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The FOMC in 1993 and 1994: Monetary Policy in Transition

Michael R. Pakko

On the surface, an analysis of monetary policy in 1993 and 1994 would seem to be a study in contrasts. During 1993, there were no changes in the policy directives of the Federal Open Market Committee (FOMC), and short-term interest rates remained steady throughout the year. In 1994, on the other hand, the FOMC announced six separate policy changes, each associated with highly publicized increases in short-term interest rates. From a broader perspective, monetary policy over the past two years could be characterized as reflecting an evolution of the Federal Reserve's instrument settings in response to strengthening economic growth. Policy remained deliberately stimulative during 1993, as members of the FOMC cautiously evaluated the robustness of the ongoing economic recovery. A careful reading of the policy record of the FOMC and statements by its members, however, reveals that a shift to a more-neutral policy stance was viewed as quite likely, though the timing of the policy adjustments was in question.

Beyond the short-term adjustments in the Federal Reserve's policy settings during 1994, a number of additional themes characterize monetary policy in 1993 and 1994. Over the course of these two years, the relationships of the monetary aggregates to economic activity continued to depart from historical patterns. As a result, the strategy of using monetary aggregates as intermediate targets has become less important in the process of formulating policy and communicating its intent to the public. At the same time, however, a broadening of consensus regarding the ultimate goals and limitations of monetary policy has continued to develop: Economists and Federal Reserve policymakers increasingly agree that price stability should be the overriding long-run concern of the central bank, serving as a foundation for maintaining economic growth.

Monetary policy in 1993 and 1994 might therefore be characterized as a period of transition. Only in hindsight will we know the ultimate outcome of this process. This article seeks to describe the nature of the evolution to date. The next section describes the nature of the multi-stage policy process embodied in the framework of intermediate targeting. Subsequent sections are organized within the structure of this framework, focusing on the way in which the intermediate targeting strategy has evolved during the past two years. In particular, the article examines the growing consensus for price stability as the ultimate objective of monetary policy, describes the continuing de-emphasis of monetary aggregate targeting, and discusses some issues relating to the characterization of short-run policy in 1993 and 1994.[1]

A BRIEF DESCRIPTION OF THE INTERMEDIATE TARGETING STRATEGY

Since at least the 1970s, the Federal Reserve's monetary policy has followed a multi-stage process, often referred to as the "Intermediate Targeting" approach.[2] The underlying presumption of this strategy is that some set of observable economic variables can serve as indicators or operational targets of monetary policy in a way that provides information about the links between specific policy actions and the ultimate goals of policy.

Typically, the intermediate targeting strategy is presented in the economic literature as a sequence of four levels of policy. At the most basic level are the tools of monetary policy—the fundamental instruments over which the Federal Reserve exerts direct control.

[1] As a committee, the FOMC represents a range of individual viewpoints. This article does not seek to characterize the views of any particular member, nor does it represent official positions of the Committee. Rather, it reflects one interpretation of recent events and decisions of the FOMC.

[2] See Meulendyke (1990) for an account of the historic evolution of the Fed's operating procedures and intermediate targeting strategy.

These tools include reserve requirements, the discount rate and open market operations.

The next stage, often referred to as the operating instruments or proximate targets of policy, consists of measures which are directly affected by policy actions, but which are not under the direct control of the Federal Reserve. Included in this category are those variables that provide information on the market for bank reserves. The actions of the Federal Reserve's open market operations directly affect the supply of reserves available to the banking system. Hence, readings on conditions in the reserve market can be drawn by observing either the quantity of reserves (measured by some reserve aggregate or its growth rate) or the interest rate in the market for inter-bank reserve lending (the federal funds rate).

