A Perspective on U.S. International Trade

William Poole

I am very pleased to be back in Louisville again, to meet tomorrow with the board of the Louisville branch of the Federal Reserve Bank of St. Louis and today to discuss trade issues with the Louisville Society of Financial Analysts. Trade is an important issue for the United States and for the entire world. My purpose is to review the fundamentals of the argument for free trade in the hope that returning to basics will be helpful to public understanding of trade issues.

A well-known joke says that you could lay all the world's economists end to end and they still wouldn't reach a conclusion. And Harry Truman's famous plea was for a one-armed economist. In fact, there is no issue on which economists are more closely in agreement than the fundamental case for free trade. Economists end to end see eye to eye on this issue, and the two-armed economist does not go through the usual dance "on the one hand, on the other hand" when discussing the fundamental case for free trade. There are special cases and temporary exceptions that modify the case for free trade, but they do not challenge the basic argument.

Despite this consensus among economists, substantial public opposition to reducing trade barriers exists. In fact, opposition can be found at both the left and right ends—and the middle—of the political spectrum.

In my remarks today, I will address three questions. First, why do economists support free trade policies? Second, what are the reasons for public opposition? Third, what can be done to narrow the gap between economists and those opposed to free trade?

Before proceeding, I want to emphasize that the views I express here are mine and do not necessarily reflect official positions of the Federal Reserve System. I thank my colleagues at the Federal Reserve Bank of St. Louis for their comments—especially Cletus Coughlin, vice president in the Research Division, who provided special assistance. However, I retain full responsibility for errors.

THE OPINIONS OF ECONOMISTS AND THE GENERAL PUBLIC ON FREE TRADE

A 1990 survey of economists employed in the United States found that more than 90 percent generally agreed with the proposition that the use of tariffs and import quotas reduced the average standard of living.[1] These results are more than a decade old; however, few economists would disagree with the following statement that appeared in 2001: "The consensus among mainstream economists on the desirability of free trade remains almost universal."[2]

On the other hand, the general public is much more reluctant to reduce trade barriers than economists are. Well-publicized protests against meetings to discuss the reduction of trade barriers have become common. The concern about free trade policies is not limited to the protestors. In a 1998 survey, only 32 percent of the general public was in favor of eliminating tariffs and other import restrictions to achieve lower prices when the cost would be that certain jobs in import-competing industries would likely be eliminated.[3] Meanwhile, 49 percent were more sympathetic to the argument that tariffs are necessary to protect jobs.

WHY ECONOMISTS SUPPORT FREE TRADE POLICIES

Underlying the consensus among economists is the judgment that nations are better off with free

[1] See Alston, Kearl, and Vaughan (1992).

[2] See Mayda and Rodrik (2001, p. 1).

[3] See Reilly (1999).

William Poole is the president of the Federal Reserve Bank of St. Louis. This article was adapted from a speech of the same title presented at the Louisville Society of Financial Analysts, Louisville, Kentucky, November 19, 2003. The author thanks colleagues at the Federal Reserve Bank of St. Louis for comments: Cletus Coughlin, vice president and deputy director of research, provided special assistance. The views expressed are the author's and do not necessarily reflect official positions of the Federal Reserve System.

Federal Reserve Bank of St. Louis *Review*, March/April 2004, *86*(2), pp. 1-7.

trade than with policies restricting trade. Before I begin discussing the analytics of international trade, let's begin by thinking about our own behavior. Most of us have jobs. With the income from our jobs, we buy numerous goods and services—food, clothing, fuel, houses, entertainment, and so on. Our economic behavior reflects the fact that we live in a highly interdependent world in which jobs are specialized. A typical household buys goods and services produced not only in its home state but also throughout the United States and the rest of the world. Indeed, each of us directly consumes only a tiny proportion of our production—the most important exception is household services, such as cleaning, cooking, and yard care. Would our lives be better if each of us individually grew all of our food, made all our clothes, pumped and refined all our oil, built our own houses and made movies? Obviously, the answer is no. Even the early settlers on the American frontier relied on others to make many of their tools, for example. Pure self-sufficiency is a recipe for a Stone Age standard of living.

Broadening the arena for trade just a little would help just a little. Would the residents of Kentucky be better off if they traded only with others in Kentucky and had no economic relationships with the rest of the United States? Once again, the answer is no. By specializing in certain activities, regions as well as individuals are able to maximize the value of work effort. By producing most goods and services for sale to others, we trade our output for the goods and services that we are not especially adept at producing.

The wisdom of specialization and exchange that holds for individual and interregional trade holds for international trade as well. Nearly 200 years ago, the economist David Ricardo demonstrated the gains from trade. To explain the principle of comparative advantage he used the example of England and Portugal trading cloth and port wine. The trade made both countries better off. His work was a generalization of Adam Smith's great insights concerning the gains from exchange.

Ricardo's theory of comparative advantage showed that nations, similar to individuals, gain from trade. Assuming that relative prices, such as the price of an apple relative to the price of a shirt, differ across two countries, then both countries can gain from trading with each other. An important point is that, even if the average worker in one country is more productive in producing each and every good than the average worker in the other country, gains from trade are possible. The gains from trade depend on *comparative* and not *absolute* advantage.

I believe it was Paul Samuelson, the first Nobel Laureate in the United States, who gave this example: Suppose an economist is a brilliant theorist and the best typist in the university. Should the economist type her own papers? Clearly, the economist will be more productive if she hires a secretary to do the typing; she, the economist, has a comparative advantage in developing economic theory and he, the secretary, has a comparative advantage in typing.

The same principle of comparative advantage holds for a country. If Portugal can produce both port wine and cloth with fewer hours of labor input per unit of output than can England, it will still pay Portugal to produce wine and trade with England for cloth, assuming that England is comparatively more efficient in producing cloth than wine. The proposition generalizes to many goods and many countries. As long as resources move into those activities in which the country is most advantaged or least disadvantaged, then all trading partners can be better off by trading some of the output that they produce at relatively low cost for some of the output that they produce at relatively high cost.

So far my discussion has focused on what economists term the "static gains" from trade. These gains arise from the reallocation of existing productive resources and the subsequent international trade. Free trade might also generate dynamic gains by stimulating economic growth. Economic theory suggests a number of routes by which free trade stimulates economic growth by increasing either productive resources or technological change. In practice, these increases are often triggered by the spur of competition when countries liberalize trade. There are many success stories of growth through trade, and no such stories of growth through self-sufficiency as far as I know.

An important growth mechanism arises when trade raises a country's real income, some of which is saved. The increased saving raises the availability of funds for investment spending, which augments a country's productive capital stock. Developing countries with relatively liberal trade regimes also commonly attract capital from abroad, further augmenting resources devoted to capital formation.

Free trade also increases the possibility that a firm importing a capital good will be able to locate a supplier who will provide a good that more nearly meets its specifications. The better the match, the larger is the increase in the firm's productivity. A

related idea is that international trade may spur the diffusion of technology by increasing the commercial contacts between employees in firms from different countries.

Another route for economic growth arises due to the increased competitive pressures associated with international trade. By reducing trade barriers, firms that were previously protected are now faced with competitors and, unless they become more efficient and responsive to consumers, they will perish. The result is that productive resources will be used more efficiently in producing goods that consumers desire.

A final route arises because, as trade barriers are reduced, the size of the market that a firm faces increases. In some cases, firms may be able to expand output at lower per-unit costs. The larger market size might also spur increased research and development spending that could spur additional growth.

How does the theory of international trade work in practice? Specifically, does international trade allow a country to achieve a higher real income than it would have otherwise achieved? The short answer is yes, but it is hard to pin down by precisely how much.[4] For a country as a whole, the gains are bound to be less for a large country such as the United States than for a small country such as Belgium. Clearly, the costs to Belgium of cutting off all trade with those outside its borders would be huge, as would also be true for a state with roughly similar population, such as Ohio.

There is an enormous professional literature on cases in which some protection might be justified or justified for a short period of time. My own judgment is that few of these arguments really stand up to rigorous analysis. I believe that the correct starting point for analysis is always that trade restriction imposes net costs on society. That is, protection produces gains for some and costs for others, but the net of gains and costs is negative.

The professional literature provides estimates of the cost of protecting a variety of industries. It is not uncommon to find estimates indicating that the cost per job saved is more than $500,000 or in some cases even as large as $1 million.

REASONS FOR PUBLIC OPPOSITION

If the logic and evidence supporting free trade is so convincing for economists, why is the general public reluctant to embrace free trade? I'll develop three themes in attempting to answer this question. The first theme is that many people do not understand the benefits of free trade. I'll call this "Theme LU," where "LU" stands for "lack of understanding." The second theme is that certain industry groups are able to apply their political power to gain protection, usually because those who bear the costs of protection are inadequately represented in the political process. I'll call this "Theme PP," where "PP" stands for "political power." My third theme is that protection can result from a fully reasoned preference to pay the costs to provide protection because the costs are spread across a wide number of people and because those who are protected would be severely impacted by free trade. I'll call this "Theme RP," where "RP" stands for "reasoned preference."

A good place to begin developing these themes is to reflect first on the case for free trade within the United States. One of the great achievements of the U.S. Constitution was to ban trade restrictions, with minor exceptions, across state lines. Since the early days of the United States, trade within the country has been a great source of economic growth. Some of the transitions have been painful for regions losing jobs, and yet public support for free trade within the United States has never been shaken. New England, especially, has seen many of its manufacturing industries move to other parts of the country and outside the United States as well. The movement of the textile industry to the South is the most famous example. To this day, a traveler in New England can see numerous textile mills built in the 19th century still standing, but converted to other uses.

The job losses in New England were painful, and it took many years to restore full employment there. Workers had to retrain, and some found that they could never restore their previous level of income. Yet the nation supported the industrial transformation, and not just because the Constitution demanded it. New jobs appeared in southern mills, lifting many workers out of rural poverty. The situation was one of "us against them" but the us and the them were in the same country, though in different regions. In some cases, government aid softened the blow suffered by newly unemployed workers in New England, but for the most part they and their families bore the costs of the industrial transformation.

Once the transformation was complete, both New England and the South gained from the new patterns of trade within the United States. The regions as a whole gained, but obviously many

[4] See Frankel and Romer (1999) and Irwin and Terviö (2000).

individuals and individual firms in New England did not. Trade does create losers, even though regions as a whole gain.

The gains from international trade are harder to understand than the gains from interregional trade. Within a country, it is easy to see that trade creates jobs in some regions and destroys jobs in other regions. Some of the adjustments from international trade involve job creation abroad and job losses at home. The gains from such trade are much harder to understand. This lack of understanding—my Theme LU—has a lot to do with support for restrictions on international trade.

Let me try to dispel some of the poor understanding of this issue. I'll focus on job gains and losses. On the surface, in any given country it appears that exports add jobs and imports cost jobs when workers in the home country find that they cannot compete with low-cost goods from abroad. So, it appears that a country could add jobs in total by subsidizing exports and blocking imports. Let's follow the logic of just such a policy, and let's assume that no countries abroad retaliate. Let's also assume that the home country is capable of producing all the goods that had been imported, so that blocking all imports does not create any untenable shortages of particular commodities.

Suppose exporters insist on payment in dollars for the goods they sell. How will foreigners obtain dollars once all their exports to the United States are cut off? Will U.S. banks lend the dollars, even though foreign firms have no possibility of selling goods in the United States to obtain dollars to repay loans? The answer is obvious.

Or perhaps U.S. exporters will accept foreign currency in payment for the goods sold abroad. What will they do with the foreign currencies? The currencies cannot be used to buy goods to import into the United States because all imports are blocked. The foreign currencies cannot be sold abroad for dollars because foreigners have no dollars to sell as a consequence of not being able to earn dollars through sale of goods to the United States. Exporters could use the foreign currencies to buy assets abroad, such as land, but presumably at some point they will tire of exchanging all their goods for foreign assets.

This argument makes clear that the heart of the argument against restricting imports is that doing so restricts exports. Every exporting firm and every worker employed by such a firm ought to have an intense interest in maintaining free trade. The connection may seem remote, but it is real: every dollar of blocked imports is also, at least eventually, a dollar of blocked exports. To point out the folly of the view that exports are good and imports bad, a 19th century economist satirically wondered whether the best outcome would be for ships transporting goods between countries to sink so that all countries could have exports without imports.

It is clear that imports and exports are connected in a fundamental way. Nevertheless—and this is a key point—a dollar of blocked imports has concentrated positive effects for the protected industry but diffuse negative effects across all export industries, amounting to pennies per item for any given export industry. In terms of jobs, blocking imports has obvious job benefits for the protected industry, whereas the job losses from reduced exports are spread widely across many industries. Trade restriction produces concentrated benefits and extremely diffuse and hard to understand costs. The costs are borne by export firms and their workers and by consumers who pay higher prices.

This fact, that protection produces concentrated gains and diffuse losses, is the source of Theme PP. Industries suffering from imports have a great incentive to seek redress through the political process, and they are often successful in doing so. Industries suffering a handful of job losses, and consumers paying a few pennies more for the goods they buy, may not even notice the losses. In any event, because the losses are individually small, those bearing the losses have no incentive to organize politically to fight protection. But keep in mind that a job loss here, and two or three there, can add up to many job losses per job saved in a protected industry.

My third theme is that fully informed voters might rationally prefer protection in some cases. Being unemployed, regardless of its length, is a noteworthy cost that generates opposition to proposed trade policy changes from both those likely to be adversely affected and those who empathize with them.

Consider the policy choices available to policymakers who are trying to protect jobs. There are really only three options. One is to swallow hard and do nothing. This option may sound cruel, but the fact is that the government leaves family and markets to handle many types of misfortunes that befall us. A second is to provide adjustment assistance to help workers make the transition from industries suffering intense import competition to new industries.

A third option is to impose import restrictions.

As I have already emphasized, these restrictions impose costs on the rest of society. A natural question is why individuals, including those with relatively low incomes, should bear the costs of maintaining jobs in other industries. The question is particularly pointed when workers in protected industries are earning wages above the national average.

In some cases, certainly, protection improves the job and income prospects of low-income workers. Many voters do appear willing to support trade restrictions to protect such workers. Protection in these circumstances seems to fit my Theme RP—that voters have a reasoned preference to bear the costs of protecting low-income workers. The willingness, therefore, to support trade restrictions may in some cases simply reflect a concern for others.

This sense of community may extend beyond U.S. borders. Many U.S. consumers appear willing to pay higher prices for items produced under better working conditions in developing countries. Moreover, most Americans favor linking labor standards to trade. For example, the 1999 Program on International Attitudes survey found that 93 percent of respondents felt that as part of international trade agreements countries should be required to maintain minimum standards for working conditions.[5] However, this linkage may instead reflect self-interest. By effectively raising the cost of its competitors, higher labor standards would serve the interests of those being harmed by the imports from low-cost competitors.

Similar to linking labor standards to trade, some sentiment exists for linking environmental standards to trade. Underlying this sentiment is a belief that by stimulating growth, trade contributes to environmental problems. Some of the concern about the environment can be linked to U.S. jobs. One argument is that lower environmental standards abroad make the U.S. a less-competitive location and induce firms to relocate. Thus, by harmonizing environmental standards, the disadvantages of production in the United States due to environmental controls would be eliminated.

Many economists, however, would argue that environmental problems should be handled nationally and that international differences in environmental standards are natural. Moreover, economic growth provides both the resources and the demand to raise a country's environmental standards. In fact, the ideal tradeoffs between economic growth and environmental quality that a country might make are likely to depend on its level of economic development. For example, research by economists Gene Grossman and Alan Krueger finds an inverted U-shaped relationship between pollution and economic development.[6] For very poor countries, increases in per capita gross domestic product are associated with worsening environmental conditions. Beyond some income level, however, increases in per capita gross domestic product are associated with improving environmental conditions; wealthier societies can and do spend more on pollution control. The turning point varies for the specific pollutant, but in almost every case the turning point occurs at a per capita income of $8,000 or less in 1985 dollars. Thus, raising the income of poor countries, a direct result of increased international trade, may be the most important factor in improving environmental conditions in low-income countries.

Despite the insights from my second and third themes, I return to Theme LU—that attitudes toward trade are heavily influenced by a lack of understanding. Quite generally, the public fails to see any broad-based gains from trade. For example, the 1999 Program on International Attitudes survey found that Americans viewed the benefits of trade as flowing to business, rather than to themselves or to American workers in general. Although the survey did not ask respondents whether they thought gains from trade went to foreigners, I'm guessing that many Americans do believe that foreigners harvest the gains and the United States loses from trade.

The difficulty of envisioning broad-based gains for the United States is understandable. It is difficult for the general public to perceive that reducing import barriers lowers prices, raises average wages, and improves jobs across a wide range of U.S. industries. It is also difficult for the general public to envision how freer trade will spur economic growth that will improve its well-being. Because U.S. international trade is already largely free, the gains for an average U.S. individual of fostering free trade are small. In other words, the gains from even freer trade as a share of total economic activity in the United States are relatively small; however, the total gains are substantial.

The general public is also concerned about the large and increasing U.S. trade deficit. Some of the concern reflects a view that U.S. exports should equal U.S. imports. This view fails to appreciate

[5] See the University of Maryland, Program on International Policy Attitudes (PIPA).

[6] See Grossman and Krueger (1995).

that a country's trade balance and its capital account are very closely related. In a speech November 14, 2003, at the Tucson chapter of the Association for Investment Management Research, I examined this relationship. I do not have time today to develop the points I made in that speech, so I will summarize some key points.

Via basic accounting, a country's capital account surplus is equal to its current account deficit. For simplicity, let's view the current account deficit as the trade deficit. A common mistake is to treat international capital flows as though they are passively responding to what is happening in the trade account. In fact, investors abroad buy U.S. assets not for the purpose of financing the U.S. trade deficit but because they believe these assets are sound investments, promising a good combination of safety and return. On a personal level, every one here has the option of moving funds abroad, for example, through mutual funds that invest in foreign stocks and bonds. Why is the net capital flow into rather than out of the United States? The reason is that for most investors the United States is the capital market of choice. There is no better place in the world to invest.

In sum, the United States has created for itself a comparative advantage in capital markets, and we should not be surprised that investors all over the world come to buy the product. As investors exploit the opportunities provided by U.S. financial markets, trade deficits can arise. Thus, my view is that our current trade deficits are not a cause for alarm because on the whole they reflect extremely positive forces driving the U.S. capital account.

NARROWING THE GAP

Now let me turn to the issue of how to narrow the gap between the opinions of economists and the general public. The first response of economists to narrowing the gap involves education. That is the obvious implication of Theme LU. However, the educational challenge is large because the majority of the general public will not be sitting through an international trade course. These communication issues are especially important because economists' arguments are often focused on issues that the general public tends to ignore or, at least, downplay.

Economists often focus on consumption aspects of international trade. They stress that free trade allows for increases in well-being because consumers can buy more and varied goods at lower prices. Public discussions, however, usually focus on jobs and production.

The statement that imports destroy some jobs is certainly correct; however, the key point is that trade causes a change in the distribution of jobs and no major change in the number of jobs, once adjustments to changing trade patterns are complete. The nature of the popular discussion highlights the job destruction aspects of trade and downplays the job creation aspects of trade. It is far easier to identify a closed plant or laid-off factory workers than it is to find the new economic activity, which is often widely dispersed, resulting from a reduction in trade barriers.

It is easy to see why workers losing their jobs would be passionately opposed to international trade. Conversely, the diffuse beneficiaries of free trade may not even realize that their good fortune arises from free trade. To maintain support for free trade policies, therefore, it is important to identify export success stories and to stress the broad-based gains to consumers stemming from lower prices.

In light of the costs imposed on some by trade, an argument can be made that programs should be available to reduce the cost for those harmed. The trade adjustment assistance program, which is administered by the U.S. Department of Labor, allows those who lose their jobs because of increased imports to receive unemployment compensation for an additional period beyond that received by other displaced workers. In addition, trade adjustment assistance recipients can also participate in retraining programs plus receive out-of-area job search allowances and moving expenses.

To the extent that this program is sufficiently funded and successful, it is possible that this program would reduce workers' lobbying efforts against trade liberalization. Even if voters are motivated by their perceptions of collective well being and not simply their own individual well being, trade adjustment assistance might increase support by those who gain and those who lose.

A third way to bridge the gap between supporters and detractors of trade liberalization is to increase the topics involved in trade negotiations. Sentiment is strong for linking labor and environmental issues with trade negotiations. Sentiment also exists for multilateral trade negotiations to deal with investment policy, competition policy, electronic commerce, and better enforcement of intellectual property rights. What is unclear is whether such changes would ultimately increase the prospects for liberalizing trade. Expanding the agenda might provide negotiators with more opportunities for

compromise; however, expanding the agenda might also bog down negotiations by introducing issues upon which compromise is very difficult.

Negotiations to reduce trade barriers are motivated by the desire to reap the benefits from freer trade. Negotiations—whether they are multilateral, regional, or bilateral—are always contentious. The multilateral agreements underpinning the World Trade Organization attempt to counteract protectionist pressures. As a last resort, the dispute settlement process allows countries to retaliate against a member found in violation of an agreement.

Retaliation provides a mechanism to enforce the treaty. We might also think of targeted retaliation as a way to make highly visible the job losses in export industries when a country imposes import restrictions. As argued earlier, in the absence of targeted retaliation, job losses in export industries are widely scattered and difficult to identify. Targeted retaliation, however, can create visible, concentrated costs on certain export industries—costs that are designed to create political opposition to import restrictions. I might note that nations ratifying the WTO treaty were very familiar with the retaliation rules, as they had been applied for many years under WTO's predecessor organization, the General Agreement on Tariffs and Trade, or the GATT.

CONCLUSION

I can summarize my perspective on international trade in a few words. Free trade is a policy that increases economic well being for a country as a whole. Specialization and exchange are the routes that generate the benefits. Specialization allows for increased productivity and higher wages, while open markets are more competitive and yield lower prices for consumers.

