that is discussed in the next subsection.
14. When inflation is measured by the behavior of the consumer price index or the Livingston survey, I get some mixed results. The statistical significance of the coefficient that appears on the funds rate spread is not robust over different sample periods.

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## NOTES:

1. However, attempts to avoid the mistakes of the past sometimes may lead to new mistakes. De Long (1997, p. 250) argues that ". . . at the deepest level, the truest cause of the inflation in the 1970s was the shadow cast by the great depression . . . ."
2. De Long (1997, p. 274) argues, "A mandate to fight inflation by inducing a significant recession was in place by 1979, as a result of a combination of fears about the cost of inflation, worry about what the 'transformation of every business venture into a speculation on monetary policy' was doing to the underlying prosperity of the American economy, and fear that the structure of expectations was about to become unanchored and that permanent double-digit inflation was about to become a possibility."
3. The 1977 amendment to the Federal Reserve Act requires the Fed to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." The Humphrey-Hawkins Act of 1978 affirms the responsibility of the federal government in general to promote "full employment and production. . . . and reasonable price stability," among other things.
4. Taylor (1993) used a log linear trend of real GDP over 1984.Q1 to 1992.Q3 as a measure of potential GDP. As discussed below, we have used a more flexible structural estimate.
5. For a complementary analysis, see Taylor (1997).
6. Given the lags in the monetary transmission mechanism, an explicitly forward-looking version of the Taylor rule—with inflation and output *forecasts* as arguments—also might be appropriate. Clarida, Gali, and Gertler (1997a, 1997b) estimate a rule using inflation forecasts and ob-

tain results similar to our own, and Rudebusch and Svensson (1998) examine the theoretical properties of such a rule.

7. The Taylor rule has gained the attention of some Fed policymakers (Blinder 1996, *Business Week* 1996, Meyer 1998, and Yellen 1996), who have used it as a helpful, broad characterization of U.S. monetary policy. In addition, it has gained some acceptance outside the Fed as a way to think about how the Fed might react to economic and inflationary developments (Prudential Economics 1996, and Salomon Brothers 1995a, 1995b). Of course, there are always questions about the reliability of any current implications of the rule because of uncertainty about the level of potential GDP. Some analysts argue that increased productivity, due to computer and other technological developments, means that potential output is being mis-measured. See Trehan (1997) for a discussion of the debate about productivity.
8. We use current data throughout this paper. It would be preferable to use the original data that policymakers actually were looking at when decisions about the funds rate were being made. Unfortunately, we do not have access to these data for our full 1970–1997 sample period. See Orphanides (1997) for an analysis of the effects of original versus final data in estimating a Taylor rule for the 1987–1992 period.
9. Mehra (1994) employs a similar dynamic specification.
10. We think that this "error correction" framework is a useful one for the consideration of dynamics. However, although the funds rate, the output gap, and the inflation rate are highly persistent, we make no claims that they are nonstationary (consistent with Rudebusch 1993).
11. This is analogous to using the average unemployment rate over periods with no net change in inflation to estimate a constant "natural" rate of unemployment (or NAIRU).
12. The real rates in Table 1 are calculated on an ex post basis as in equation (1), but similar results were obtained using ex ante rates constructed with the one-year-ahead inflation forecasts from the Philadelphia Fed's inflation expectations survey.
13. Still, it is possible that the equilibrium rate was elevated during the Volcker period given the large federal budget deficits. For a model-based definition of a time-varying equilibrium rate, see Bomfim (1997).
14. There is also, of course, the issue of time variation in $\pi^*$ and $r^*$ (as noted in footnote 13). Even during a given Chairman's term, there may well be changes in the target inflation rate. Indeed, this is the essence of the opportunistic approach to monetary policy described by Bomfim and Rudebusch (1998).
15. This series is conceptually similar and highly correlated with the $Q^*$ series in Braun 1990; Hallman, Porter, and Small 1991; and Orphanides (1997).
16. Given the lags in the transmission process of monetary policy, there is little danger of reverse causation from $i_t$ to $\pi_t$ and $y_t$.
17. The $Q$-statistic suggests the possibility of autocorrelation in the regression. Much of this may be due to our use of time-aggregated data. When we respecified the regression using end-of-quarter funds rate data, the $Q$-statistic did not show signs of autocorrelation, the lagged change in the funds rate became statistically insignificant, and the other coefficients were close to the results in the original specification. This result adds to our confidence in the specification of the right-hand-side variables in regression B, which we retained in the interest of obtaining an equation that can be used in a quarterly macroeconomic model with quarterly average measurement of the funds rate.
18. This regression shows signs of autocorrelation (the $Q$-statistic has a $p$-value of 0.6 percent). As with the Greenspan regression, when the funds rate is defined in terms of the level of the last week in the quarter, rather than as a quarterly average, the coefficients in the equation change very little, but the $Q$-statistic becomes insignificant.
19. The equations were estimated from 1961.Q1 to 1996.Q4. See Rudebusch and Svensson (1998) for details. The estimates in (5) and (6) differ very slightly from those in that paper because of the longer sample and data revisions.

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