I've suggested three themes as to why free-trade policy continues to be a matter of controversy: first, that many trade issues are poorly understood; second, the concentrated nature of adverse trade effects combined with the diffuse nature of trade gains creates a political dynamic favoring protection in some cases; and, third, in some cases voters may prefer to pay the costs of protection for the purpose of sheltering vulnerable groups from the full rigors of open international markets.

The challenge for educators, economists, and policymakers is to find ways to increase political support for free trade. It is clear that there is much work left to be done.

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State Government Finances: World War II to the Current Crises

Thomas A. Garrett and Gary A. Wagner

States are facing their most severe budget crises in the post-World War II era. Recent data from the National Conference of State Legislatures (NCSL), however, suggest that these budget crises may be softening. Initially, in April 2003, the NCSL reported that aggregate state budget deficits for fiscal year (FY) 2003 would be in the range of $20 to $30 billion, and possibly as large as $78 billion in FY 2004[1]; more than half of the states were projecting a budget deficit in excess of 5 percent of general fund revenue for FY 2004, and one in four states was forecasting a deficit greater than 10 percent. In contrast to the April 2003 figures, the NCSL reported seven months later in November 2003 that state budget deficits totaled $17.5 billion for FY 2003, states projected a cumulative deficit of $2.8 billion for FY 2004, and only ten states were projecting budget deficits for FY 2004.[2]

Much of the reduction in budget deficits is a result of spending cuts, tax and fee increases, and moderate revenue growth that occurred during late 2003. The National Governors Association reported in June 2003 that more than 37 states have reduced their FY 2003 budgets by $14.5 billion using these various instruments.[3] However, the National Governors Association also reported that 19 states (a historically high number) still propose a negative-growth budget for FY 2004.

This article will explore the extent, causes, and proposed solutions of the current fiscal crises from a historical perspective of state finance. Although the current fiscal crises are severe, it becomes more difficult to assess without a more complete understanding of the historical changes that have occurred in state revenue and expenditure streams. This article will address the role of major expenditures and revenue sources in the context of the current slowdown and how reliance on various revenue sources has changed over the past 50 years. The role of nontraditional revenue sources, such as state lotteries and casino gaming, will also be discussed. The article further addresses various fiscal institutions—such as tax and expenditure limitation laws, rainy day funds, and balanced budget rules—and explores the role each play in state budgeting and finance.

A HISTORY OF STATE FINANCES

State Expenditures

While the underlying cause of fiscal stress is the inability of states to forecast precisely when and by how much revenue growth will decline, expenditures also play an important role in state fiscal health. As Holcombe and Sobel (1997) note, because government services such as education and health care tend to be provided at costs below comparable private sector services, the demand for government services will exceed the state's limited resources. Over the past decade, state budgets have been under considerable pressure from rapidly rising Medicaid expenditures, unfunded federal mandates in the area of health and human services, and a growing prison population.

As Table 1 demonstrates, expenditures for state governments topped $1.18 trillion in FY 2001, with education and public welfare expenditures accounting for more than 50 percent of the typical state's budget. Education expenditures include spending on higher education, elementary and secondary education, Veteran's education benefits, and public libraries. Spending on higher education accounts for the bulk of state education spending, but there has been a trend toward a larger role for states in elementary and secondary education. Public welfare expenditures include outlays related to Medicaid,

[1] NCSL (2003a).

[2] NCSL (2003b).

[3] National Governors Association (2003).

Thomas A. Garrett is a senior economist at the Federal Reserve Bank of St. Louis, and Gary A. Wagner is an assistant professor of economics at the A.J. Palumbo School of Business, Duquesne University. Molly D. Castelazo provided research assistance.

Federal Reserve Bank of St. Louis *Review*, March/April 2004, *86*(2), pp. 9-25.

Table 1

Summary of State Expenditures, FY 2001

	Amount (billions $)	Percent of total expenditures	Percent of general expenditures
Total expenditures	1,184.1		
General expenditures	1,043.3	88.1	
Education	374.5	31.6	35.9
Public welfare	260.3	22.0	24.9
Health and hospitals	78.3	6.6	7.5
Highways	78.8	6.7	7.6
Correction & police protection	48.3	4.1	4.6
Natural resources & parks	22.8	1.9	2.2
Interest on general debt	30.5	2.6	2.9
Other	149.9	12.7	14.4
Liquor & utility expenditures	22.0	1.9	
Insurance trust expenditures	118.8	10.0	

SOURCE: U.S. Census Bureau, State Government Finances: www.census.gov/govs/www/state.html.

public nursing homes, children's services such as orphanages and foster care, and services for the homeless.

The largest remaining components of expenditures, in descending order of importance, include insurance trust expenditures, highways, and health and hospitals.[4] Combined with education and public welfare, these five categories constitute roughly 75 percent of state expenditures. In addition to the states' expanding role in providing education and welfare services, unfunded federal government mandates in those areas and education finance lawsuits place substantial pressure on state budgets.[5]

[4] Insurance trust expenditures are payments made to beneficiaries of public retirement systems. Highway spending includes expenditures on the construction, operation, and repair of toll highways, non-toll highways, roads, bridges, and tunnels. Health and hospitals expenditures includes spending on the construction, operation, and repair of public hospitals (including veteran's hospitals), as well as spending on unemployment compensation and insurance, disability benefits, and veterans' benefits.

[5] An unfunded federal mandate is a rule requiring state governments to provide services or goods without receiving federal compensation. See Gold (1995) for a more thorough discussion of changes in Medicaid and the role of unfunded federal mandates in the 1980s and 1990s. According to the Advocacy Center for Children's Educational Success with Standards, 29 education finance lawsuit decisions have been made since 1989. In 19 of these cases, courts ruled that education finance systems were inequitable, inadequate, or both. Additional information regarding education finance lawsuits may be found at www.accessednetwork.org.

There have been some noticeable changes in the relative importance of major spending categories over time, as demonstrated in Figure 1. In 1950, for instance, spending on education, public welfare, and highways represented near-equal shares of expenditures (roughly 20 percent for each area). The most dramatic decline since 1950 has occurred in the area of highway spending, falling from about 20 percent of the budget in 1950 to less than 8 percent today. The declining importance of highway spending is a result of a growing trend toward providing more public assistance and the fact that gasoline taxes used to finance highway spending are not indexed to inflation (which causes the real value of gasoline tax revenue to decline over time).

Education and public welfare spending have also changed considerably since 1950. Education spending increased markedly during the 1950s and 1960s, reaching a peak of 40 percent of expenditures in 1968, as states expanded their role in providing higher education. Since the late 1960s education spending has declined slightly, except for a mild increase in the mid-1990s, and remains that largest component of state spending at just over 34 percent of general fund outlays. It should be noted that, while education spending has declined slightly in relative importance, education spending has increased over time with the growth in state budgets.

In contrast to education, the trend in public welfare spending has experienced a sizable increase twice in the past 50 years. Following the creation of Medicaid in 1965, public welfare spending grew from 13 percent of the budget to 19 percent by 1972.[6] Welfare spending remained at around 19 percent of the budget until 1990, when changes in Medicaid made more children and low-income women eligible for benefits. As a result, public welfare spending (driven almost entirely by Medicaid spending) rose from 19 percent to more than 26 percent of general expenditures during the 1990s. Snell, Eckl, and Williams (2003) contend that the rapid increase in Medicaid spending was due to expanded enrollment in the program, demographic changes, and rising health care costs.

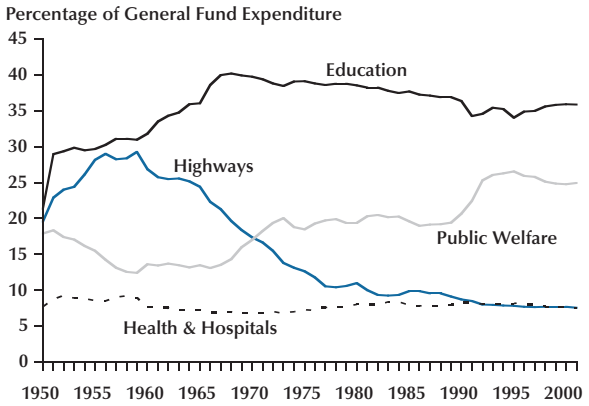
Medicaid is an entitlement program, which means that states are compelled to provide benefits once eligibility is established, so states can do very little to control the cost of the program. Dye and McGuire (1998) find that, in response to recessions, public welfare spending rises, while education spending falls. The fact that policymakers have little discretion over public welfare spending and considerable discretion over education spending is the primary reason why education spending (particularly higher education) tends to be one of the hardest hit areas of the budget as states attempt to close deficits.

State Revenue Sources

Although revenue generated from taxation is the primary source of funds for state governments, states receive revenue from a variety of sources. As Table 2 illustrates, state governments collected nearly $1.2 trillion in revenue during FY 2001, with just over 47 percent coming from own-source taxes. The remaining sources of revenue, listed in descending order of relative importance, include intergovernmental revenue (the bulk of which is federal grants), insurance trust revenue, revenue from user charges and fees, and revenue from state-operated liquor establishments and utility companies.[7] The two largest sources of revenue, taxes and intergovernmental grants, accounted for nearly 75 percent of state revenue in FY 2001.

Figure 1

Sources of State Expenditure, 1950-2001



In terms of own-source tax revenue, the data in the column "Percent of total revenue" show the importance of various taxes as a share of total revenue, and the data in the column entitled "Percent of tax revenue" illustrate the significance of these same taxes as a share of tax revenue. For instance, while individual income taxes accounted for 17.6 percent of total state revenue in FY 2001, they accounted for more than 37 percent of all tax revenue.

As the data demonstrate, nearly 70 percent of all state tax revenue comes from two sources—individual income taxes and general sales taxes. A general sales tax is applicable to all sales of goods and/or services (with perhaps an exemption for food). A selective sales tax is applied (often in addition to the general sales tax) to the sale of specific items such as alcohol, tobacco, motor fuel, and pari-mutuel wagering. Selective sales taxes are also called excise taxes. If one defines sales taxes broadly to include both general and selective sales taxes, then individual income and sales taxes account for slightly more than 83 percent of state tax revenue and nearly 40 percent of total state revenue. The remaining sources of tax revenue—license taxes, corporate income taxes, and other taxes—account for 17 percent of tax revenue and 8 percent of total revenue.[8]

State governments have historically relied on individual income and the sale of goods and services

[6] Medicaid spending now makes up roughly three-fourths of all public welfare spending, making it the single largest program provided by the states. Although Medicaid is a federal program, it is administered and partially financed by the states.

[7] Intergovernmental revenue is revenue received from other governments, such as shared tax revenue and grants. Insurance trust revenue primarily includes contributions, premiums, and payroll taxes of employers and employees that participate in public retirement programs. User charges include fees or payments on such services as public school lunches, public hospitals, highways, parking, and sanitation.

[8] License taxes include revenue generated from the sale of licenses for selling liquor, hunting and fishing, and driving motor vehicles. Motor vehicle license taxes account for about half of all license taxes.

Table 2

Summary of State Revenue, FY 2001

	Amount (billions $)	Percent of total revenue	Percent of tax revenue
Total revenue	1,180.3		
Tax revenue	559.7	47.4	
Individual income tax	208.1	17.6	37.2
General sales	179.3	15.2	32.1
Selective sales	78.7	6.7	14.1
License taxes	32.9	2.8	5.8
Corporate income tax	31.7	2.7	5.7
Other taxes*	29.0	2.5	5.1
Intergovernmental revenue	305.6	25.9	
Insurance trust revenue	120.0	10.2	
User charges and fees	93.1	7.9	
Miscellaneous revenue†	90.9	7.7	
Liquor & utility revenue	11.0	0.9	

SOURCE: U.S. Census Bureau, State Government Finances.
*Includes casino tax revenue.
†Includes net lottery revenue (total sales minus prize payouts minus administration costs).

as primary tax bases. As Table 3 indicates, of the 43 states that currently utilize some form of an individual income tax, nearly three-fourths had their tax in place before World War II. Apart from the numerous rate and base changes that occurred, the most recent major changes in state individual income taxes occurred between 1961 and 1976, when 11 states began taxing personal income for the first time. Connecticut was the last state to make significant changes to their individual income tax when, in 1991, the state began taxing wage and salary income in addition to previously taxed interest and dividend income.

Along with the individual income tax, state governments have historically relied on corporate income as a source of funds. Of the 45 states that currently tax corporate income, more than 80 percent initially adopted the tax prior to World War II; the last two states to tax this base, Ohio and Florida, did so in 1971. Revenue generated from the taxation of corporate income presently accounts for less than 6 percent of state tax revenue and has never accounted for more than 9 percent. In addition, although gasoline tax revenue was not explicitly listed in Table 3, revenue from the taxation of motor fuel was a large component of state tax revenue, especially before the mid-1970s. All 50 states currently tax the sale of gasoline, and only Alaska and Hawaii did not have a gasoline tax in place before 1930.

The final tax base noted in Table 3, the general sales tax, is the newest major base to be added to states' portfolios of funding sources. Of the 45 states that currently impose a general sales tax, 21 adopted the tax in the post-World War II era. The adoption pattern of the general sales tax falls primarily into two distinct time periods—a first wave of states that adopted the tax during the Great Depression and a second wave that adopted the tax to help advance the expansion of government services that occurred in the 1960s.

While the data in Table 2 show that individual income taxes and general sales taxes are currently the largest components of state tax revenue, the relative importance of various taxes has shifted considerably over time. In 1950, for example, revenue from general sales taxes accounted for the largest share of general fund revenue, followed by the motor fuel tax, excise taxes on alcohol and tobacco, the individual income tax, and finally the corporate income tax. The relative importance of

Table 3

Adoption Dates of Selected State Taxes

	Individual income	Corporate income	General sales	Gasoline
Alabama	1933	1933	1936	1923
Alaska	1949*	1949		1946
Arizona	1933	1933	1933	1921
Arkansas	1929	1929	1935	1921
California	1935	1929	1933	1923
Colorado	1937	1937	1935	1919
Connecticut	1969†	1915	1947	1921
Delaware	1917	1957		1923
Florida		1971	1949	1921
Georgia	1929	1929	1951	1921
Hawaii	1901	1901	1935	1932
Idaho	1931	1931	1965	1923
Illinois	1969	1969	1933	1927
Indiana	1963	1963	1933	1923
Iowa	1934	1934	1933	1925
Kansas	1933	1933	1937	1925
Kentucky	1936	1936	1960	1920
Louisiana	1934	1934	1938	1921
Maine	1969	1969	1951	1923
Maryland	1937	1937	1947	1922
Massachusetts	1916	1919	1966	1929
Michigan	1967	1967§	1933	1925
Minnesota	1933	1933	1967	1925
Mississippi	1912	1921	1930	1922
Missouri	1917	1917	1934	1925
Montana	1933	1917		1921
Nebraska	1967	1967	1967	1925
Nevada			1955	1923
New Hampshire	1923‡	1970		1923
New Jersey	1976	1958	1966	1927
New Mexico	1933	1933	1933	1919
New York	1919	1917	1965	1929
North Carolina	1921	1921	1933	1921
North Dakota	1919	1919	1935	1919
Ohio	1971	1971	1934	1925
Oklahoma	1915	1931	1933	1923
Oregon	1930	1929		1919
Pennsylvania	1971	1935	1953	1921
Rhode Island	1971	1947	1947	1925
South Carolina	1922	1922	1951	1922
South Dakota			1933	1922
Tennessee	1931‡	1923	1947	1923
Texas			1961	1923
Utah	1931	1931	1933	1923
Vermont	1931	1931	1969	1923
Virginia	1916	1915	1966	1923
Washington			1933	1921
West Virginia	1961	1967	1933	1923
Wisconsin	1911	1911	1961	1925
Wyoming			1935	1923

SOURCE: ACIR (1994).

*Repealed in 1979.

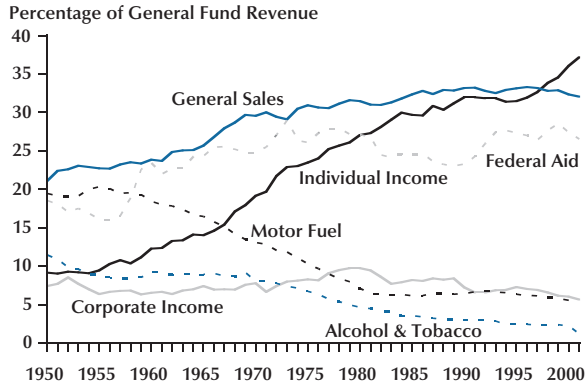
†Connecticut began taxing wage and salary income in 1991; prior to this date, income taxes were imposed on interest and dividend income.

‡Income taxes imposed only on interest and dividend income.

§Repealed in 1976.

Figure 2

Sources of State Tax Revenue, 1950-2001



major state revenue sources over the period 1950 to 2001, each measured as a share of general fund revenue, is illustrated in Figure 2.[9]

As Figure 2 shows, the relative importance of federal aid and tax revenue from individual income and general sales has increased considerably over the past 50 years, while revenue generated from the sale of alcohol, tobacco, and motor fuel has diminished in importance. During the 1950s, for instance, nearly 30 percent of general fund revenue was derived from alcohol, tobacco, and motor fuel taxes, compared with roughly 6 percent in 2001. The decline in tobacco tax revenue is due in part to individuals becoming more health conscious, and the decline in motor fuel tax revenue as a share of general fund revenue can be partly attributed to more fuel-efficient automobiles. Another explanation for their diminishing importance is that these taxes are linked to the quantity of goods consumed rather than the price of the goods. As a result, these taxes fail to keep pace with inflation.

The most striking series in Figure 2 are individual income and general sales tax revenue. The importance of individual income tax revenue has risen steadily over the past five decades and is now the single most important tax base. Climbing from 9 percent of general fund revenue in the early 1950s, revenue from individual income taxes surpassed revenue from general sales taxes in the mid-1990s before reaching its peak of 37 percent of general fund revenue in 2001. While increases in income tax rates and expansions in the income tax base have obviously contributed to the growing importance of this revenue source, the most rapid period of growth in individual income tax revenue occurred between 1960 and the mid-1970s when ten states initially adopted the tax. However, Figure 2 also reveals that the growth in income tax revenue during the economic expansion of the 1990s (when no states adopted personal income taxes) is near the growth during the 1960s and 1970s. Income tax revenue accounted for an increasingly higher percentage of general fund revenue during the economic boom of the 1990s, due to rapidly growing salaries and capital gains from stock options and bonuses.

In contrast to the individual income tax, the relative importance of general sales tax revenue has risen at a much steadier rate. At just over 22 percent of general fund revenue in 1950, revenue from general sales taxes now constitutes roughly 32 percent. In fact, the expansion in general sales tax revenue that occurred between 1950 and 1980 appears to have slowed and even declined slightly in the past decade. This trend can be attributed to the move toward a service-oriented economy on which general sales taxes are not typically applied, and also possibly to the growth in electronic commerce, which is generally not subject to sales taxes.[10]

Federal aid and corporate income taxes have not exhibited such a strong upward or downward trend as the other revenue sources. There is no question, based on Figure 2, that revenue from federal grants has fluctuated more than other revenue sources. However, the average revenue obtained through federal grants over the period (24 percent of general fund revenue) is only 1 to 2 percent lower than federal grant revenues during the economic boom of the 1990s. Similarly, revenue from corporate income taxes is currently less than 6 percent of general fund revenue and averaged 7.4 percent over the sample period.

Cyclical Variability of Tax Revenues. While historical shifts in the relative importance of revenue sources may seem disconnected from the current crisis and economic downturns in general, the composition of a state's revenue sources has a significant bearing on how revenue streams fluctuate with changes in economic activity (Holcombe and Sobel, 1997; Crain, 2003). If revenue streams in one state decrease more during downturns than revenue

[9] The share of general fund revenue, as opposed to total revenue, is used because a consistent series of total state revenue is not available prior to 1965.

[10] Buyers are required to pay sales taxes on electronic commerce if the firm has a physical presence (termed "nexus") in the buyer's state. See Goolsbee (2000) for a discussion of the issues surrounding taxation of electronic commerce. Industry and political developments on the issue can be found at www.ecommercetax.com.

streams in another state, then the state with the more volatile revenue stream would be expected to experience a much more severe fiscal crisis during any given recession. The amount by which revenue from a specific tax varies with the business cycle is referred to as the cyclical variability of the tax.

Since different sources of tax revenue are derived from different tax bases, each of which reacts differently to changes in the business cycle, the various sources of revenue for state governments will react differently to business cycle swings. Thus, if the portfolio of state revenues becomes more dependent on a revenue source that has a high cyclical variability, then in most cases the overall portfolio of revenue will also become more sensitive to changes in the business cycle. Following Holcombe and Sobel (1997), the cyclical variability of a tax in a given state is measured by estimating the regression

$$(1) \qquad \Delta\ln(Base_t) = \alpha + \beta \cdot \Delta\ln(Y_t) + \varepsilon_t,$$

where $Base_t$ is the tax base (taxable income, retail sales, etc.) for a particular tax at time t and Y_t denotes state real personal income at time t.[11] The estimated coefficient (β) is the measure of the cyclical variability of the particular tax base. Since $\Delta\ln(Base_t)$ and $\Delta\ln(Y_t)$ are the percentage changes in the tax base and personal income, respectively, β measures the percentage change in the tax base given a percentage change in personal income.[12] A value of β that is larger than 1 in absolute value indicates that revenue from a particular tax base is more volatile than aggregate economic activity, while a value smaller than 1 in absolute value indicates that it is less volatile.

With regard to the measure of cyclical variability in general, the tax base (and thus tax revenue) is procyclical if $\beta > 0$, countercyclical if $\beta < 0$, and independent of the business cycle if $\beta = 0$. Research has revealed that revenue tends to be procyclical for most sources of tax revenue.

Table 4 shows the cyclical variability of several sources of state tax revenue estimated by Holcombe and Sobel (1997). These estimates are based on the national aggregate of state tax bases, so gross domestic product (GDP) rather than state personal income was used in the regression equations. Each coefficient is statistically significant and, with the exception of the motor fuel and liquor taxes, all revenue sources are more variable than the business cycle. In the case of the corporate income tax, a 1-percentage-point decline in GDP will, on average, reduce corporate income tax revenue by more than 3 percentage points.

Table 4

Cyclical Variability of Selected State Revenue Sources

Revenue source	Estimate of β (standard error)
Individual income tax	1.164 (0.161)
General sales tax (with food)	1.229 (0.098)
General sales tax (without food)	1.612 (0.111)
Corporate income tax	3.369 (0.685)
Motor fuel tax	0.729 (0.175)
Liquor	–0.586 (0.225)

SOURCE: Holcombe and Sobel (1997, p. 92). β is obtained from the regression of $\Delta\ln(Base_t)=\alpha + \beta \cdot \Delta\ln(GDP_t) + \varepsilon_t$.

General sales tax revenue is considerably more stable when food is part of the tax base. This highlights a general but important theme regarding the variability of revenue—the more broadly a particular tax base is defined, the lower the cyclical variability of the revenue from that base.[13] The implication of a changing composition of state tax revenue should be very clear at this point: Over the past 50 years, states' reliance on motor fuel and alcohol and tobacco revenue has diminished, while reliance on individual income and general sales taxes has expanded. Thus, the typical state's tax portfolio has shifted away from revenue sources that are less cyclical than the economy and toward revenue sources that are more cyclical than the economy.[14]

[11] Tax revenue can be used instead of the tax base. However, this requires accounting for discretionary changes in tax policies and tax rates that occur over time. While tax bases may change over time, Holcombe and Sobel (1997) use broad-based tax bases rather than narrow-based tax bases to overcome this problem.

[12] Holcombe and Sobel (1997) refer to the estimated slope coefficient in equation (1) as the "short-run elasticity" to distinguish it from the "long-run elasticity" that measures how a particular revenue source grows over time. The long-run elasticity is found by estimating the above regression with the tax base and business-cycle variables in levels rather than first differences.

[13] Although there are a number of strategies that state policymakers may follow to reduce the cyclical variability of tax revenue, which in turn would smooth the overall revenue stream, such a discussion extends beyond the scope of this paper. See Holcombe and Sobel (1997) and Sobel and Wagner (2003) for additional details.

[14] Over time, however, the share of output generated from the relatively less cyclically sensitive service-producing industries has risen modestly in comparison with relatively larger cyclically sensitive good-producing industries. This would suggest that growth from individual income and corporate tax revenues (about 75 percent of total state revenues) should become less cyclical over time as well.

Table 5

State Lottery Start-Up Dates and FY 2002 Sales

State	First year of lottery	FY 2002 sales ($ millions)	State	First year of lottery	FY 2002 sales ($ millions)
Arizona	1981	294.82	Montana	1987	33.63
California	1985	2,915.90	Nebraska	1993	73.91
Colorado	1983	407.97	New Hampshire	1964	212.90
Connecticut	1972	907.90	New Jersey	1970	2,068.52
Delaware*	1975	674.01	New Mexico	1996	133.97
Florida	1988	2,330.36	New York	1967	4,753.62
Georgia	1993	2,449.36	Ohio	1974	1,983.11
Idaho	1989	92.67	Oregon*	1985	816.94
Illinois	1974	1,590.15	Pennsylvania	1972	1,934.16
Indiana	1989	626.31	Rhode Island*	1974	1,171.10
Iowa	1985	181.22	South Carolina†	2002	319.99
Kansas	1987	190.08	South Dakota*	1987	629.96
Kentucky	1989	638.72	Texas	1992	2,966.27
Louisiana	1991	311.62	Vermont	1978	81.99
Maine	1974	157.90	Virginia	1988	1,108.07
Maryland	1973	1,306.55	Washington	1982	438.61
Massachusetts	1972	4,213.22	Washington, DC	1982	211.13
Michigan	1972	1,688.04	West Virginia*	1986	848.63
Minnesota	1990	377.36	Wisconsin	1988	427.57
Missouri	1986	585.19	Total		42,153.43

SOURCE: North American Association of State and Provincial Lotteries (www.naspl.org), state lottery websites, and Clotfelter and Cook (1989, Chap. 8).
*Includes video lottery sales.
†Sales began January 2002.

Nontraditional Revenue Sources

State Lotteries. The first state lottery began in New Hampshire in 1964, and since that time 38 states and the District of Columbia currently have state lotteries, with Tennessee and North Dakota scheduled to begin lottery operations within the next year or two. Lottery sales in the United States totaled $42 billion in FY 2002, with states collecting over $13 billion in net lottery revenues.[15] The primary objective of state lotteries is to generate revenue, and lotteries are seen by proponents and state officials as a voluntary way to raise this revenue. Many states earmark lottery revenue for certain social programs such as education, senior citizen care, and economic development. On average, net lottery revenue accounts for roughly 2 percent of total state tax revenue.[16] FY 2002 lottery sales and start-up dates are shown in Table 5.

Several reasons have been cited to explain state lottery adoption. First, although lottery revenue is significantly more variable than non-lottery revenue, a low correlation between lottery and non-lottery revenue suggests that the variability in lottery revenue will not destabilize overall revenue.[17] Thus,

[15] From the North American Association of State and Provincial Lotteries (www.naspl.org): Net lottery revenue is gross sales minus prize payouts and other expenses such as retailer commissions, advertising, and general operations.

[16] See Clotfelter and Cook (1990) for a discussion on state lotteries and state lottery financing.

[17] Szakmary and Szakmary (1995).

lotteries are an attractive means for states to diversify their revenue portfolio. Further research has shown that the first states to adopt lotteries did so independently in response to fiscal pressures, but in later years states have adopted lotteries in response to the fear of lost revenue from lotteries in neighboring states.[18] This may be due to the fact that many states had begun to exhaust their traditional revenue sources and thus began to explore nontraditional sources of revenue. Adopting a nontraditional revenue source is arguably more politically appealing than raising rates on existing taxes or expanding current tax bases.

Using state lotteries to raise government revenue has been criticized for several reasons. First, research has shown that lotteries place a greater financial burden on the poor; that is, lower income individuals spend a higher percentage of their income on lottery tickets than higher income individuals.[19] While the regressivity of lotteries is also true for sales, excise, and payroll taxes, state governments do not actively promote these activities as they do their lotteries.

Second, while states justify the existence of lotteries by earmarking lottery revenues (e.g., for education), studies have shown that lotteries have not increased expenditures in these targeted areas.[20] This is because, like many revenue sources, lottery revenues are interchangeable within the state budget. State legislators can simply reduce the total amount of funds budgeted for, say, education by a certain amount and use the remaining funds elsewhere; then they can use lottery revenues to bring total education expenditures back to their pre-lottery levels.

Finally, the expected return to the player of most lottery games is about 50 cents on a $1 ticket. This 50 percent payback rate is much lower than on other gambling activities such as casino gaming, which has an average return of about 90 to 95 percent. Unlike casino gaming, which is regulated by the state, lotteries are essentially a state-run monopoly. Consumer welfare would certainly be enhanced if the payback rate on lotteries were higher, but this conflicts with the current revenue maximization goal of state lotteries.[21]

Casino Gaming. Casino gaming has become a major industry in the United States over the past two decades. Prior to the late 1980s, casino gaming was legal only in Nevada and Atlantic City, New Jersey. The 1990s saw a marked increase in the number of states that legalized casino gaming. Riverboat casino gaming first began in Iowa and Illinois in 1991 and quickly spread throughout the Midwest. Riverboat gaming now also exists in Indiana, Mississippi, and Missouri. Louisiana and Michigan legalized land-based casino gaming within the last decade.

Annual gaming net revenue (gross wagers minus player winnings) has grown from $9 billion in 1991 to over $40 billion in 2001. The casino industry consists of two major parties—Indian tribes and publicly traded private corporations such as Harrah's Entertainment and Trump Hotels and Casino Resorts. The Indian Gaming Regulatory Act (Public Law 100-497) passed in 1988 allows Indian tribes to own and operate casinos on their reservations. Tribal gaming is now available in 25 states and generated nearly $13 billion in revenue during 2001. Corporate casino gaming is available in nine states and generated over $27 billion in revenue in 2001.

While tribal gaming is available in more states, corporate casino gaming has traditionally been perceived as a more appropriate tool for fostering general economic development through increased employment and tax revenues.[22] The primary reason for this is that states have no power to tax Indian casino revenue because Indian casinos are sovereign entities from the state.[23] While states and Indian tribes do cooperate in regulation and security issues (dictated by state-tribal gaming compacts), the relationship between a tribe and a state is very similar to the relationship between two states—one state generally cannot legally dictate what another state can do.

Corporate casinos, however, are private industries that are taxed and regulated by a state. As seen in Table 6, casino revenues are quite sizeable, making them an attractive revenue source. Most states have a graduated casino revenue tax schedule, with marginal tax rates ranging from about 5 percent to over

[18] Alm, McKee, and Skidmore (1993).

[19] Clotfelter and Cook (1989, Chap. 6).

[20] Spindler (1995) and Garrett (2001).

[21] Clotfelter and Cook (1989, Chap. 11).

[22] Indian tribes use gaming revenue from their casinos to foster economic development on their reservations. Economic development from corporate casino gaming, however, has the potential to effect a much greater population.

[23] States have negotiated payments from tribes in return for certain services such as security and maintaining and improving highway access to casinos. Also, the current state budget crises have prompted several states, such as California, to consider the direct taxation of Indian casino revenue.

Table 6

Casino Revenue—Selected States

State	2001 Revenue ($ millions)	2000 Revenue ($ millions)	Percent change
Colorado	675.3	631.7	6.9
Connecticut	1,401.6	1,308.7	7.1
Illinois	1,783.8	1,657.8	7.6
Indiana	1,841.8	1,689.7	9.0
Iowa	922.9	892.6	3.4
Louisiana	1,883.2	1,708.9	10.2
Michigan	1,007.4	742.9	35.6
Mississippi	2,700.8	2,650.4	1.9
Missouri	1,137.1	996.6	14.1
Nevada	9,466.9	9,599.4	–1.4
New Jersey	4,303.9	4,299.6	0.1
Total	27,124.7	26,178.4	3.6

NOTE: Tribal and corporate casino revenue are considered in the above figures, which represent revenues to the casinos net of player winnings.
SOURCE: Adler (2003, p. 6).

50 percent. As with state lotteries, many states earmark their casino tax revenue for social programs, such as education.

The primary reason that many states have approved corporate casino gaming is that it is seen as a potential tool for economic growth. The greatest perceived benefits are increased employment, greater tax revenue to state and local governments, and growth in local retail sales. Increasing fiscal pressures on state budgets during the 1990-91 recession, the fear of lost revenue to neighboring states' casinos, and a more favorable public attitude regarding casino gaming have all increased the appeal and acceptance of casinos over the past decade.

THE ROLE OF FISCAL INSTITUTIONS

Unlike the federal government, the options available to state governments during periods of fiscal stress are often limited by their institutional structures. The most well-known fiscal constraints facing state policymakers are balanced budget laws and tax and expenditure limit laws (TELs). From the perspective of economic downturns, balanced budget rules and TELs typically require state policymakers to cut expenditures, increase taxes, or use some combination of both to offset the period of fiscal stress.

Every state, with the exception of Vermont, is subject to some form of balanced budget rule. The Advisory Commission on Intergovernmental Relations (ACIR, 1987) classifies state balanced budget rules into five categories: (1) the governor is required to submit a balanced budget; (2) the legislature is required to adopt a balanced budget; (3) the state may carry forward a budget deficit to be corrected in the next fiscal year; (4) the state may not carry forward a budget deficit into the next budget cycle (which is 2 years for the 20 states operating on a biennial cycle); and (5) the state may not carry forward a budget deficit into the next fiscal year. Categories 1 and 2 are examples of ex ante rules placing constraints on behavior prior to the fiscal year and do not require any actions to remedy an end-of-the-year deficit. Category 3 permits perpetual debt financing as long as planned expenditures in the next fiscal year plus the current deficit do not exceed expected revenue. The final two categories, 4 and 5, require states to take some action during the current fiscal year if an end-of-the-year deficit is projected. The type of balanced budget rule for each state (designated by number) and the adoption dates of TELs and rainy day funds are provided in Table 7.

In addition to balanced budget rules, a number

Table 7

Selected State Fiscal Institutions

	Balanced budget rule	Expenditure limit	Tax limit	Rainy day fund
Alabama	5			
Alaska	1,3	1982		1986
Arizona	5	1978		
Arkansas	5			1990
California	1,3	1979		1985
Colorado	5	1991, 1992	1992	1983
Connecticut	1,2,3	1991, 1992		1979
Delaware	5	1978		1977
Florida	5		1994	1959
Georgia	5			1976
Hawaii	1,4,5	1978		2000
Idaho	2	1980		1984
Illinois	1,2			2000
Indiana	5			1982
Iowa	5	1992		1992
Kansas	5			1993
Kentucky	4,5			1983
Louisiana	2	1993	1979	1990
Maine	5			1986
Maryland	1,2,3			1985
Massachusetts	1		1986	1986
Michigan	3		1978	1977
Minnesota	4		1980, 1986	1981
Mississippi	5	1992		1982
Missouri	5	1981		1992
Montana	2,4,5			
Nebraska	5	1979		1983
Nevada	1,2			1994
New Hampshire	1	1990		1987
New Jersey	5			1990
New Mexico	5			1978
New York	1			1945
North Carolina	5	1991		1991
North Dakota	4			1987
Ohio	5			1981
Oklahoma	5	1985		1985
Oregon	4	1979		
Pennsylvania	1,2,3			1985
Rhode Island	5	1992		1985
South Carolina	3,5	1980, 1984		1978
South Dakota	5			1991
Tennessee	3,5	1978		1972
Texas	2,4			1987
Utah	5	1989		1986
Vermont				1988
Virginia	4			1992
Washington	3	1993		1981
West Virginia	5			1994
Wisconsin	3			1981
Wyoming	4			1982

NOTE: The five balanced budget rules are: (1) the governor is required to submit a balanced budget; (2) the legislature is required to adopt a balanced budget; (3) the state may carry forward a budget deficit to be corrected in the next fiscal year; (4) the state may not carry forward a budget deficit into the next budget cycle (which is 2 years for the 20 states operating on a biennial cycle); and (5) the state may not carry forward a budget deficit into the next fiscal year.

SOURCE: ACIR (1994), Wagner (2003), Rueben (1997).

of states have TELs in place (generally adopted during the "tax revolt" era of the late 1970s) that are designed to limit the growth in state spending and/or tax revenue collection. In general, TELs specify the maximum increase in the rate of growth in the state's tax revenues and expenditures from one year to the next. The limits vary widely across states but are typically based on the growth in real personal income or population growth plus inflation.

Research investigating balanced budget rules and TELs suggests that such institutional structures alter states' responses in periods of fiscal stress.[24] For instance, Poterba (1994) finds that states with strict balanced budget rules, which are categories 4 and 5 in Table 7, adjust taxes and expenditures more strongly in response to an unanticipated budget shortfall than do states with ex ante balanced budget rules. Moreover, states with TELs typically experience slower rates of tax revenue growth as a result of the constraints and are less likely to increase taxes (and more likely to reduce expenditures) in response to unanticipated budget shortfalls.

In an effort to reduce reliance on expenditure reductions and/or tax increases to mitigate periods of fiscal stress, states typically save surplus revenue during good years for use during lean years when revenue growth is below average. While such surplus funds have historically been maintained as a general fund surplus, nearly all states have supplemented this practice with use of a rainy day fund (RDF), which is nothing more than a separate account in state budgets where surplus funds may be retained. The basic idea underlying the difference between the general fund and a RDF is this: Surplus monies that states intend to save long term are retained in a RDF, while monies retained for the short term are placed in the general fund. Both general fund and RDF balances typically earn interest following the state's investment policies regarding surplus funds.

As Table 7 shows, of the 46 states that currently have a RDF, only a handful were in place before 1980. States with RDFs generally deposit some fraction of a general fund surplus into the RDF and retain the remainder in the general fund. Thus, for states with RDFs, the total funds available to correct unexpected shortfalls at any given time equals the sum of the state's general fund and RDF balance, which Gold (1995) argues is the best indicator of a state's overall fiscal health.

States' RDF balances have dropped significantly in the past two years as states attempted to mitigate their budget crises. In January 2002, total RDF balances topped $17 billion. Aggregate balances dropped to $11.4 billion at the end of FY 2002, and fell further to $8.5 billion at the end of FY 2003. For FY 2004, 13 states are expected to tap their RDFs to minimize budget shortfalls. However, many states are reluctant to reduce RDF balances further, and many states (Arizona, Idaho, and Oklahoma, for example) have depleted their balances altogether.[25]

The central issue regarding RDFs and their ability to assist states in easing recessionary pressures is the extent to which monies saved in RDFs are simply replacing monies saved in the general fund. Much like the fungibility of lottery revenues, since RDFs are nothing more than separate accounts in state budgets (just like the general fund), policymakers may simply reduce the size of the general fund surplus by $1 for every $1 deposited in the RDF. In fact, Wagner (2003) finds that for every dollar that states deposited into their RDF, total savings (the sum of the state's RDF and general fund balance) increased by only $0.44 to $0.49. This clearly suggests that, for the average state, RDFs have not played a significant role in improving fiscal health.

Apart from the issue of substitutability with the general fund, the most important point regarding RDFs and savings is not so much how the funds are saved, but whether or not sufficient funds are saved at all. The notion of optimal savings for states has not been widely addressed in the literature, with the exception of Holcombe and Sobel (1997). The conclusion reached by these authors is that certain types of RDFs will improve a state's ability to weather downturns, specifically those RDFs having rules that force policymakers to save and limit how the funds may be spent. However, the typical state's savings are grossly insufficient to substantially lessen the need for expenditure reductions and/or tax increases.

THE STATE BUDGET CRISES[26]

Scope of the Crises

The year 2003 was arguably the worst year for state budgets and budget forecasts in recent history.

[24] For additional evidence regarding the effects of balanced budget rules, see Levinson (1998). The effectiveness of TELs is explored in Elder (1992) and Rueben (1997).

[25] NCSL (2003c).

[26] All data in this section has been obtained from the NCSL (2003a, b; www.ncsl.org/programs/fiscal/budissus.htm) and the Center on Budget and Policy Priorities (2002, www.cbpp.org/11-14-02sfp.htm).

Table 8

Summary of Projected FY 2004 State Budget Deficits as of April 2003

Budget deficit (millions $)	Number of states	Budget deficit as a % of general fund	Number of states
>$5,000	2	>20%	4
$1,000-$5,000	8	15-20%	3
$500-$1,000	8	10-15%	6
$100-$500	10	5-10%	13
<$100	19*	<5%	21*

SOURCE: NCSL (2003a).
*Includes 18 states with no projected budget deficit. Data were unavailable for three states.

In April 2003, the NCSL reported that collective state budget deficits for FY 2003 could range from $22 billion to $30 billion. Thirteen states reported budget deficits in excess of 5 percent of general fund revenues. Projections for FY 2004 were more dire, with estimates ranging from $54 billion to $78 billion. California alone had an estimated budget deficit of $17.5 billion, or roughly 21 percent of its general fund budget. For FY 2004, 26 states forecasted budget deficits greater than 5 percent of general fund revenue, while 13 of these forecasted deficits in excess of 10 percent of general fund revenue. Table 8 summarizes the forecasted FY 2004 budget deficits that were projected in April 2003, both in levels and as a percentage of general fund revenue.

The recession in the early 1990s was comparatively less disruptive to state coffers. The deficit between state tax revenues and expenditures (in 2002 dollars) was $11 billion (0.14 percent of GDP) and $17 billion (0.21 percent of GDP) in 1991 and 1992, respectively. The projected collective state budget deficits for FY 2004 are roughly five times greater (0.71 percent of GDP) than during the recession a decade ago.

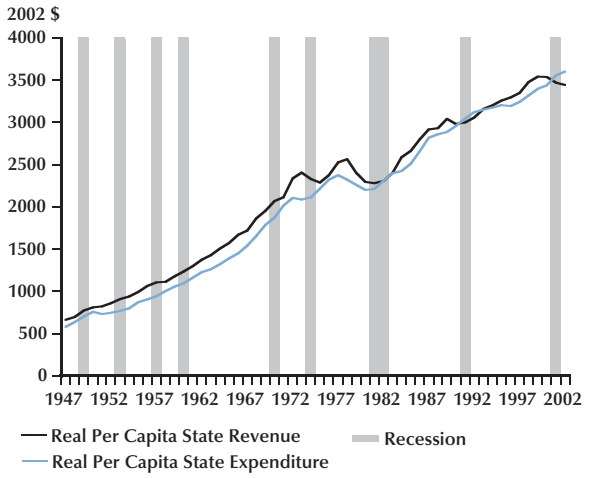
The budget deficits have forced states to make drastic spending cuts on various programs, including education, Medicaid, and corrections. As discussed in the introduction, these cuts along with tax and fee increases and modest revenue growth have all led to improved state budget forecasts for FY 2004. Roughly half of all states have or are planning to make cuts in one or more of the above programs. Twenty-seven states have proposals to reduce or contain Medicaid costs. For example, Illinois reduced Medicaid funding by $205 million, Kansas reduced services in mental health and disability services, and Massachusetts eliminated its MassHealth Basic insurance that left 50,000 people ineligible for Medicaid assistance. K-through-12 education spending is likely to be reduced in 21 states, and 26 states are considering cuts in higher education. The Connecticut governor has recommended a $104 million decrease in K-through-12 education, Michigan's governor has proposed a 6.75 percent reduction in state aid to higher education institutions, and Tennessee has reduced higher education expenditures by $102 million. These cuts, combined with tax and fee increases and modest revenue growth have led to improved state budget forecasts for FY 2004.

What Caused the Budget Crises?

Budget deficits are caused by a reduction in revenues, an increase in expenditures, or both. To understand the causes of the current crisis, one must look to the previous decade. Over the period 1993 to 2000, state revenue collections grew markedly as a result of the unusually high levels of economic activity; thus many states were faced with budget surpluses; as a result, almost every state enacted large permanent tax cuts. The majority of cuts were on personal and corporate income taxes, although many states also reduced sales and excise taxes. Ten states enacted cuts totaling between 1 and 3 percent of total tax revenues, while 33 states enacted cuts in excess of 3 percent of total tax revenues. According to the Center on Budget and Policy Priorities, the tax cuts of the 1990s reduced actual state tax revenue by 8.2 percent. However, tax revenues continued to grow with the economic boom throughout the 1990s despite the broad reduction in tax rates across states.

Figure 3

Real Per Capita State Revenue and Expenditures, 1947-2002



States had essentially financed permanent tax cuts with the temporary economic boom. The recession beginning March 2001 (NBER classification) and the stock market collapse throughout 2000 and 2001 have led to a reduction in personal and corporate incomes, capital gains, and consumption. States once flush with revenues quickly saw their coffers drained. Unlike the 1990-91 recession when nearly every state raised taxes in response to budget shortfalls, few states have raised taxes since the recent economic slowdown as a result of greater voter disdain for tax increases. And, in most cases, the tax increases have focused on relatively narrow and low-growth tax bases such as retail sales, alcohol, and tobacco, thus limiting both the short-run and long-run growth potential of new revenues.[27] Fiscal pressures on the federal budget have also resulted in less intergovernmental aid to states from the federal government. Furthermore, states are partially responsible for covering the costs of homeland security in the wake of September 11, 2001. Slow economic growth, a weak stock market, an increase in homeland security responsibilities, and a greater reliance on weakening tax bases all continue to prolong states' budget crises.

The stock market collapse and the recent recession clearly affected the revenue side of state financing. However, are current budget deficits entirely due to a reduction in revenue, or has state expenditure growth also increased over the past decade, thereby widening the deficit between revenues and expenditures? Annual real per capita state expenditures and revenues from 1947 to 2002 are shown in Figure 3 along with NBER recessionary periods.[28] The aggregate state budget deficit is at the far right of Figure 3, and it is much greater than the deficit present during the 1990-91 recession. Inspection suggests that the growth in real per capita expenditures during the 1990s was not greater than earlier decades. In fact, the average annual growth in real per capita state expenditures over the period 1992-2000 was 1.2 percent, compared with 3.2 percent and 1.5 percent in non-recession years during the 1980s and 1970s, respectively.

Table 9

State Revenue and Expenditure Growth, 1998-2002

Year	Annual growth in real per capita revenues (%)	Annual growth in real per capita expenditure (%)
1998	3.9	2.3
1999	1.9	2.4
2000	–0.2	1.3
2001	–1.9	3.4
2002	–0.7	1.3

However, recent revenue and expenditure data reveal that expenditure growth did not slow in the wake of decreasing tax revenues. Annual growth in state per capita revenues and expenditures from 1998 to 2002 is shown in Table 9. While annual real expenditure growth averaged roughly 2 percent, annual real revenue growth from 2000 to 2002 was negative. This scenario occurred during other recessionary periods, as shown in Figure 3; however, state budget surpluses prior to this recent recession were smaller than those prior to earlier recessions, thus increasing the chances that a reduction in revenue would lead to a budget deficit. Currently and historically, state governments have continued to increase expenditures even through years of negative revenue growth.

States financed permanent tax cuts with the

[27] For a discussion of the structural problems in state finance, see Knight, Kusko, and Rubin (2003).

[28] Data are from the Office of Management and Budget (www.whitehouse.gov/omb/budget/fy2004/hist.html).

economic boom of the 1990s, and the stock market collapse and the recent recession hit state budgets hard by reducing revenues from capital gains, personal and corporate income, and general sales taxes. The importance of income and sales tax revenues to state finances and the relatively high variability of these revenue sources over the business cycle amplified the budget shortfalls seen across the states. In addition, tax revenue reductions and the failure of state governments to curb recent expenditure growth in the wake of negative revenue growth are factors attributed to the current state budget crises.

States' Response to the Crises

State governments are implementing or considering various policies aimed at increasing revenue, including an increase in various tax rates. Fewer states have implemented or are considering rate hikes after this recession than during the 1990-91 recession, despite the fact that state budgets are in greater trouble now than a decade ago. In April 2003, the NCSL reported that six states have increased cigarette taxes and two states have increased alcohol taxes. Fourteen states were considering an increase in these taxes, and eleven states were debating an increase in the sales tax. Six states were looking at increases in personal income and corporate income tax rates. Rather than raising tax rates, several other states were considering ways to close tax loopholes and expand tax bases. The Nelson A. Rockefeller Institute of Government (2003) reported that, as of November 2003, eighteen states have raised taxes by $6.2 billion for FY 2004.

Given the reluctance of state government to raise traditional tax rates, states are pursuing other options in addition to traditional tax increases, some of which were discussed here earlier. Several states are considering the adoption or expansion of casino gaming, and others have or are proposing an increase in casino tax rates. Cutbacks or salary reductions for state employees are also common, as are cuts in education and health care. Tuition hikes are also occurring in many states, along with increases in license fees and vehicle registration fees. Ten states have also tapped into their RDFs during FY 2003. Finally, state governments also use what Petersen (2003) calls "smoke and mirror" efforts to deal with their current crises, such as using funds from the tobacco tax settlement and raiding state pension funds.

CONCLUSIONS: PRELUDE TO MORE CRISES?

While the current state budget crises are the most severe in the postwar era, states have faced other budget crises in the past. It thus seems reasonable that states would realize that favorable economic conditions cannot last forever and, therefore, implement revenue and expenditure policies that would allow them to weather periods of fiscal stress. Even when the current crises are resolved, however, there should be little doubt that states will again experience budget crises in the future. During economic booms, as in the 1990s, state lawmakers tend to cut tax rates while tax coffers are flush and make additional expenditure commitments that they have difficulty keeping when the economy slows. As economic conditions improve, state revenues will rise again. If the past is a guide, these revenues will be committed to ongoing spending programs or tax rates will be cut. The single step of raising taxes and fees is no panacea to the procyclical spend/cut pattern of state governments.

Furthermore, the set-up of state revenue systems does not bode well for long-term fiscal solvency. Many states are currently considering increases in sales and excise taxes. However, growth in this source of tax revenue has slowed in recent history as the economy moves toward services, which are traditionally exempt from state sales taxes. In addition, a continued decrease in the number of smokers questions the ability of cigarette tax increases to provide a reliable long-term source of revenue. Although personal and corporate income taxes trend with economic conditions, growth in corporate income tax revenues has decreased over the past 20 years, partly due to decreased tax rates but also due to tax avoidance actions taken by businesses. The cyclical variability of sales and income taxes also suggests that state governments will be faced with relatively greater revenue variability in the future as long as increasing portions of state revenues come from these sources.

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The Federal Reserve Responds to Crises: September 11th Was Not the First

Christopher J. Neely

The terrorist attacks of September 11, 2001, had two immediate consequences: They took an enormous human toll and they created a potentially serious crisis for the economy through their impact on financial markets. The Federal Reserve reacted to the potential economic crisis by providing an unusual amount of liquidity and reducing the federal funds rate more than would be expected from levels of output and inflation. This was not the first time, however, that the Federal Reserve responded quickly and forcefully to unusual conditions in financial markets that threatened to spill over to the real economy. Indeed, the September 11th attacks reminded us that problems in financial markets can disrupt the whole economic system.

This article describes the Federal Reserve's reactions to crises, or potential crises, in financial markets. The crises considered are periods of sudden revision in expectations or physical disruption that threaten the stability of the economic system through asset price volatility. The Federal Reserve has responded to financial crises in three main ways: (i) The Fed has provided immediate liquidity through open market operations, discount window lending, and regulatory forbearance; (ii) the Fed has lowered the federal funds target over the medium term; (iii) the Fed has participated in foreign exchange intervention with the U.S. Treasury.

The next section of the article explains how sudden changes in asset prices or asset price uncertainty spill over into the rest of the economy. Next, the article explains how the Federal Reserve Bank can use its tools to help minimize the impact of the uncertainty and physical disruptions of crises. Finally, several recent episodes—the stock market crash of 1987, the Russian default, and the September 11th attacks—are examined as case studies.

HOW DO CRISES AFFECT THE ECONOMY?

Stock market crashes, in general, the Russian default, and the September 11th attacks were associated with sudden, substantial revisions in expectations about future economic and financial variables. Although each episode had unique causes and features, they were all accompanied by liquidity crises in financial markets that could have disrupted economic activity and threatened price stability.[1] These financial crises are caused by some combination of a simple physical disruption of the financial system and/or sudden uncertainty about economic conditions. Those problems manifest themselves in lower asset prices, which, in turn, create balance sheet problems for financial institutions.[2]

Financial institutions are wedded together in a complex system of payments that makes the system vulnerable to the failure of large banks or hedge funds.[3] And some parts of the system, like *specialists* on Wall Street and hedge funds, are highly *leveraged*, meaning that they typically borrow most of the money with which they purchase assets.[4] If asset

[1] Although the Federal Reserve can achieve price stability over the long run, financial crises that generate extreme economic conditions might create pressures to follow other policies. For example, a banking collapse could potentially create deflation and a liquidity trap that might require the Fed to commit to inflate the currency for some years.

[2] Mishkin (2001) discusses financial crises in the context of foreign exchange crises in emerging markets.

[3] Hedge funds pool investors' money to invest in a variety of financial instruments. By limiting participation to wealthy investors and large institutions, they avoid most regulatory controls and do not register with the Securities and Exchange Commission.

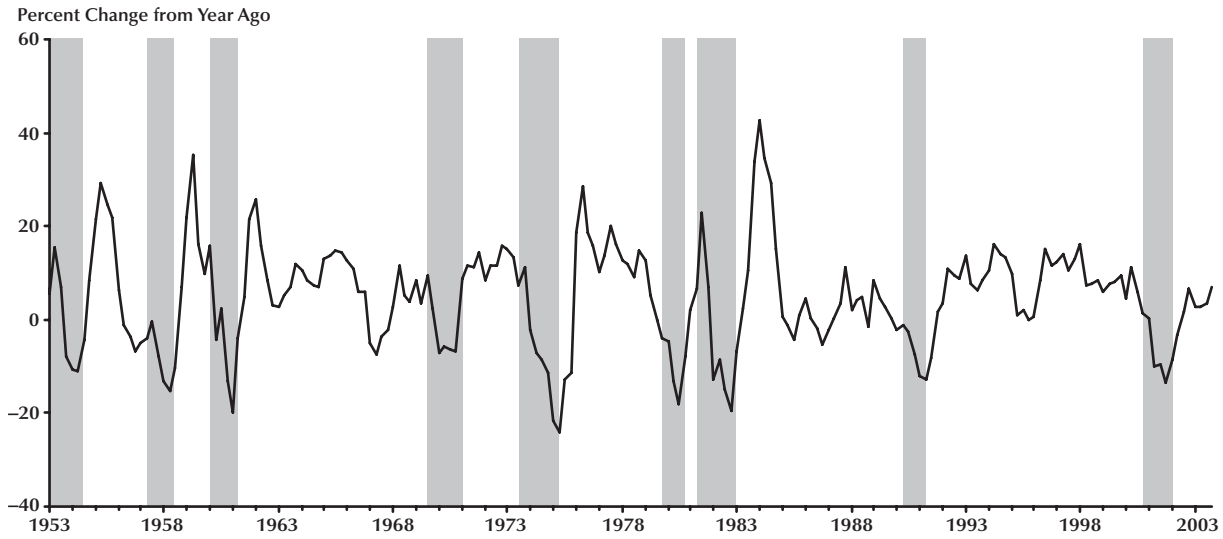
[4] A specialist is a firm charged with making a market—being prepared to buy or sell a stock on their own account at a reasonable spread—when there is temporary excess supply or demand for a stock. Larger imbalances between supply and demand at a given price might require the specialist to halt trading temporarily, until a new opening price can be established. Ordinarily, specialists make money from the spread that compensates them for the service of providing liquidity to the market all the time. In 1987 there were about 50 specialist firms (Santoni, 1988).

Christopher J. Neely is a research officer at the Federal Reserve Bank of St. Louis. Charles Hokayem, John Zhu, and Joshua M. Ulrich provided research assistance.

Federal Reserve Bank of St. Louis *Review*, March/April 2004, *86*(2), pp. 27-42.

Figure 1

Real Gross Private Domestic Investment During Recessions



NOTE: The figure shows the year-to-year percentage change in real gross private domestic investment in the United States. Shaded bars denote recessions.
SOURCE: Bureau of Economic Analysis.

prices decline significantly, the value of the firm's liabilities (i.e., loans) can exceed the value of its assets, in which case the value of the firm to its owners (equity) becomes negative and the firm goes bankrupt without additional capital. But if a hedge fund goes bankrupt, it will be unable to make payments to the banks from which it has borrowed money, which might make them insolvent as well. Or, firms might find it necessary to ration scarce liquidity to make only particularly important payments during periods of illiquidity. In this event, some debts will not be settled on time. The danger that one's counterparty will fail to settle a transaction is called *counterparty risk*. Fear of counterparty risk can cause financial gridlock, where firms and individuals refuse to enter into financial transactions. Failure of counterparties to make payments can also lead to *systemic risk*—where the health of the whole financial system is endangered by the possibility of domino-style bankruptcy.

A breakdown of the financial system itself will immediately affect the whole economy because economic activity depends on the efficient functioning of the payments system. If one cannot be assured that one will be paid, then there is little incentive to work or to sell.

In the medium term, such financial breakdowns can hobble the economy because the financial system provides *intermediation*; that is, it matches people who wish to save money with firms who want to invest that money in productive activities. Other industries can have disruptions or slowdowns with little effect on other business. If the financial system stops functioning, however, savers aren't matched with investors and investment falls in every sector. And investment is traditionally the most volatile component of output. Figure 1 shows that U.S. recessions (shaded bars in the figure) are always accompanied by a large falloff in investment.

A fall in stock prices can also affect the real economy through its influence on the credit-worthiness of firms. When a firm's stock price falls, the value of the firm to its owners declines. The owners—who have limited liability—then have an incentive to borrow money to take risky but potentially profitable actions; as owners they keep any gains but their losses are limited to their equity stake. Naturally, though, no one would want to lend money to firms with low equity because this incentive to take risky gambles makes the loan too risky (Bernanke and Gertler, 1989; Calomiris and Hubbard, 1990).

Falls in equity can also affect economic activity through *trade credit*. Trade credit is the practice in which buyers take delivery of goods and pay for

them later. A firm with low equity might be unable to get trade credit to continue operations.[5]

Financial crises in the United States that exacerbated 19th century recessions contributed fundamentally to the formation of the Federal Reserve System in 1914 (Dwyer and Gilbert, 1989).[6] Prior to the creation of the Federal Reserve System, the U.S. economy was beset by occasional banking panics, particularly the severe 1907 banking panic, which directly motivated the creation of the Federal Reserve System in 1914 (Federal Reserve Bank of Minneapolis, 1988).

One of the most important responsibilities for the new central bank was to provide an elastic supply of currency to banks to meet temporary increases in currency demand. One of the most prominent sources of such temporary increases in currency demand was banking panics. In other words, a primary goal of the Federal Reserve System was to avert banking panics. Deposit insurance, prudent regulation, and the Fed's own willingness to act as a lender of last resort have made banking panics almost unheard of since the Great Depression.[7] Extreme conditions, such as the terrorist attacks of September 11, 2001, can still threaten the health of the economy through their effect on financial markets. During such circumstances the Fed has continued to act as a lender of last resort to the financial system to maintain stable business conditions.

HOW DOES THE FEDERAL RESERVE REACT TO FINANCIAL CRISES?

One might think that if drastic changes in asset prices can harm the economy, then the Federal Reserve should try to prevent such changes. This conclusion is not correct. It is important to distinguish between preventing problems in financial markets from spilling over to the real economy and trying to directly control asset prices. Most policymakers believe that the Fed should not try to target asset prices—like stocks—or prevent their adjustment.

> I believe it is very important that the Federal Reserve not take a position per se on the level of prices in asset markets, especially the stock market. It is very easy to be wrong about the appropriate level; this judgment ought to be left to the market.
>
> —William Poole, President of the Federal Reserve Bank of St. Louis (2001)

Indeed, leaving aside the question of whether the Federal Reserve knows the fundamental value of stocks, the Fed's tools might be inappropriate for the task. The Federal Reserve potentially has two tools with which it could influence stock prices: (i) It could use open market operations to influence stock prices through interest rates, or (ii) it could administratively adjust *margin requirements* for stock markets.[8] Margin requirement changes have been rare in recent history, so their effects are not well understood. And monetary policy is a very blunt instrument with which to change equity prices. It might require large changes in interest rates—with commensurate changes in prices, output, and employment—to change equity prices to any substantial degree. Although central banks cannot target stock prices, they can mitigate the disruptive effects that stock price corrections can have on the real economy.

Short-, Medium-, and Long-Term Policy Reactions

It is useful to break down the effects of crises into short-term effects on liquidity, medium-term business cycle effects on output and inflation, and long-term effects on consumption and production. As discussed, the uncertainty that crises produce often necessitates immediate provision of additional liquidity to the financial system. In the medium term, central banks often find it useful to maintain lower interest rates than they otherwise would, to safeguard business conditions and keep banks and other financial institutions healthy. Although regulators seek to make bank portfolios relatively insensitive to changes in interest rates, banks still tend to have short-term liabilities and long-term assets. Therefore,

[5] Of course, declines in stock prices can also affect the economy by reducing wealth and consumption. But such a reduction in consumption can be a rational, optimal response to revisions in expected future income. In contrast, the credit market problems discussed in the text are market imperfections due to asymmetric information, which can be aggravated by a sudden fall in stock prices.

[6] President Wilson signed the Federal Reserve Act on December 23, 1913. Dwyer and Gilbert (1989) argue that bank panics did not cause recessions but that they might have exacerbated the consequences of such slowdowns.

[7] The creation of the Federal Deposit Insurance Corporation (FDIC) in 1934 was a very important part of the solution to banking panics.

[8] The margin requirement is the cash-to-value ratio needed to purchase a given amount of stocks. In other words, a 20 percent margin requirement means that—at most—80 percent of a stock's purchase price may be borrowed.

declining short-term interest rates usually improve bank balance sheets.

Finally, the underlying causes of crises can often have long-term effects on the economy. For example, the terrorist attacks of September 11, 2001, led to increased demand for defense and security. Resources that would have been spent on other needs—consumption of health care, durable goods, investment, etc.—went instead to prevent further attacks. These effects lie outside the Fed's major macroeconomic mission, to contribute to maximum sustainable economic growth by maintaining low and stable inflation. There is little that a central bank can or should do about such long-run effects.

Provision of Liquidity

Financial crises are almost synonymous with a lack of liquidity—that is, when financial firms have assets that they cannot convert quickly to cash to make payments. The traditional job of central banks, such as the Federal Reserve, is to provide extra liquidity in times of crisis. The Federal Reserve can provide extra liquidity several ways: (i) The Fed can buy assets, usually Treasury securities, providing banks with greater reserves and lowering the federal funds rate; (ii) the Fed can lend directly to banks through the discount window, again providing them with greater reserves; and (iii), as a regulator, the Fed can encourage banks to loan money more freely—it can engage in *regulatory forbearance*.

Measuring Monetary Policy with the Taylor Rule

One would like to distinguish the Federal Reserve's direct reactions to a crisis from its reaction to the economic conditions that caused the crisis, or its indirect reaction to the effects of the crisis on output and inflation. For example, in the aftermath of the September 11th terrorist attacks, one would like to disentangle the Fed's reaction to the effect on liquidity and public confidence from the Fed's reaction to the recession that was going on at that time. To distinguish the Fed's reaction to a crisis itself from its normal reaction to prevailing economic conditions, one needs a model for the Fed's usual response to economic conditions.

There have been many attempts to model the Fed's normal behavior, but the most popular is the Taylor rule (Taylor, 1993). Taylor set out to model how the Federal Reserve had recently set short-term interest rates in response to a small set of particularly important economic variables: the Fed's desired inflation target, current output, and current inflation. The version of the Taylor rule used in this paper is as follows:

$$(1)\quad f_t^* = 2.5 + \pi_{t-1} + \frac{\left(\pi_{t-1} - \pi^*\right)}{2} + 100 \cdot \frac{\left(y_{t-1} - y_{t-1}^P\right)}{2},$$

where f_t^* is the predicted federal funds rate from the Taylor rule; π_t is the year-over-year inflation rate in percentage terms, calculated from the gross domestic product (GDP) deflator; y_t is the log of real GDP; y_t^P is the log of potential real GDP; and π^* is the Fed's target inflation rate.[9] Potential GDP is the predicted value from a log linear trend model of GDP with a break in trend growth permitted in 1972.

The Taylor rule is clearly a simplification of the Fed's behavior; the Federal Open Market Committee (FOMC) looks at a wide variety of indicators in making policy. But Taylor (1993) found that (1) described the Fed's behavior during the 1980s and 1990s fairly well while using variables (output and inflation) that are parts of the Fed's legal mandate. Later research confirmed that the rule stabilizes output and inflation well in many economic models and even describes the behavior of central banks around the globe pretty well (Taylor, 1998; Gerlach and Schnabel, 2000; Rudebusch and Svensson, 1998; Levin, Wieland, and Williams, 1999; and Judd and Rudebusch, 1998).

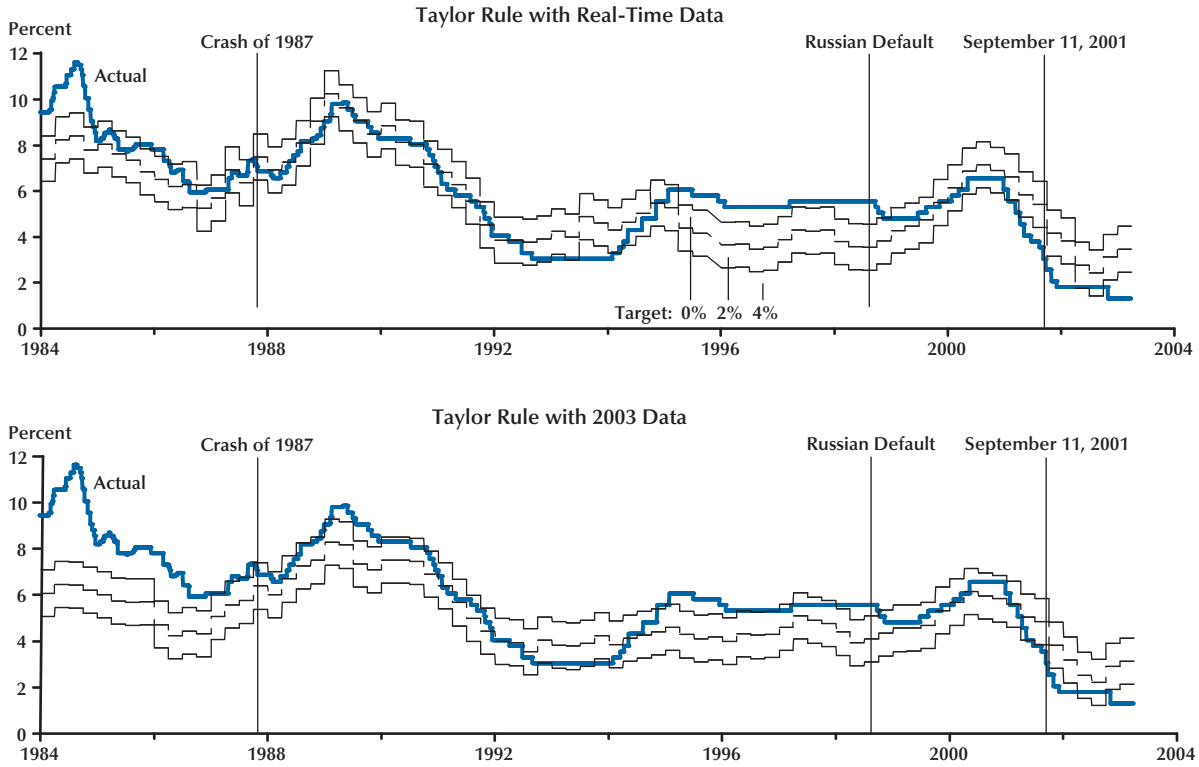
Orphanides (2001), however, points out a potential problem with evaluating policy with the Taylor rule: Economic data are usually revised after their initial release, and economic conditions viewed with revised data can look very different from conditions viewed with the initial data. Therefore, Orphanides (2001) argues that, to understand policymakers' actions, one should use *real-time* data, the latest data available to the policymakers at the time policy was made.

The top panel of Figure 2 shows the predicted federal funds rate, using real-time data, for Taylor rules with inflation targets of 0, 2, and 4 percent, along with the actual federal funds rate. The highest dashed line indicates the Taylor rule prediction for an inflation target of 0 percent, and the lowest dashed line indicates the Taylor rule prediction for an inflation target of 4 percent. The bottom panel of the same figure shows the actual federal funds

[9] This version of the Taylor rule is similar to that used in the Federal Reserve Bank of St. Louis *Monetary Trends* except that it uses the GDP deflator instead of the personal consumption expenditures deflator to measure inflation and real-time data instead of final data.

Figure 2

Federal Funds Rate and Taylor Rule Predictions



NOTE: Top panel: Federal funds rate target (solid blue line) and targets implied by Taylor rules with inflation targets of 0 (top black line), 2 (middle black line), and 4 percent (bottom black line), using real-time data (output and inflation data that would have been available at approximately the time policy was made). Bottom panel: Same figures but using final revised 2003 data to calculate output and inflation. Vertical lines show the dates of crises studied in this article.

rate with predicted values, using ex post (2003) data to compute the implied funds rates. The Taylor rule appears to describe the federal funds rate fairly well with either type of data. The real-time data makes the Taylor rule fit much better for the period 1984 to 1990, but it also makes actual late-1990s policy look much tighter (consistent with a lower inflation rate) than does the 2003 data. The vertical lines in the panels depict the dates of the crises that are examined in this paper: The stock market crash of October 19, 1987; the Russian government's default on its debt on August 11, 1998; and the September 11, 2001, terrorist attacks.

Of course, Figure 2 also makes it plain that the Taylor rule approximates the Fed's behavior fairly imprecisely. From 1994 to 1996, for instance, the implied Fed inflation target fell from more than 4 percent to less than zero. Clearly, this doesn't reflect changes in the Fed's actual preferences for inflation but rather is simply due to the fact that the simple Taylor rule omits some important determinants of the federal funds rate target. As one compares the actual funds rate changes with the Taylor rule predictions, one should keep in mind the crudeness of the approximation.

CASE STUDIES

The Stock Market Crash of October 19, 1987

There has been much debate on the causes of the crash of October 1987. The Brady Commission, headed by former Senator—later Treasury Secretary—Nicolas F. Brady, blamed portfolio insurance and program trading for the size of the 1987 crash. The Commission also found that specialists were partly to blame for selling into the crash rather than buying to ease the crash. Santoni (1988) argues that analysis of high-frequency data shows that program

trading and portfolio insurance were not to blame for the size of the 1987 crash. Rather, the article concludes that the crash was a rational reaction to fundamental news about stocks, though it does not make a case for what that news might have been.

Some analysts blamed monetary policy for contributing to the crash, but there was little agreement on the nature of the problem. Roberts (1987), for example, argued that tight monetary policy caused the crash. Canto and Laffer (1987), on the other hand, argued that monetary policy was too loose, citing growth in the monetary base. Short-term interest rates indisputably were rising prior to the crash of 1987, and stock markets tend to do poorly (well) when interest rates rise (fall) (Jensen, Mercer, and Johnson, 1996; and Thorbecke, 1997). By itself, this would argue for Roberts's (1987) view. Of course, rising interest rates do not, by themselves, cause stock prices to crash, but they may have been one factor in the bust.

In the two months prior to the crash, stock markets experienced significant losses. For example, the top panel of Figure 3 shows that from August 25 to October 16, 1987, the S&P 500 lost about 16 percent of its value. On October 19, 1987, stock prices fell precipitously: The S&P 500 plunged by 20 percent and the Dow Jones Industrial Average sank more than 500 points, the largest one-day decline in stock market history. Panel 2 in Figure 3 shows that the 30-day *implied volatility* of stock prices rose enormously as stock prices dropped. Implied volatility measures the uncertainty about future stock prices obtained by equating options prices with those from a theoretical option pricing formula, such as the Black-Scholes formula. As such, it is synonymous with market perceptions of price risk. Implied volatility (as shown in Figure 3) remained high for many months following the stock market crash. Panels 3 and 4 in Figure 3 show that bond yields fell (bond prices rose) as investors sought safe haven from the volatile stock market; and the trade-weighted foreign exchange value of the dollar slid after the crash as nervous investors fled U.S. assets.

The stock market crash had potentially serious effects in both the short and long term. Over the short term, the price drop created an enormous problem for brokerage houses and market specialists. Many specialists and large securities firms reportedly had accumulated unusually large inventories of stock, for which they must pay five days later.[10] To make payment, these financial firms needed to borrow money. The volatility and low level of stock prices made the stock itself poor collateral, however, and banks were reluctant to provide further credit to the specialists and brokerage houses with their solvency in doubt. The financial services industry faced widespread bankruptcy that would have had serious repercussions for the real economy through its impact on the payments system and financial intermediation. Stewart and Hertzberg (1987) detail the events of the crash of October 19, 1987.

Immediately after the crash, Chairman Greenspan announced the Federal Reserve System's "readiness to serve as a source of liquidity to support the economic and financial [system]" (Stewart and Hertzberg, 1987). The Fed poured liquidity into markets by lending directly through the discount window, by buying Treasury securities (open market operations), and by encouraging banks to lend to Wall Street.[11] Policy was implemented with unusual flexibility to ensure adequate liquidity. On several occasions, for example, the Fed's Open Market Desk entered the market to supply reserves before its customary time of the day for open market operations (Sternlight and Krieger, 1988). A convenient measure of the degree of liquidity provided to the market in this period is excess reserves (total reserves less required reserves). Table 1 shows that excess reserves rose to the unusually high level of almost $1.6 billion in the reserve period ending November 4, 1987.

In the weeks that followed, the Federal Reserve continued to ease pressure in money markets, lowering interest rates. Panel 5 of Figure 3 shows that the Fed lowered the federal funds target, which influences all short-term interest rates, several times in the four months following the crash, for a total reduction of about 80 basis points.[12] Compared with the Taylor rule predictions calculated from the output gap and inflation, short-term interest rates did decline; monetary policy was eased beyond what one might have expected from the output and inflation at the time.[13]

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[10] The New York Stock Exchange (NYSE) clearance and settlement cycle is now three days.

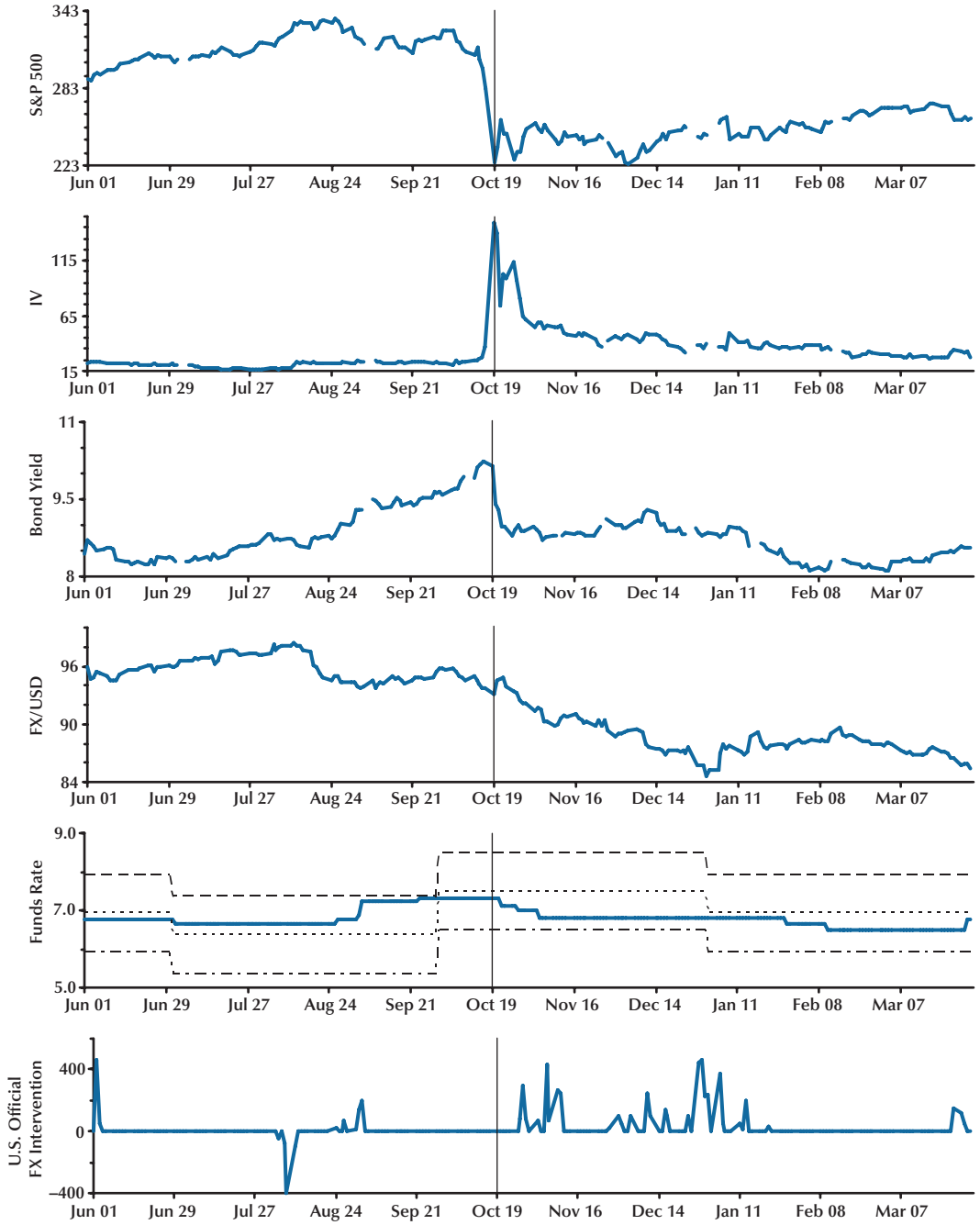
[11] Calomiris (1994) provides a comprehensive discussion of the uses of the discount window.

[12] In 1987 the Federal Reserve described its policies in terms of "money market conditions" rather than explicit federal funds rate targets. The Federal Reserve Bank of New York, however, provides federal funds rate target data back to 1980.

[13] A standard to judge unusually large changes would be desirable. Given the substantial movements around the Taylor series targets (in Figure 2), however, formal statistical tests would have little power to reject the null that changes during crisis periods are of normal size. Therefore this paper retains an informal approach.

Figure 3

Data Around the Time of the Stock Market Crash of October 19, 1987



NOTE: Daily financial data around the time of the stock market crash of October 19, 1987. The first five panels show the S&P 500 index, the NYSE implied volatility from options prices, the yield on 10-year U.S. government bonds, the trade-weighted value of the dollar, and the federal funds rate target (solid blue line) and the targets implied by Taylor rules with inflation targets of 0 (top dashed line), 2 (middle dotted line), and 4 percent (bottom dashed-dotted line) (using real-time data). The final panel shows U.S. official foreign exchange intervention, in purchases of millions of dollars. The vertical line denotes the date of the stock market crash, October 19, 1987.

Table 1

Provision of Liquidity in Response to the Stock Market Crash of October 19, 1987

Reserve maintenance period ending	Excess reserves
September 9, 1987	1,194
September 23, 1987	515
October 7, 1987	833
October 21, 1987	967
November 4, 1987	1,561
November 18, 1987	492
December 2, 1987	1,213
December 16, 1987	1,206
December 30, 1987	806

NOTE: Values show excess reserves (total bank reserves less required reserves) in millions of dollars for the two-week reserve maintenance periods around the stock market crash of October 19, 1987.

SOURCE: Sternlight and Krieger (1988).

In the medium term, the stock market crash reduced the wealth of shareholders, who might have been expected to reduce their consumption. Such an expectation would, in turn, tend to reduce business investment and employment. This uncertainty about future economic activity would further reduce output by limiting the consumption of people who did not hold stock, but who might be concerned about their future employment.

In fact, there was relatively little impact on consumption from the crash of 1987. This might be due to the recovery of stock prices—prices were back to pre-crash levels within two years—or the fact that the rapid runup in stock prices early in the year meant that people had not adjusted their consumption upward, so there was little downward effect from the crash.

> Stock prices went up so rapidly this year that people didn't know how rich they were. Now, many of them don't know how poor they are.
>
> —Franco Modigliani, Nobel Prize laureate for research on consumption, quoted in Stewart and Hertzberg (1988)

The bottom panel of Figure 3 illustrates another policy response to the crash in which the Fed participated: *foreign exchange intervention*.[14] The turmoil in the stock market combined with speculation that U.S. and foreign authorities no longer wanted to stabilize the dollar contributed to a falling dollar.[15] In response, the Federal Reserve Bank of New York purchased several hundred million U.S. dollars on foreign exchange markets, on behalf of the Treasury and the Federal Reserve. This action was intended to stabilize the dollar during its post-crash decline, though it is not clear that it had such an effect (see panel 4 of Figure 3).

In the wake of these policy actions, stock prices recovered and implied volatility declined as markets returned to normal conditions in the following months. (Hafer and Haslag, 1988, discuss the FOMC's reaction to the stock market crash.) It is generally agreed that the Fed's prompt action prevented a financial meltdown.

> The financial system would have ceased to function were it not for the central bank's broad interpretation of its responsibilities as the ultimate source of liquidity.
>
> —William L. Silber, letter to *The Wall Street Journal*, February 23, 1998

The Russian Default

In the mid-1990s, Russia struggled with the burdens of mostly negative economic growth, massive debt inherited from the Soviet era, and an inefficient tax system (Chiodo and Owyang, 2002). At the same time, Russia attempted to maintain a target zone exchange rate against the U.S. dollar. The Asian crisis of July 1997 made international investors even more cautious about investing in developing economies (like Russia). Moreover, Russia's fiscal situation worsened in 1998 as oil prices fell—Russia is a major oil exporter—and the Russian Duma (the legislature) failed to pass appropriate tax reform legislation.

Fiscal concerns posed a real problem for the

[14] *Foreign exchange intervention* is the practice of monetary authorities buying and selling currency in the foreign exchange market to influence exchange rates. In the United States, for example, the Federal Reserve and the U.S. Treasury generally collaborate on foreign exchange intervention decisions, and the Federal Reserve Bank of New York conducts operations on behalf of both. Neely (1998, 2000) discusses foreign exchange intervention in more detail.

[15] On February 22, 1987, there had been an international agreement, called the Louvre Accord, to stabilize the dollar. By late October, currency traders were unsure whether or not this agreement was still in effect.

maintenance of the exchange rate because fiscal deficits must be financed by some combination of borrowing and monetization—expanding the money supply.[16] And the limited appetite of foreign investors to hold more Russian debt meant that fiscal deficits would ultimately translate into an expanded money supply. Expanding the money supply would increase the Russian price level (in rubles), making Russian goods more expensive on world markets and reducing the real quantity of rubles demanded to buy those goods. This fall in demand would increase pressure for a devaluation of the ruble, which would lead to a capital loss for foreign investors in Russian assets.

Because financial markets are forward looking, the prospects of such a capital loss in the future led investors to question the ability of the Russian government to honor its debts and they began withdrawing their capital from Russia.[17] As demand for Russian assets fell, Russian interest rates rose and stock prices fell. On August 11, 1998, the Russian government stopped trying to fix the value of the ruble (i.e., it allowed the ruble to *float*), defaulted on domestic debt, and halted payments on its foreign debt.

After the Asian crisis and the Russian default, international investors saw greater risk in emerging market debt and began to seek safer assets in which to invest their money. Spreads between yields on more- and less-safe assets widened around the globe, as investors considerably revised their assessment of the dangers of investing in developing countries. A key factor in rising perceptions of risk was the fact that the International Monetary Fund (IMF) chose not to bail out Russia, as it had done for Bulgaria, Thailand, and Mexico. Prior to August 1998, Russia had been considered too important for the IMF to forego assisting it in a payments crisis. Emerging market funds sold some of their positions in profitable countries to meet margin calls on their Russian positions. These sales further widened the spreads between securities in emerging and developed countries.

The Russian default had potentially important implications for U.S. economic policy. The flight of investors to safer assets can be seen in the top panel of Figure 4, which displays the falling yields on 10-year U.S. bonds after the Russian default. At the same time, U.S. equity prices declined and their implied volatilities rose threefold from pre-crash levels (panels 2 and 3 of Figure 4). The foreign exchange value of the dollar rose briefly after the default, only to decrease as uncertainty in U.S. equity markets increased and the likelihood increased that the FOMC would cut the federal funds target (panel 4 of Figure 4).[18] Indeed, the dollar did fall farther, temporarily, following the period of federal funds target cuts in the fall.

In making policy in the wake of the Russian default, the Fed lowered short-term U.S. interest rates to minimize the consequences of international financial conditions for the U.S. economy and to ameliorate those conditions abroad. By lowering short-term interest rates, central banks of industrialized economies created greater demand for imported goods and also lowered international borrowing costs. Lower interest rates for emerging economies ultimately might raise U.S. exports and the earnings of U.S. firms.

After two rate hikes in September and October, however, some feared that the November easing would encourage unrealistically high U.S. equity market valuations, which had had several years of very strong performance and were overvalued by traditional measures such as price-earnings ratios.

> ... the Federal Reserve chairman has a tricky task. He must bring the US economy and stock market off their highs - without provoking a panic…Risk premiums in bond markets have shrunk since the last cut, while stock markets have soared…the cut risks stoking the boom.
>
> —Lex column: "Greenspan's Bubble," November 18, 1998, *Financial Times*

Any effect of this third cut on equity valuations was almost certainly marginal, outweighed by the insurance effect on the real economy.

In all, the FOMC reduced the funds rate target by 75 basis points over the four months following the Russian default (panel 5 of Figure 4). While these funds rate reductions in the wake of the 1998 Russian default were persistent, the funds target

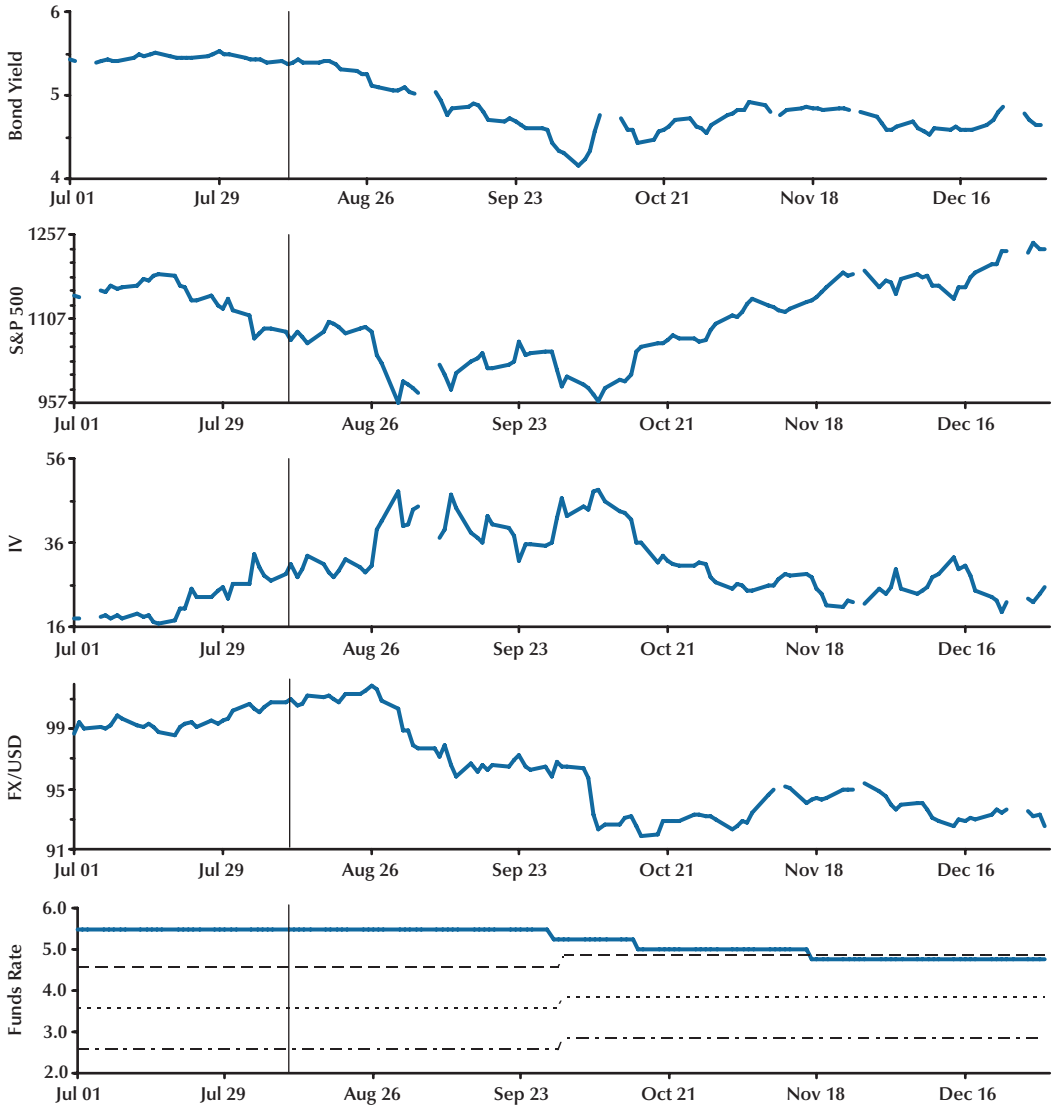
[16] The reader might wonder if U.S. fiscal deficits would also cause monetization and inflation. The U.S. government is in far better fiscal condition than the Russian government was.

[17] Neely (1999) offers an introduction to the problems of capital flight—the withdrawal of assets from a country—and capital controls—legal constraints on international trade in assets.

[18] Tensions with Iraq and the Long-Term Capital Management (LTCM) collapse were also cited as contributing to the dollar's vulnerability.

Figure 4

Data Around August 11, 1998, the Russian Default



NOTE: Daily financial data around the time of the Russian default in August 1998. The first four panels show the yield on 10-year government bonds, the S&P 500 index, the NYSE implied volatility from options prices, and the trade-weighted value of the U.S. dollars. The final panel shows the federal funds rate target (solid blue line) and the targets implied by Taylor rules with inflation targets of 0 (top dashed line), 2 (middle dotted line), and 4 percent (bottom dashed-dotted line) (using real-time data). Vertical lines show August 11, 1998, the date of the Russian default.

remained consistent with a very low U.S. inflation target at any point. These reductions helped to insulate the U.S. economy from the asset market turbulence of the default.[19] Financial markets remained volatile throughout 1998 until interest rate reductions by the central banks of several developed countries took effect (see implied volatility in panel 3 of Figure 4).

Among the casualties of the Russian default was the highly leveraged hedge fund, Long-Term Capital Management (LTCM). LTCM followed a "convergence-arbitrage" strategy in which it examined closely related assets, buying the apparently cheaper asset and selling the overpriced asset. To make money from extremely small disparities in prices, LTCM was very highly leveraged, making it vulnerable to small losses. That strategy was very profitable for several years and led to the narrowing of these disparities in prices. But the LTCM strategy was predicated on the belief that very similar assets must ultimately converge to the same price. There is two-way risk, however. Often the price difference for similar assets is due to differences in liquidity, and such a difference would only increase in times of stress, such as a default. The Russian default caused very large, protracted differentials in the prices of the assets that LTCM was attempting to arbitrage.[20]

While the failure of a financial firm and the bankruptcy of its owners is not ordinarily a matter of concern for a central bank, LTCM was so large and deeply leveraged that a disorderly demise presented the possibility of cascading failures of its many creditors. Concerned about the stability of the financial system, the Federal Reserve Bank of New York facilitated a meeting of LTCM creditors (banks) on September 23, 1998, in which those banks agreed to provide additional capital in exchange for 90 percent of the firm's stock. No public money was used or put at risk in the transaction. The purchase simply permitted an orderly dissolution of LTCM's assets. The new investors allowed the original owners to retain a 10 percent stake in the firm to induce them to assist in the liquidation of LTCM's assets (Greenspan, 1998).

[19] Saidenberg and Strahan (1999) argue that U.S. firms' lines of credit with banks helped to cushion those borrowers from sharp rises in commercial paper rates in the wake of the Russian default.

[20] Jorion (2000) examines LTCM's strategy and mistakes in some detail. Greenspan (1998) reports on the Fed's role in the LTCM bailout.

The September 11th Terrorist Attacks

On September 11, 2001, 19 Al Qaeda terrorists hijacked 4 airline flights within the United States. Two of those planes were deliberately flown into the twin towers of the World Trade Center, at the heart of U.S. financial markets. A third was flown into the Pentagon. The fourth crashed southeast of Pittsburgh, Pennsylvania, during a struggle between the terrorists and passengers as the latter successfully sought to prevent the terrorists from reaching targets in Washington, DC. The September 11th terrorist attacks on the World Trade Center and the Pentagon not only brought about a human tragedy that caused approximately 3000 deaths (Hirschkorn, 2003) but also had potentially serious ramifications for the economy and monetary policy.

The immediate effects of the attacks included the disruption of the payments system, a one-week closure of the NYSE, and a temporary suspension of air flights within the United States. The first two panels of Figure 5 show that U.S. stock prices fell, and the implied volatility of equities rose and remained high for several months. So, there was both direct physical disruption of the financial system and the liquidity effects of a stock market crash.[21] As discussed earlier, falling asset prices and heightened uncertainty often lead banks and other intermediaries to reduce or halt lending.

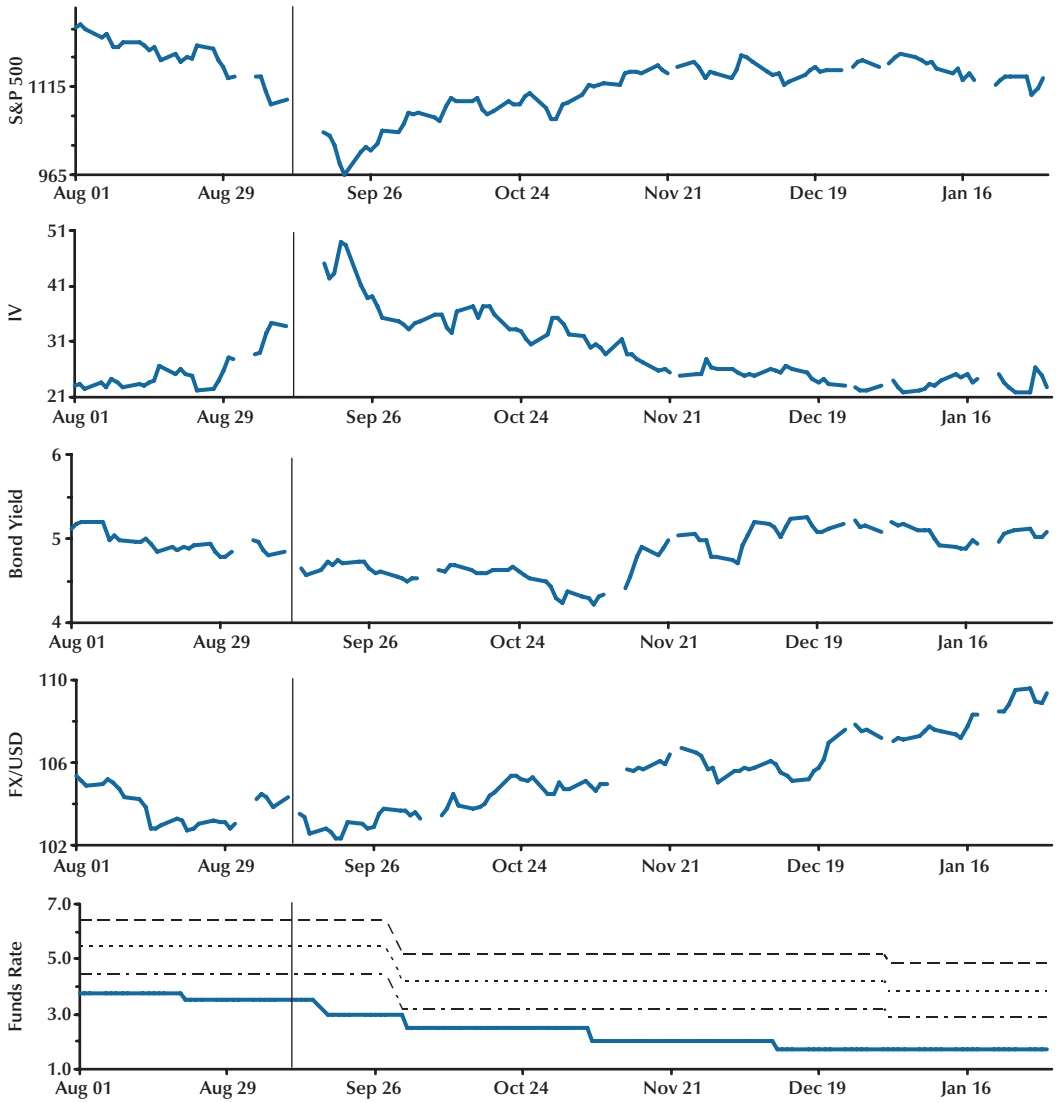
Initially, the Federal Reserve sought to restore confidence and avoid significant disruption to the payments and financial system by providing liquidity in a number of ways: repurchase agreements by the New York desk (repos); direct lending through the discount window; extension of *float*; swap lines to permit foreign central banks to meet liquidity needs in U.S. dollars; and repeated reductions in the federal funds rate in the weeks following the attacks (Neely, 2002; Lacker, 2003).

The extension of credit through the float requires some explanation. When a bank presents a check to the Fed for clearing, the presenting bank may be credited with the amount of the check before the paying bank is debited. Float is the money that has been credited to receiving banks before being debited from paying banks; it is a loan by the Federal Reserve to the banking system. The September 11th attacks resulted in the suspension of air transport, greatly slowing check clearing operations. The Fed, however,

[21] McAndrews and Potter (2002) study the liquidity effects of the attacks in some depth. Fleming and Garbade (2002) look at settlement issues. Lacker (2003) takes a close look at the payments system disruptions.

Figure 5

Data Around the September 11, 2001 Terrorist Attacks



NOTE: Daily financial data around the time of the September 11th terrorist attacks. The first four panels show the S&P 500 index, the NYSE implied volatility from options prices, the yield on 10-year U.S. government bonds and the trade-weighted value of the U.S. dollar. The first panel shows the federal funds rate target (solid blue line) and the targets implied by Taylor rules with inflation targets of 0 (top dashed line), 2 (middle dotted line), and 4 percent (bottom dashed-dotted line) (using real-time data). The vertical lines show September 11, 2001.

Table 2

Provision of Liquidity in Response to September 11, 2001

Wednesday figures	Repos	Discount window lending	Float	Deposits at Federal Reserve Banks
Average July 4 to Sep 5	27,298	59	720	19,009
Sep 12	61,005	45,528	22,929	102,704
Sep 19	39,600	2,587	2,345	13,169
Sep 26	51,290	20	–1,437	18,712
Oct 3	32,755	0	173	14,376
Oct 10	33,505	46	5,306	20,986
Oct 17	37,045	1	1,623	27,395
Oct 24	30,050	42	654	18,746

NOTE: Data (in millions of U.S. dollars) were taken from the Board of Governors' H.4.1 releases, July 5 to October 25, 2001. *Repos*, *Discount window lending* and *Float* are labeled "repurchase agreements," "adjustment credit," and "float," respectively, in "factors supplying reserves." Deposits at Federal Reserve Banks are the sum of "service related balances and adjustments" and "reserve balances with F.R. Banks."

decided to continue to credit the reserve accounts of banks as usual, passively extending this loan to the banking system. Table 2 shows that float rose substantially just after September 11, 2001.

The level of deposits at Federal Reserve Banks summarizes the liquidity provided to the economy. On September 12, this measure stood at $102 billion, more than five times the average of the previous ten Wednesdays (see Table 2). Within three weeks, however, the available liquidity figures—repos, discount lending, float, and deposits at Federal Reserve Banks—were indistinguishable from pre-attack figures.

Panels 3 and 4 of Figure 5 show that 10-year bond yields fell (bond prices rose) and the foreign exchange value of the dollar at first declined but then rose strongly for several months. Initially, the dollar declined somewhat as the direct attack on the United States more than offset the usual safe-haven reputation of U.S. assets. Over the next few months, however, the dollar appreciated significantly. Analysts cited three factors that bolstered the value of the dollar during this period: better-than-expected U.S. economic performance, short-term interest rate cuts by the world's major central banks, and successful military operations in Afghanistan.

Over the medium term, the attacks generated great uncertainty about further attacks and the steps necessary to prevent further attacks. These fears manifested themselves immediately in sharply higher implied volatility for stocks and depressed consumer confidence. The atmosphere reduced consumption and investment and exacerbated the incipient economic slowdown.

Forecasters almost unanimously predicted that the attacks would exacerbate the developing slowdown through their effect on consumer confidence, asset prices, and transitory dislocations in transportation, law enforcement, defense spending, communications (mail), etc. For example, Macroeconomic Advisers revised their pre-attack forecast for 2001 growth down from 0.9 percent to –0.6 percent in the wake of the attacks. This effect was expected to be partially reversed in 2002; the post-attack Macroeconomic Advisers 2002 forecast was revised upward from 3.0 percent to 4.1 percent.

Complicating the Fed's policy decision problem, the unusual nature of the disruption to the payments systems, air transport, and other sectors meant that the September and October economic statistics provided less information than usual regarding longer-run trends. The final panel of Figure 5 shows that the FOMC lowered the federal funds rate target by 175 basis points in the three months following September 11th. Monetary policy was already fairly accommodative by the metric of the Taylor rule predictions, however, and the reductions in the funds target served only to maintain this accommodative stance, not to increase it. In other words, the Taylor rule called for lower rates, and the actual rate reductions only kept pace with the rule's prescription.

The long-term economic effects of the attacks can be classified into wealth effects and taste-technology shocks. Over this horizon, investment must rise and consumption must ultimately fall a bit to replace much of the destroyed physical and human capital. Bram, Orr, and Rapaport (2002) estimate that the property damage, cleanup, and earnings losses of the destruction of the World Trade Center range from $33 to 36 billion through June 2002. Spending on law enforcement and defense activities will rise and—as they are mostly public goods—so will the taxes to pay for them. For example, the war in Afghanistan is a direct result of the terrorist attacks. Such costs are hard to measure because one doesn't know what defense or law enforcement costs would have been in the absence of the attacks. Kogan (2003), however, estimates that the total cost to the federal government from the September 11 attacks, homeland security, and the wars in Afghanistan and Iraq will be about $220 billion, from 2001 through 2004.

In addition to these direct losses, the attacks imposed more subtle costs on the economy. By raising the costs associated with activities such as travel, security, and insurance, the attacks will shift resources among industries. In this sense, the attacks might be viewed as a negative productivity shock, as more resources will be required to produce the same product. That is, travelers will require more security to fly to Memphis and IBM will pay a higher cost for a given level of property insurance for a downtown office building. These costs are very difficult to measure.

Given the enormous size and productivity of the U.S. economy, the costs imposed by the September 11th attacks will have only the most marginal impact on the U.S. standard of living (Hobijn, 2002). For example, the direct cost to the federal government ($220 billion) is only about one-half of 1 percent of U.S. output from 2001 through 2004.

DISCUSSION AND CONCLUSION

The stock market crash of 1987 and the September 11th attacks posed substantial potential dangers to the economy through disruption of the payments system and financial markets. The stock market crash generated liquidity problems through dramatically lower stock prices and greatly increased uncertainty. The September 11th attacks, too, resulted in lower asset prices and much higher uncertainty, but they also physically disrupted the payments and financial system. In both cases, the Federal Reserve provided immediate liquidity to ensure that the payments system continued to function and eased short-term interest rates for some time, to reduce the pressure on the financial system and protect real economic activity.

The Russian default had less dramatic effects on the United States, but still posed potential problems to U.S. financial markets through dramatically higher risk premia. The episode probably led the Fed to maintain lower short-term interest rates than would otherwise have been the case. Also, the Fed helped to facilitate the orderly dissolution of LTCM, a large hedge fund, to help ensure the continuing functioning of financial markets.

In some ways, however, the monetary policy response to all three of these experiences was similar to the response to bank panics that the Federal Reserve System was created to handle. Falling asset prices and heightened uncertainty can prompt banks to reduce or halt customary lending to financial markets just when that capital is most needed. The stock market crash of 1987, the Russian default of 1998, and the attacks of September 11, 2001, all threatened the health of the U.S. economy through their potential impact on the financial system. In response to these recent financial crises, the Fed has functioned as a lender of last resort, much as the authors of the Federal Reserve Act intended more than 90 years ago.

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Appendix

Figure 1: The Bureau of Economic Analysis and Haver Analytics provide quarterly U.S. domestic investment data.

Figure 2: The Board of Governors and the Federal Reserve Bank of New York make available daily federal funds rate targets. The Federal Reserve Bank of Philadelphia maintains and publishes the real-time data on GDP and the GDP deflator. The Bureau of Economic Analysis supplies the most recent data on GDP and the GDP deflator.

Figures 3, 4, and 5: *The New York Times* and *The Wall Street Journal* provide daily data on the S&P 500 index and the NYSE implied volatility, respectively. The Board of Governors of the Federal Reserve makes available data on the yields on 10-year U.S. government bonds, the trade-weighted value of the dollar, and U.S. official foreign exchange intervention.

Timeless Perspective vs. Discretionary Monetary Policy in Forward-Looking Models

Bennett T. McCallum and Edward Nelson

Recent analyses by Clarida, Galí, and Gertler (1999), Jensen (2002), Svensson and Woodford (2004), Walsh (2003), and especially Woodford (1999, 2000, 2003) have been highly productive in advancing the profession's understanding of monetary policy that is intended to be optimal. Specifically, these papers emphasize the importance, for policy purposes, of the distinction between macroeconomic models (of private behavior) that are "forward looking"—i.e., have equations that include expectations of future values of endogenous variables—and those that are not. This distinction—applied to the structural form of the model—is of great theoretical significance, since models derived from optimizing analysis almost invariably include expectations of future variables. A major point of the cited literature is that there is, in forward-looking models, an inefficiency that results from *discretionary* policymaking, relative to that of a well-designed policy *rule*, that obtains in addition to the familiar inflationary bias. (The inflationary bias has been extensively discussed in a huge literature that typically uses non-forward-looking models.) This "dynamic loss" arising from discretionary monetary policy, which is implicit in earlier work by Currie and Levine (1993) among others, has been valuably emphasized in the cited papers, especially Woodford (1999).

There are many associated issues, nevertheless, that remain to be considered. One of these is the *quantitative* extent to which a policy rule of the type in question provides improved outcomes relative to (optimal) discretionary behavior. That magnitude depends, of course, on the model employed—its parameter values and general aspects of the specification. An exploration of these features is clearly warranted. A second and related topic, moreover, concerns the distinction proposed by Svensson (1997, 1999) between "targeting rules" and "instrument rules." Is there, in fact, a major difference? Or can targeting-rule outcomes be closely approximated by instrument-rule procedures? Third, in the context of optimal policy-rule analysis, issues concerning operationality—stressed by McCallum and Nelson (1999)—arise naturally. Is the superiority of rule-based over discretionary policymaking enhanced or diminished by realistic specification of information available to the policymaker? Finally, how important is this newly emphasized dynamic loss compared with that from the more familiar inflationary bias that arises from discretionary policymaking?

In exploring these issues, we begin with an exposition of the basic analysis that emphasizes Woodford's concept of a "timeless perspective" monetary policy and its relationship to previous concepts of rule-based policymaking.

BASIC ANALYSIS

As an illustrative framework, we begin with the forward-looking macroeconomic model that is used by Woodford (1999, 2000) and also is a special case of the models in Clarida, Galí, and Gertler (CGG) (1999) and Jensen (2002).[1] This simplest version features only a forward-looking price adjustment or aggregate supply relation of the Calvo type, augmented with shocks that keep the current natural-rate level of output from being economically efficient.[2] Below, in addition, we consider a more general

[1] The latter two papers permit first-order autoregressive processes for the shock variables, which make their systems somewhat richer than that considered by Woodford, and also consider model variants that include lagged inflation and output-gap terms.

[2] For some discussion of the nature of the u_t shock in equation (1), see Woodford (1999, 2000), CGG (1999, pp. 1566-67), Erceg, Henderson, and Levin (2000), and Giannoni (2000).

Bennett T. McCallum is the H.J. Heinz professor of economics at Carnegie Mellon University and a research associate of the National Bureau of Economic Research. Edward Nelson is a research officer at the Federal Reserve Bank of St. Louis and research affiliate of the Centre for Economic Policy Research. The authors thank James Bullard, Robert Dittmar, William Gavin, Mark Gertler, Christian Jensen, Douglas Laxton, Andre Minella, Jón Steinsson, Lars Svensson, Carl Walsh, Alex Wolman, and Michael Woodford for helpful discussion and comments. Jason J. Buol provided research assistance.

Federal Reserve Bank of St. Louis *Review*, March/April 2004, *86*(2), pp. 43-56.

relation that, although less clean theoretically, yields implications that some analysts (e.g., Fuhrer, 1997) consider to be more realistic empirically. Denoting inflation (relative to its steady-state value) in period t by π_t, and the output gap by y_t, the basic relation is the New Keynesian Phillips curve (NKPC):

$$(1) \qquad \pi_t = \alpha y_t + \beta E_t \pi_{t+1} + u_t,$$

where $\alpha > 0$, $0 < \beta < 1$, and u_t is the shock term.[3] For simplicity, we initially assume that the process generating u_t is white noise. The model that we (and the cited authors) have in mind actually also includes an optimizing IS-type demand relationship of the form

$$(2) \qquad y_t = E_t y_{t+1} + b_1(R_t - E_t \pi_{t+1}) + v_t, \qquad b_1 < 0$$

where R_t is the central bank's interest rate instrument and v_t is a preference or government spending shock.[4] But we shall at first pretend that the central bank can directly control π_t as an instrument—an assumption that is very common in the literature and is innocuous in the present context.[5] We will later extend the analysis in a manner that involves inclusion of equation (2) and use of an interest rate instrument.

The central bank's objective function at time t is taken to be of the form

$$(3) \qquad \textit{Minimize } E_t \, \Sigma_{j=0}^{\infty} \beta^j (\pi_{t+j}^2 + \omega y_{t+j}^2), \qquad \omega > 0$$

which Woodford (2003) has shown to be consistent with individual optimality in terms of agents' preferences under certain reasonable conditions.[6,7] Consequently, the central bank's problem at some point in time, here taken (without loss of generality) to be $t = 1$, can be expressed as minimization of the Lagrangian expression

$$(4) \qquad \begin{aligned} L_1 = E_1[(\pi_1^2 + \omega y_1^2) + \beta(\pi_2^2 + \omega y_2^2) + \ldots \\ + \lambda_1(\alpha y_1 + \beta \pi_2 + u_1 - \pi_1) \\ + \beta \lambda_2(\alpha y_2 + \beta \pi_3 + u_2 - \pi_2) + \ldots] \end{aligned}$$

with respect to π_1, π_2, ..., and y_1, y_2, ...[8] As shown by Woodford (1999) and CGG (1999), under policy *commitment* the optimizing conditions include

$$(5a) \qquad 2\omega y_t + \alpha \lambda_t = 0, \qquad t = 1, 2, \ldots$$

$$(5b) \qquad 2\pi_t + \lambda_{t-1} - \lambda_t = 0, \qquad t = 2, 3, \ldots$$

$$(5c) \qquad 2\pi_1 - \lambda_1 = 0.$$

Here equations (1), (5a), (5b), and (5c) apparently determine optimal values of π_t, y_t, and λ_t for period $t = 1$ and planned values as of $t = 1$ for periods $t = 2, 3, \ldots$ But these choices entail dynamic inconsistency, since the central bank could re-solve the problem in period 2 and would then choose $2\pi_2 - \lambda_2 = 0$ instead of the condition $2\pi_2 + \lambda_1 - \lambda_2 = 0$ that is suggested by (5b). Thus the standard commitment solution, in which the central bank implements (5a), (5b), and (5c),[9] views the central bank as selecting values in $t = 2, 3, \ldots$ that it currently considers undesirable from the perspective of its own decisionmaking process. Since such a pattern of behavior seems highly implausible, this type of commitment solution does not provide an attractive equilibrium concept.

There is another equilibrium concept, however, involving a different type of commitment, that is much more attractive—as Woodford (1999) argues convincingly. Instead of using (1), (5a), and (5b) together with the start-up condition (5c) to determine paths of π_t, y_t, and λ_t for $t = 1, 2, \ldots$, the central bank can use (1), (5a), and (5b) without any start-up condition by applying (5b) in all periods. This approach, which Woodford terms the "timeless perspective," involves ignoring the conditions that prevail at the regime's inception—say, by imagining that the decision to apply (5a) and (5b) had been made in the distant past. In this case, there is no dynamic inconsistency in terms of the central bank's own decisionmaking process. Specifically, if there is no

[3] The coefficient β in (1) represents the private sector's discount factor. Since its value is smaller than 1.0, equation (1) would imply that the Phillips curve is not of the accelerationist type if π_t were defined as inflation. With our interpretation, that implication does not prevail, however. This point has recently been mentioned by Svensson and Woodford (2004).

[4] Because we have written (2) in terms of the output gap—a somewhat undesirable practice, as the IS relationship fundamentally pertains to aggregate demand, not the output gap—the v_t term also includes the expected change in the log of the natural rate of output.

[5] If the relation (2) is included as an additional constraint, with optimization then conducted with respect to R_t as well as y_t and π_t, the Lagrange multiplier attached to this constraint equals zero for all t.

[6] The model that Woodford uses to derive this welfare function has no u_t disturbance in the Phillips curve (1). Giannoni (2000) provides a rationalization for the u_t term that would continue to imply the objective (3).

[7] Note that we are using the same discount factor in both (1) and (3). Below we briefly mention an implication of differing values.

[8] In (4), the terms $E_t \pi_{t+1}$ from (1) can be written without E_t operators because $E_1 E_t \pi_{t+1} = E_1 \pi_{t+1}$, by the law of iterated expectations.

[9] When period $t + j$ comes around, the central bank can by assumption observe y_{t+j} and π_{t+j}, so it can implement (5a)-(5b) exactly.

change in the central bank's model, then the relationships between π_2 and y_2 chosen by this process in period 2 agree with the relationship planned in period 1.

An alternative description of this mode of policy behavior can be obtained by specifying that the analyst's concern is with macroeconomic performance within and across regimes, not with transitions from one regime to another. In this case, the analysis specifies that the policy regime has been in effect long enough that effects of the particular initial conditions, which obtained at the time of its inception, have become negligible. This is the conception adopted by Lucas (1980, p. 205), Taylor (1979, p. 1278), and others. Our contention is that this is the most appropriate presumption for monetary policy analysis. To us it seems implausible that, following a policy regime change, private agents could immediately begin forming expectations consistent with the new regime. The basic rational expectations approach requires that a policy regime has been in effect long enough for private agents to understand it and believe in its continuation.

It is perhaps worth mentioning that this timeless-perspective type of policy behavior agrees in spirit with what has been viewed by most analysts, since publication of Barro and Gordon's (1983) exposition of the Kydland and Prescott (1977) insights, as "policymaking according to a rule." The various quotes in Woodford (1999) taken from McCallum (1999a) illustrate that agreement,[10] as does Woodford's placement of his analysis in a section of his (1999) paper entitled "Rule-Based Policymaking." The modification that King and Wolman (1999, pp. 374-75) make to the commitment case, in their study of optimal monetary policy, also corresponds to adoption of a timeless perspective.[11] It is also worth emphasizing that many studies of optimal monetary policy in forward-looking models have considered policies that are labeled "commitment," but which (because these policies ignore the period 1 first-order condition and use only the remaining portion of the commitment conditions) should really be regarded as reflecting timeless perspective policy. Recent examples in this last category of studies include CGG (1999) and Batini and Nelson (2001).

For comparison, we need to derive the counterpart of conditions (5a)-(5c) provided by "discretionary" policymaking, i.e., a process that presumes period-by-period reoptimization involving each period's start-up conditions. In this case the derivatives with respect to the terms in the Lagrangian expression (4) that correspond to $E_t\pi_{t+1}$ in (1) are all equal to zero.[12] Thus the counterpart of (5b) becomes

$$2\pi_t - \lambda_t = 0, \qquad t = 1, 2, \ldots \tag{6}$$

which is similar to the first-period condition (5c) in the commitment optimization, but now applies to each period. Note that discretion can be characterized by the absence of the lagged Lagrange multiplier in the central bank's first-order condition, as stressed by Woodford (2003, Chap. 7).

In addition, let us express the policy-optimality conditions with the Lagrange multipliers λ_t substituted out. Then, for the discretionary optimum, we obtain from (6) and (5a) the following:

$$\pi_t = -(\omega/\alpha)y_t. \tag{7}$$

By contrast, the timeless-perspective, rule-based condition implied by (5b) and (5a) is

$$\pi_t = -(\omega/\alpha)(y_t - y_{t-1}). \tag{8}$$

The latter expression is equivalent to (8) or (7) in Woodford (1999) and to (4.18) of CGG (1999). It is of some interest to note that in the special case $\omega = \alpha$, and with constant potential output growth, the timeless-perspective rule (8) calls for nominal income growth targeting. This point is related to the findings reported by Jensen (2002) and Walsh (2003).

Quite recently, it has been recognized that use of (8) in all periods, as proposed by CGG (1999) and Woodford (1999), is not optimal within the class of time-invariant policy rules. Specifically, there is a slightly different rule that generates superior results on average, i.e., that yields a smaller unconditional expectation of the conditional expectation in (3).[13] Analysis conducted to date suggests, however, that the welfare improvements are not substantially great.

[10] See, for example, Woodford's (1999) footnote 22.

[11] King and Wolman's (1999) modification is patterned after an analogous procedure in Kydland and Prescott's (1980) study of optimal tax policy.

[12] The reason is somewhat more complex than in the Barro-Gordon (1983) model, which is not forward looking: see Woodford (1999, pp. 308-9) or CGG (1999, p. 1672).

[13] See Jensen and McCallum (2002), Jensen (2001), and Blake (2001). These papers indicate that optimality requires that (8) be altered to $\pi_t = -(\omega/\alpha)(y_t - \beta y_{t-1})$. If private-sector and central-bank discount factors differ, it is the private-sector value that appears in this latter expression.

In any event, these results do not negate interest in comparisons between the Woodford-CGG timeless-perspective results and those based on discretionary behavior.

Equilibrium Behavior in the Basic Model

To determine how inflation and the output gap behave in the timeless-perspective equilibrium, we obtain the rational expectations solution to the model consisting of the policy rule (8) and the private behavioral relation (1). In particular, we look for the minimal state variable (MSV) solution that excludes bubbles and sunspots, as discussed by McCallum (1999b). Thus we conjecture that π_t and y_t are related to the clearly relevant state variables y_{t-1} and u_t as follows:

$$\pi_t = \phi_{11} y_{t-1} + \phi_{12} u_t \tag{9a}$$

$$y_t = \phi_{21} y_{t-1} + \phi_{22} u_t. \tag{9b}$$

Then $E_t \pi_{t+1} = \phi_{11}(\phi_{21} y_{t-1} + \phi_{22} u_t)$ and substitution into (1) and (8) yields the undetermined-coefficient relationships:

$$\phi_{11} = \alpha\phi_{21} + \beta\phi_{11}\phi_{21} \tag{10a}$$

$$\phi_{12} = \alpha\phi_{22} + \beta\phi_{11}\phi_{22} + 1 \tag{10b}$$

$$\phi_{11} = (\omega/\alpha)(1 - \phi_{21}) \tag{10c}$$

$$\phi_{21} = -(\omega/\alpha)\phi_{22}. \tag{10d}$$

From (10a) and (10c), we find that ϕ_{21} satisfies

$$\beta\phi_{21}^2 - \gamma\phi_{21} + 1 = 0, \tag{11}$$

where $\gamma = (1 + \beta + \alpha^2/\omega)$. The relevant root, according to both the stability and MSV criteria, is

$$\phi_{21} = [\gamma - (\gamma^2 - 4\beta)^{0.5}]/2\beta, \tag{12}$$

which satisfies $0 < \phi_{21} < 1$. Following CGG (1999), we use the symbol $\delta = \phi_{21}$. Then the values for ϕ_{11}, ϕ_{12}, and ϕ_{22} can be found to be $\phi_{11} = (\omega/\alpha)(1 - \delta)$, $\phi_{12} = 1/(\gamma - \beta\delta)$, and $\phi_{22} = -(\alpha/\omega)/(\gamma - \beta\delta)$, and the solutions are

$$\pi_t = (\omega/\alpha)(1 - \delta)y_{t-1} + (\gamma - \beta\delta)^{-1} u_t \tag{13}$$

and

$$y_t = \delta y_{t-1} - [(\alpha/\omega)/(\gamma - \beta\delta)]u_t. \tag{14}$$

These can be shown, with some tedious algebra, to agree with solution expressions reported by CGG (1999, e.g., their equation (8.1)).[14]

Finally, to find the MSV equilibrium under discretionary optimal policy, we use (7) rather than (8) as the policy rule. In a system consisting of (1) and (7), there are no clearly relevant state variables other than u_t, so we conjecture a solution of the form

$$\pi_t = \phi_1 u_t \tag{15}$$

$$y_t = \phi_2 u_t. \tag{16}$$

Then $E_t \pi_{t+1} = 0$ and the values of ϕ_1 and ϕ_2 are found to be $\omega/(\omega + \alpha^2)$ and $-\alpha/(\omega + \alpha^2)$, respectively.

Neither Woodford (1999) nor CGG (1999) includes an analysis of the relative losses—the unconditional expectations of the objective function—under the two modes of policymaking. Indeed, they do not actually put forth any claim that the timeless-perspective losses are generally smaller than those from discretionary policymaking.[15] We do not attempt any general algebraic analysis here, but proceed by examining the issue quantitatively using calibrated models with specific parameter values varied over fairly wide but realistic intervals. Such an analysis is included in the next section.[16]

QUANTITATIVE ANALYSIS

Our agenda now is to specify values for the model's parameters α, β, and ω; find the rational expectations solutions described above; and report, for a range of values for the variances and serial correlation of u_t, the average values of the loss function. The average values of the intertemporal loss function (3) are proportional to the mean of the instantaneous loss function—its unconditional expectation—which is what we report.[17] (Thus the

[14] Issues involving *determinacy* of this solution, and others considered below, are considered by Bullard and Mitra (2002) and Svensson and Woodford (2004). More fundamental, in our opinion, is the *learnability* of various solutions, also discussed by Bullard and Mitra. In that regard, Evans and Honkapohja (2003) have shown that the solution (13)-(14) is learnable if an appropriate interest rate rule is used to implement the optimality condition (8), but is not learnable for some other modes of implementation. Similar results apply to other solutions discussed below.

[15] The recent results of Blake (2001) indicate that such a claim would be incorrect, although the contrary cases involve unusually low values of α/ω and β.

[16] A few quantitative results have previously been reported by Giannoni (2000), Vestin (2000), Woodford (1999), and Walsh (2003), but without the type of systematic exploration provided here.

[17] Here we follow the example of King and Wolman (1999), Rotemberg and Woodford (1999), Rudebusch and Svensson (1999), and Walsh (2003) in our use of the unconditional expectation of (3) as the policy criterion.

Table 1

Losses with TP and DIS Policy Behavior, Basic NKPC

(Reported values are losses times 10^5, TP/DIS)

	Value of ω			
Value of α	0.001	0.01	0.0625	0.10
0.10	0.21/0.23	0.96/1.25	1.69/2.16	1.84/2.27
0.05	0.59/0.71	1.54/2.00	2.07/2.40	2.15/2.44
0.01	1.84/2.27	2.28/2.48	2.43/2.50	2.45/2.50

unconditional expectation of (3) equals the reported values multiplied by $1 + \beta + \beta^2 + \ldots = (1 - \beta)^{-1}$.) In what follows, these values are calculated using asymptotic formulae for the moments of the variables in the model (e.g., Hamilton, 1994, p. 265).[18] We use our modification of the QZ algorithm of Klein (2000) to obtain the MSV solution.

Results for the Basic Model

Table 1 reports values of the loss function for a range of α and ω values, with β kept at 0.99 throughout. For α, we suggest that actual values probably lie between 0.01 and 0.05; see, e.g., the estimates in Galí and Gertler (1999). For the central bank preference parameter ω, our range of 0.001 to 0.1 includes values that place almost all weight on inflation variability and values that give much weight to output gap variability. Since we are using quarter-year time periods, equal weights in terms of annualized inflation (as in the original Taylor rule) imply $\omega = (1/4)^2 = 0.0625$. The standard deviation of the white noise u_t shocks is taken to be 0.005 (i.e., 0.5 percent).[19] Thus the annualized standard deviation is about 2 percent, slightly less than is realistic for the U.S. economy. In each entry of Table 1 there are two numbers; the first is the average (i.e., unconditional expectation) loss for the timeless-perspective (TP) solution, and the second is for the discretionary (DIS) solution. From the table it can be seen that the TP policy produces smaller losses than the DIS policy for all examined values of α and ω. The quantitative extent of the difference is about 15 to 20 percent for most values in the table, but falls to a magnitude as low as 2 percent.

[18] These values have been checked by comparison with averages of the same statistics across 100 stochastic simulations (200 periods).

[19] The value chosen for this standard deviation directly influences the values of calculated losses, but does not influence the relative magnitudes of the losses under TP and discretionary policies.

What, if anything, can be said about the absolute levels of these loss magnitudes? Clearly it is possible to compare them to the costs of a steady, maintained inflation. Suppose that inflation is kept constantly at a rate that exceeds the target rate by 1 percent per year. That implies $\pi_t = 0.01/4 = 0.0025$, so with y_t kept at zero, the value of the period loss becomes $0.0025^2 = 0.63 \times 10^{-5}$. Thus the TP and DIS losses in Table 1 with $\alpha = 0.05$ and $\omega = 0.01$, for example, are about 2.4 and 3.2 times as large as the cost of an inflation rate that exceeds the target by 1.0 percent per year. Translating the inflation cost into equivalent consumption terms would be highly problematic, since the results depend sensitively upon the precise shape of the money demand function in the vicinity of the target inflation rate. This problem would remain even if we were to assume that the central bank loss function were based on the utility function of individual agents.

Results for the Basic Model with Serially Correlated Shocks

To consider whether these results are robust, we modify the model somewhat. In particular, we now assume that the u_t shock process is serially correlated according to a first-order autoregressive specification with an autoregression parameter value of 0.8. This change does not affect the TP and DIS rules for the basic model, but will result in solution processes for inflation and the output gap that feature considerable persistence, much more like actual data than those generated by the basic model with white noise u_t shocks. We retain a value of 0.005 for the standard deviation of u_t by reducing the innovation variance by a factor of $[1/(1 - 0.8^2)] = 2.778$. Results are shown in Table 2.

A greater percentage difference now holds in the TP and DIS outcomes for most α and ω values. The ratios of DIS to TP losses, that is, are somewhat

Table 2

Losses with TP and DIS Policy Behavior, NKPC with $\rho_u = 0.8$

(Reported values are losses times 10^5, TP/DIS)

	Value of ω			
Value of α	**0.001**	**0.01**	**0.0625**	**0.10**
0.10	0.24/0.26	0.98/3.43	7.89/21.4	10.6/29.9
0.05	0.89/1.19	5.82/14.9	17.3/42.3	21.4/47.2
0.01	10.6/29.9	29.9/53.1	45.2/57.0	48.2/57.3

larger than in the case with white noise shocks. This is not too surprising, for the fundamental advantage of the TP rule is that it takes correct account of private sector expectations and, therefore, of intertemporal aspects of the situation, which are more pronounced when serial correlation of the shocks is included.

Alternative Model

An alternative specification that also tends to generate persistence in inflation, and consequently has been prominent in recent research, is provided by replacement of price-adjustment relation (1) with the following:

(17)
$$\pi_t = \alpha y_t + \beta\theta E_t\pi_{t+1} + \beta(1-\theta)\pi_{t-1} + u_t. \qquad 0 < \theta < 1$$

Relations of this general type have been promoted by Fuhrer (1997), among others, and are considered in the rule analysis of CGG (1999), Jensen (2002), and Walsh (2003). To find the TP policy rule with (17) replacing (1), we follow the procedure outlined earlier and obtain the following first-order conditions in place of (5)[20]:

(18a) $$2\omega y_t + \alpha\lambda_t = 0 \qquad t = 1, 2, \ldots$$

(18b)
$$2\pi_t + \theta\lambda_{t-1} - \lambda_t + \beta^2(1-\theta)E_t\lambda_{t+1} = 0 \qquad t = 2, 3, \ldots$$

(18c) $$2\pi_1 - \lambda_1 + \beta^2(1-\theta)\lambda_2 = 0.$$

Adopting the Woodford-CGG timeless perspective approach, by substituting out the λ_t multipliers between (18a) and (18b), yields the optimality condition

(19)
$$\pi_t = (\omega/\alpha)[\theta y_{t-1} - y_t + \beta^2(1-\theta)E_t y_{t+1}]. \qquad t = 1, 2, \ldots$$

Here, $E_t y_{t+1}$ appears instead of y_{t+1}, because the latter is not known at t.

For the case of discretionary optimization, there are actually two possible concepts. First, one might conceive of the central bank as implementing (18a) and (18c) in period 1 and *planning* to implement (18a) and (18b) in each subsequent period. When period 2 arrives, however, the central bank re-solves its problem and again implements (18a) and (18c), now updated to period 2. Indeed, in this case the central bank re-solves and implements this solution in each period. With Lagrange multipliers substituted out, the relevant optimality condition is

(20) $$\pi_t = -(\omega/\alpha)[y_t - \beta^2(1-\theta)E_t y_{t+1}],$$

where again it is recognized that y_{t+1} is not known in period t. The second concept, used by CGG (1999, p. 1692) and Jensen (2002), does not involve the dynamic inconsistency that is clearly implied by the first. Instead of planning to implement (18b) in future periods, the central bank recognizes in period 1 that in period 2 it will behave just as it does in period 1. Therefore, in minimizing (3), $E_1\pi_2$ in the constraint (17) for period 1 will be replaced with $\rho_1\pi_1$, where ρ_1 is a parameter of the equilibrium solution expression $\pi_t = \rho_1\pi_{t-1} + \rho_2 u_t$. In the present case with white noise u_t, the relevant optimality condition with this conception of discretionary behavior is

(21) $$\pi_t = -(\omega/\alpha)[(1-\beta\theta\rho_1)y_t - \beta^2(1-\theta)E_t y_{t+1}].$$

Thus there is a smaller responsiveness of inflation (and a larger responsiveness of output) to shocks than would be present if policy behavior were as implied by (20). Since (21) evidently reflects a more

[20] In general, changing the Phillips curve specification means that the loss function (3) can no longer be obtained directly from an approximation of household utility. For example, Steinsson (2003) shows that a Phillips curve like equation (17) implies that the period loss function is no longer time-separable. Following CGG and Jensen, we neglect this nonseparability and continue to use (3) as our welfare criterion.

Table 3

Losses with TP and DIS Policy Behavior, Model Including (17)

(Reported values are losses times 10^5, TP/DIS)

	Value of ω			
Value of α	0.001	0.01	0.0625	0.10
0.10	0.22/0.23	1.36/1.48	3.70/4.34	4.56/5.45
0.05	0.72/0.75	2.99/3.44	6.60/8.17	7.83/9.85
0.01	4.56/5.45	10.6/13.7	17.7/22.6	19.7/24.6

standard version of discretion than (20), it will be used in what follows.[21]

Results are reported in Table 3 for the case in which (17) describes price adjustment behavior, with $\theta = 0.5$, when u_t is white noise. Here the ratio of DIS losses to TP losses is somewhat larger than in Table 1 for the lower right-hand cells but smaller elsewhere. In all cases covered by our α and ω values, the TP losses are smaller than the DIS losses. The table therefore establishes, for a wide range of parameter choices, that the superiority of TP over DIS policies is robust to allowing for intrinsic persistence in inflation.

TARGET RULES AND INSTRUMENT RULES

A monetary policy that implemented the optimality conditions studied above would correspond to following what Svensson (1997, 1999) terms "targeting rules," as distinct from "instrument rules." In these papers, as well as others, Svensson argues that consideration of targeting rules is preferable for actual central banks and for policy analysis. McCallum (1999a) and McCallum and Nelson (1999) have, by contrast, suggested that instrument rules are more interesting from a normative point of view. It could also be argued that they are more relevant empirically, in the sense that the actual inflation-targeting regimes currently in place in New Zealand, Canada, the United Kingdom, and elsewhere are more satisfactorily represented by formal analytical models with instrument rules than with target rules.[22] An important part of this argument is that no actual central bank has revealed what its loss function is—e.g., what its value of ω is in expression (3). Of course an argument of this nature can never be conclusive, but we would point out that Woodford (1999, pp. 287-99) has presented a sophisticated discussion that predominantly supports this position.

A strictly analytical claim made by McCallum (1999a, p. 1493, footnote 17) is that an instrument rule can typically be written so as to imply instrument responses that would tend to bring about the satisfaction of any (feasible) specified target rule. In the context of the present analysis, for example, one could include the optimizing IS relation (2) as part of the model and then specify an instrument rule for R_t that is designed to implement an optimality condition such as (8). In this case, the rule could be written as

$$R_t = (1-\mu_2)\{\bar{r} + \pi_t + \mu_1[\pi_t + (\omega/\alpha)(y_t - y_{t-1})]\} + \mu_2 R_{t-1}, \tag{22}$$

which, with $\mu_1 > 0$, $\mu_2 \geq 0$, is similar to an extended[23] version of the Taylor (1993) rule, but with $\pi_t + (\omega/\alpha)(y_t - y_{t-1})$ rather than $\pi_t + y_t$ as the target variable, i.e., the variable that the rule seeks to keep close to some desired value. If the economy is one in which current aggregate demand can be influenced by R_t, then as μ_1 is increased, the variability of the term in square brackets in (21) tends to be decreased, yielding an approximation to the satisfaction of optimality condition (8).[24]

To determine whether it is in fact the case that increasing μ_1 values would lead to approximate satisfaction of (8)—and likewise of the discretionary

[21] We proceed computationally by assuming a value for ρ_1, solving the model conditional on that value, determining the value implied by the solution, and iterating. For an alternative, dynamic programming approach to the problem, see Steinsson (2003).

[22] See, for example, the discussions of the respective central bank practices given by Archer (2000), Freedman (2000), and King (1999).

[23] The extension takes the form of an added R_{t-1} term to reflect interest rate smoothing.

[24] This argument does not maintain that (22) is the only instrument rule that would serve the purpose of implementing (8), but merely that it will do so (and has been mentioned in the literature).

Table 4

Losses with Interest Instrument Versions of TP and DIS

Behavior, Basic NKPC Model with $\alpha = 0.05$ and $\mu_2 = 0$

(Reported values are losses times 10^5, TP/DIS)

	Value of ω			
Value of μ_1	**0.001**	**0.01**	**0.0625**	**0.10**
0.5	2.51/2.51	2.90/2.86	5.29/4.20	7.36/4.69
5.0	2.12/2.14	2.45/2.43	3.38/2.63	3.40/2.62
50.0	0.86/1.04	1.58/2.03	2.09/2.41	2.17/2.44
500.0	0.59/0.72	1.54/2.00	2.07/2.40	2.16/2.44

optimality condition (7)—consider the values reported in Table 4. There, $\alpha = 0.05$ and $\mu_2 = 0$ are retained throughout, with various values of ω specified and μ_1 increased from the Taylor value 0.5 to extremely large magnitudes.[25] The shock term in relation (2) includes two components, a white noise taste component with standard deviation 0.02 and also $\bar{y}_t - E_t \bar{y}_{t+1}$, where the natural-rate value $\bar{y}_t$ comes from an AR(1) process with AR parameter 0.95 and innovation standard deviation 0.007.[26] The results indicate that, at least for this example,[27] the instrument rule approximates very closely the target-rule optimality conditions for large μ_1 values (strong feedback responses). With $\mu_1 \geq 50$, for example, the $\omega = 0.0625$ case gives TP and DIS loss values of 2.09 and 2.41, respectively, which are essentially identical to the target-rule losses shown in Table 1. Thus, instrument rules can be written to include target rules as extreme special cases, but are more general.[28]

OPERATIONALITY

Exercises such as those of the preceding sections are interesting and even enlightening, but are far removed from the monetary policy problems facing actual central bankers. In reality, decisionmakers at central banks have only vague notions about the "true model"—i.e., the workings of the actual economy—and have highly incomplete and imperfect information regarding current values of many variables of macroeconomic importance. Serious studies of desirable policy should recognize these features of reality. We now wish to determine how such *operationality* considerations are related to the issues regarding optimality in forward-looking models that have been considered here. Clearly, a complete study is beyond the scope of this paper, but some leading problems can be considered. First we consider two particular points, ones that have been stressed in previous work by McCallum and Nelson (1999) and McCallum (1999a).

The first point is the central bank's lack of knowledge of the current value of output at the time it sets its interest rate instrument for that period. To be more realistic, one could include the most recent period's value y_{t-1}, but a preferable approach would be to use $E_{t-1} y_t$. Accordingly, we now investigate the effects of including $E_{t-1} y_t$ in place of y_t in instrument rule simulations such as those used earlier. In addition, we consider cases in which current inflation is not observed, so that $E_{t-1} \pi_t$ is used by the central bank in place of π_t, and in which neither of these variables is observed.

A first set of results is shown in Table 5, where the first row repeats results from Table 4 for comparison. The second row gives the results with the expected current output gap included in place of the (unobserved) current value. It will be seen that the magnitude of the losses seen in the table is, in this case, much greater than with full information, with the extent of the increase positively related to ω (i.e., to the strength of the response to the imperfectly observed gap variable). For each ω value con-

[25] We are using relation (1) with a white noise shock term.

[26] This component must be included because the IS equation (2) is written in terms of the output gap.

[27] Similar results have also been obtained for the case where the shock term in (1) is AR(1) with parameter 0.8.

[28] It has been suggested that large values of μ_1 would induce excessive volatility of the R_t instrument, but such an outcome will not obtain if these large values keep the variability of π_t and y_t low. Our results indicate that, in fact, the latter case prevails.

Table 5

TP and DIS Losses with Unobservable Output

Basic Model with $\alpha = 0.05$, $\mu_1 = 50$, and $\mu_2 = 0$
(Reported values are losses times 10^5, TP/DIS)

	Value of ω			
	0.001	0.01	0.0625	0.10
With y_t and π_t in rule	0.86/1.04	1.58/2.03	2.09/2.41	2.17/2.44
With $E_{t-1}y_t$ and π_t in rule	0.74/0.90	3.21/3.29	12.0/17.2	16.1/27.1
With y_t and $E_{t-1}\pi_t$ in rule	2.62/2.57	2.58/2.52	2.53/2.50	2.52/2.50
With $E_{t-1}y_t$ and $E_{t-1}\pi_t$ in rule	2.77/2.64	12.5/3.00	185.6/5.10	31,220/6.60
With $E_{t-1}y_{t+1}$, $E_{t-1}y_t$, and $E_{t-1}\pi_{t+1}$ in rule	2.64/2.64	3.00/3.00	5.10/5.10	6.60/6.60

Table 6

TP and DIS Losses with Unobservable Output

Model Including (17) with $\alpha = 0.05$, $\mu_1 = 50$, and $\mu_2 = 0$
(Reported values are losses times 10^5, TP/DIS)

	Value of ω			
	0.001	0.01	0.0625	0.10
With $E_t y_{t+1}$, y_t, and π_t in rule	1.03/1.11	3.05/3.58	6.60/8.24	7.84/9.88
With $E_{t-1}y_{t+1}$, $E_{t-1}y_t$, and π_t in rule	0.90/0.99	4.58/4.56	28.3/25.0	44.5/39.7
With $E_t y_{t+1}$, y_t , and $E_{t-1}\pi_t$ in rule	2.31/2.41	3.92/4.41	7.06/8.59	8.20/10.2
With $E_{t-1}y_{t+1}$, $E_{t-1}y_t$, and $E_{t-1}\pi_t$ in rule	2.22/2.35	4.39/4.58	25.3/11.0	51.2/14.2
With $E_{t-1}y_{t+2}$, $E_{t-1}y_{t+1}$, and $E_{t-1}\pi_{t+1}$ in rule	2.89/3.12	3.39/4.36	8.47/17.3	11.0/26.4

NOTE: y_{t-1} appears in all the TP rules except those of the last row, where it is replaced by $E_{t-1}y_t$.

sidered, it remains true that the TP losses are smaller than the DIS losses. In the third row, we suppose that inflation (instead of output) is currently unobservable. In this case, the losses are essentially equal for all ω values and for both TP and DIS policies. The value of the loss function, moreover, is very nearly equal to the value of the variance of the u_t shock term.

In the fourth row, we suppose that both inflation and output are currently unobservable. In this case, the TP losses jump up drastically while the DIS losses increase, but by much less. It is understandable that losses could be very large in this case, for the setup is one in which policy is in effect trying to stabilize current variables although they are not observable. In the discretionary case, certainty equivalence implies that the attempt at stabilization is being carried out as efficiently as possible when $t-1$ expectations are used in the rule in the absence of current observations (see Svensson and Woodford, 2003), but this principle does not carry over directly to the TP case. In that case, it turns out that inclusion of $E_{t-1}\pi_{t+1}$, $E_{t-1}y_{t+1}$, and $E_{t-1}y_t$ yields much better results. In fact, those results, shown in the fifth row of Table 5, are equivalent to those given in the fourth-row DIS cases.

A second set of results, pertaining to the case in which the price adjustment relation (17) replaces (1), is given in Table 6. Qualitatively, the results are not too different from those of Table 5. In particular, when neither π_t nor y_t is currently observable, the TP performance is poor. But it can be improved by shifting forward the dates of each variable (whose values are those expected on the basis of $t-1$ data).

Indeed, in this case, the TP results are superior to those based on the DIS procedure, instead of being equal as in Table 5.

Our second point of concern is arguably of even greater practical importance. It involves the unobservability of the natural-rate level of output that goes into the central bank's measure of the output gap. In this case the nature of the problem is quite different, we contend. Rather than reflecting merely a lack of current information, the problem is largely conceptual—that is, it stems from the existence of various different concepts of the relevant reference value (which we have been calling "natural rate"). That there are several distinct concepts in use is implicit in the terms used by different researchers and practitioners. In addition to the term "potential," which is frequently used by practitioners, there are the words "trend," "capacity," "NAIRU," "market clearing," and "flexible price," besides "natural rate." There are perhaps fewer distinct concepts than terms, but there seem to be at least three fundamentally different ones: trend, NAIRU, and flexible-price concepts. And, of course, there are many ways of measuring trend output that are quite different in their effects. Furthermore, since reliance on any particular concept will be maintained over time, differences will not possess the orthogonality properties of pure "noise."

Which of the concepts is most appropriate theoretically? From the perspective of dynamic, optimizing analysis, the answer is the third of the three just listed, the flexible-price concept—that is, the output level that would prevail in the absence of nominal price stickiness. There have been very few attempts to implement this type of measure empirically, but there is one in McCallum and Nelson (1999), which we briefly review.

This procedure begins with the assumption that output is produced according to a Cobb-Douglas production function relating the log of output linearly to the logs of labor and capital (n_t and k_t), a deterministic trend, and a shock term a_t reflecting the stochastic component of technological change. Then, since k_t and a_t are given in t whether or not prices are flexible, the difference between the logs of actual and flexible-price output (i.e., the output gap) will be proportional to the difference between actual and flexible-price labor input, $n_t - \bar{n}_t$. For simplicity, McCallum and Nelson (1999) assumed that the flexible-price level $\bar{n}_t$ (per period, per person) is a constant and, numerically, they measured n_t for the United States, 1955:Q1–1996:Q4, as total man-hours employed in nonagricultural private industry divided by the civilian labor force. This measure is scaled so that the average value of $n_t - \bar{n}_t$ equals zero. The necessity of that step is undesirable, but on the positive side there is no deterministic trend in the resulting $n_t - \bar{n}_t$ series. Then, using 0.7 as the elasticity of output with respect to labor, they constructed a series for the output gap y_t (shown in McCallum and Nelson, 1999, p. 28) and contrasted with a measure based on simple log-linear detrending. This series, in combination with the corresponding output series, provides a series for $\bar{y}_t$.[29] It has approximately the time series properties assumed above.

An important point is that non-zero realizations of the technology shock a_t affect the McCallum-Nelson measure of $\bar{y}_t$ one-for-one, whereas many detrending procedures, used extensively by academics and to some extent by central banks, remove a_t almost entirely from each period's measure of $\bar{y}_t$. The same is true, furthermore, for many NAIRU-based procedures. So the question at hand is whether this conceptual discrepancy is of quantitative importance—whether the use of a mistaken concept would create major welfare losses from policy rules that rely upon measures of the output gap. We approach this question here by assuming that the McCallum and Nelson (1999) measure of the gap is correct, but that the central bank incorrectly uses the measure based on linear detrending in the context of instrument rule (22). For simplicity, we assume that the central bank has accurate knowledge of the true trend, which is excessively optimistic, so the conceptual error as implemented is only that the central bank neglects the influence of a_t on $\bar{y}_t$.

Results are reported in Table 7. The loss values reported there can be compared with those in Table 4, in which the experiment is the same except for the postulated mis-measurement of $\bar{y}_t$. It is clear that the consequences of the conceptual error are quite substantial, except for $\omega = 0.001$, and are much larger for large values of ω. Because these values imply giving more weight to the output gap, the results are consistent with the suggestion of McCallum (1999a) and Orphanides (2003) that it is dangerous to respond strongly to measures of the output gap. Furthermore, Table 7 indicates that the TP outcomes are considerably more desirable

[29] Galí and Gertler (1999) also use labor market data, in a different but related manner, in the context of estimating the Calvo specification (equation (1)).

Table 7

Losses from Responding to Incorrect Concept for Potential Output

(Reported values are losses times 10^5, TP/DIS)

	Value of ω			
Value of μ_1	**0.001**	**0.01**	**0.0625**	**0.10**
0.5	4.09/4.31	4.37/6.67	6.11/18.8	7.75/24.8
5.0	2.13/2.21	2.42/3.98	4.00/16.5	4.93/22.7
50.0	0.86/1.06	1.63/3.38	3.11/16.2	4.15/22.5
500.0	0.59/0.74	1.61/3.33	3.12/16.2	4.17.22.5

Table 8

DIS Losses due to Inflation Bias

Basic Model

(Reported values are losses times 10^5)

	Value of ω			
Value of α	**0.001**	**0.01**	**0.0625**	**0.10**
0.10	0.001	0.10	3.91	10.0
0.05	0.004	0.40	15.6	40.0
0.01	0.10	10.0	391	1,000.0

than those resulting from DIS behavior. This result is in keeping with the spirit of the suggestions of McCallum (1999a), Orphanides (2003), and Jensen (2002) that responding to some variable reflecting nominal income growth may be more attractive than responding to the level of the output gap.

INFLATIONARY BIAS

An issue of obvious interest is how the magnitudes of the losses shown in Tables 1 through 7 compare with those implied by the discretionary inflationary bias discussed in the enormous literature that uses non-forward-looking models. The inflationary bias carries over to the forward-looking models, as Woodford (1999) and CGG (1999) have pointed out, if the central bank's objective function includes terms such as $\pi_t^2 + \omega(y_t - k)^2$, with $k > 0$, reflecting a desire by the central bank to keep output above the natural-rate value that would obtain on average in the absence of nominal frictions (i.e., with fully flexible prices). In the model at hand, the magnitude of the bias is simply $(\omega/\alpha)k$, as can be easily verified. To get a clear idea of the magnitudes involved, let us then suppose that $k = 0.01$, i.e., that the central bank aims for a level of output that exceeds the natural-rate value by 1 percent. Then if $\omega/\alpha = 1$, the bias would be 0.01 and its square, 0.0001, would be appropriate for comparison with the values in Tables 1, 4, and 5.[30] Those tables' entries are losses multiplied by 10^5, of course, so in this case the loss value comparable to the first-row/fourth-column entries of Table 1 would be 10. More generally, we have the values reported in Table 8, where for values of ω equal to or greater than 0.0625 the inflationary bias is more important, if relevant, than the newly emphasized dynamic loss.

It is, of course, not clear that actual central banks behave as if k exceeds zero, i.e., behave so as to aim for an output rate higher than the flexible-price (natural rate) value. The position that intelligent central banks do *not* aim for higher output values has been advanced by Svensson (1999), King (1996), and others. It nevertheless seems possible to us that positive values of k might well reflect the behavior of some actual central banks, even ones with well-

[30] For the exercises reported in these tables, the standard deviation of u_t is, we think, fairly realistically calibrated.

informed and inflation-averse leaders. The reason is that $k > 0$ would be a feature of central bank preferences that accord with a welfare criterion based on household utility when factors such as monopolistic competition or tax distortions, which imply that the flexible-price competitive equilibrium is not socially optimal, are present (see Woodford, 2003). Of course, central banks may regard it as more appropriate to respond to these real distortions using devices other than monetary policy; this, indeed, is the assumption in many recent analyses of optimal monetary policy (including Woodford, 2003, and Aoki, 2001). In any event, knowledge of the relative importance of this bias is relevant for the strategic decisions of central banks.

CONCLUDING REMARKS

We began this analysis by reviewing the distinction between the timeless perspective and discretionary modes of monetary policymaking, the former representing rule-based policy as formalized by Woodford (1999). This distinction becomes important in models with forward-looking expectations, a model feature that was not typically used in the rules-vs.-discretion literature. Typically, there is a second inefficiency from discretionary policymaking, distinct from the more familiar inflationary bias. We calculated the quantitative magnitude of this second inefficiency or loss, using calibrated models of two types prominent in the current literature and a wide range of values representing the relative seriousness of inflation and output-gap variability. The magnitude of the losses is significant, and greater in some (but not all) cases than the inflationary bias arising from a 1 percent excess of the central bank's output target over the natural-rate value. The losses tend to be somewhat larger in model specifications that imply inflation rate persistence and are often (but not universally) larger with more objective-function weight on output-gap variability.

In addition, we have examined the distinction between instrument rules and targeting rules; our results indicate that targeting-rule outcomes can be closely approximated by instrument rules that respond to any failure of the targeting rule's optimality condition to hold. Using the instrument rule formulation, we briefly investigated operationality issues, involving the unobservability of current output and perhaps inflation. In addition, we examined a set of cases that assume that the monetary policymaker is using the wrong concept of the natural-rate or potential level of output. In almost all of the various cases examined in the paper, the performance of timeless-perspective policymaking is at least as good as that provided by optimal discretionary behavior. Furthermore, these optimal rules can be well approximated by simple feedback rules based on an interest rate instrument.

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