On the next level are the intermediate targets of policy. Theoretically, intermediate targets should have two key attributes: They must be affected by the actions of monetary policy and have a predictable relationship to the ultimate goals of policy. An ideal intermediate target would therefore serve to provide timely information on the implications of policy actions, allowing policymakers to make mid-course corrections in response to readings on the intermediate target. As the monetary policy process has evolved over recent decades, the intermediate targeting strategy has developed around the notion of using monetary aggregates as intermediate targets. In fact, the use of monetary aggregates is reflected in the congressional mandate given to the Fed to guide the conduct of policy, requiring that the Fed report "objectives and plans...with respect to the ranges of growth or diminution of the monetary and credit aggregates... ."[3]

Finally, at the end of the spectrum are the ultimate goals of monetary policy. The success or failure of policy can only be meaningfully judged by its ability to achieve these goals. Yet the particular criteria for making such a judgment have not always been apparent. Congress has legislated a number of objectives for the Fed to pursue, which include economic growth, high employment, stable prices and low long-term interest rates. If the various objectives seem, at times, to be incompatible with one another, the legislation leaves unclear how conflicts should be resolved.

Within the intermediate targeting framework, the policymaking process can be thought of as involving strategic and tactical decisions relating the settings at the various levels. As mandated by the Full Employment and Balanced Growth Act of 1978 (otherwise known as the Humphrey-Hawkins Act), the FOMC evaluates its longer-term objectives twice per year, reporting to the Congress on its projections for economic activity, and presenting its intermediate targeting objectives in terms of monetary aggregate growth ranges. This bi-annual exercise can be thought of as establishing the objectives and strategy of policy. At each of its eight meetings per year, the FOMC makes this strategy operational by providing a "directive" to the Manager of the System Open Market Account at the Federal Reserve Bank of New York. This directive specifies a short-term operating objective, cast qualitatively in terms of a "degree of pressure on [bank] reserve positions." The directive also suggests the Committee's inclination toward modification of policy during the intermeeting period. The officials at the Open Market Desk then carry out the tactical aspects of the policy, arranging day-to-day purchases or sales of Treasury securities to achieve the Committee's objectives for proximate targets (for example, the federal funds rate and reserve aggregate growth), in some cases adjusting the instrument settings in response to incoming information regarding the intermediate target variables.

Figure 1 illustrates the process in a step-by-step manner in a way which indicates the links among the various stages and suggests the type of feedback rules with which policy is evaluated and modified. The strategic decisions of the FOMC are represented by the directional arrows running from ultimate objectives back toward the tools of policy, while the tactical decisions of short-run policy implementation run in the opposite direction.

As the structure of the economy and economists' understanding of its mechanisms change over time, the Federal Reserve's approach to policymaking has evolved to meet new challenges. This evolution of the structure of policymaking is perhaps more significant than the day-to-day and month-to-month adjustments of the Fed's policy instruments,

[3] Public Law 95-523, The Full Employment and Balanced Growth Act of 1978, Sec. 108.

but is often overlooked in analyses of monetary policy. Subsequent sections of this article examine some of the emerging trends in the adaptation of the FOMC's policymaking approach, organized within the context of the intermediate targeting framework.

POLICY GOALS: PRICE STABILITY AND ECONOMIC GROWTH

By tradition and legislation, the Federal Reserve is charged with considering a number of objectives in the formulation of monetary policy. For example, the Federal Reserve Act as amended in 1977 specifies that the Fed is to "promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates."[4] Federal Reserve policymakers also seek to maintain "orderly" financial markets, which operationally has meant an apparent tendency to smooth interest rate changes.

The existence of multiple goals raises the possibility that two or more objectives may come into conflict. Although congressional legislation specifies a number of goals, it gives no clear guidance how potential conflict among objectives should be resolved. Historically, Federal Reserve policymakers have tended not to specify the relationships among the goals explicitly or how potential conflicts are to be resolved, preferring instead to defer to the need to retain flexibility in the implementation of policy. As Maisel (1973) noted: "Frequently, members of the FOMC argued over the merits of a policy without ever having arrived at a meeting of the minds as to what monetary policy was and how it worked. These problems were, and still are, neither recognized nor clarified."[5]

Recently, however, public statements by FOMC members have tended to emphasize the long-run consistency between the objectives of "price stability" and economic growth, recognizing that the trade-off which was once commonly thought to exist between inflation and real economic growth does not exist in the long run (see the shaded insert titled, "Statements by FOMC Members on Price Stability"). This view has been shaped both by theoretical advances in macroeconomics and the experience of the 1970s in particular. As Federal Reserve Chairman Alan Greenspan has noted:

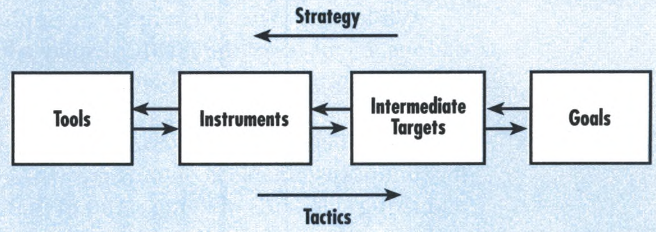
> "...the experience of the past three decades has demonstrated that what appears as a tradeoff between unemployment and inflation is quite ephemeral and misleading. Over the longer run, no such tradeoff is evident...Experience both here and abroad suggests that lower levels of inflation are conducive to the achievement of greater productivity and efficiency and, therefore, higher standards of living."[6]

From this perspective, the trade-offs among the various goals of monetary policy appear less in conflict with one another than they are often perceived to be: In the long run, the pursuit of price stability is consistent with—perhaps even necessary for—the maintenance of economic growth and low long-term interest rates. This view also stands in contrast to many characterizations of recent monetary policy by the media, which suggest that the Fed's policy is to deliberately impede economic growth in order to subdue inflation.[7] Nevertheless, there is often pressure from outside the Federal Reserve to pursue policies which promise to provide short-term gains in output and employment, but at the expense of potential inflationary consequences in the longer term.[8]

Despite the general support for price stability, such broad statements of purpose remain somewhat vague as operational objectives. As Chairman Greenspan described the issue: "...price stability does not require that measured inflation literally be zero but rather is achieved when inflation is low enough that changes in the general price level are insignif-

Figure 1

The Fed's Intermediate Targeting Strategy



[4] Federal Reserve Reform Act, Section 2A, November 16, 1977 (91 Stat. 1387).

[5] Maisel (1973), p. 78.

[6] Statement before the Joint Economic Committee, U.S. Congress, January 31, 1994. *Federal Reserve Bulletin* (March 1994, p. 232).

[7] For a critique of this view, see Jordan (1994).

[8] See, for example, Papadimitriou and Wray (1994).

STATEMENTS BY FOMC MEMBERS ON PRICE STABILITY

While their views often differ in emphasis and with regard to specific policy recommendations, members of the FOMC display a broad unanimity of opinion regarding the ultimate long-run objectives of monetary policy:

"...the Federal Reserve seeks to foster maximum sustainable economic growth and rising standards of living. And in that endeavor, the most productive function the central bank can perform is to achieve and maintain price stability."

– Alan Greenspan, Chairman, Federal Reserve Board

"Inflation has to, by default, take primacy because that is what we can control in the long run."

– Alan Blinder, Vice Chairman, Federal Reserve Board

"The Federal Reserve is committed to keeping inflation down not for its own sake, but because it is important for long-term economic growth for this country."

– Lawrence B. Lindsey, member, Federal Reserve Board

"I think in general we've made good progress on price stability, but it's not something where you can say, 'We've won the battle and we can go home.' It's something we always have to pay attention to."

– Susan M. Phillips, member, Federal Reserve Board

"Keeping inflation low is a necessary ingredient for maximizing sustainable economic and job growth."

– Edward G. Boehne, President, Federal Reserve Bank of Philadelphia

"What monetary policy *can* do to promote long-run economic efficiency is to stabilize the aggregate price level and to create a climate of confidence about the outlook for price stability."

– Jerry L. Jordan, President, Federal Reserve Bank of Cleveland

"I believe that the primary goal of policy is to promote economic growth and employment and that the Federal reserve can best pursue this goal by fostering a stable aggregate price level over time."

– J. Alfred Broaddus, Jr., President, Federal Reserve Bank of Richmond

"We now know that maximum sustainable economic growth is achieved when changes in the price level cease to be a factor in economic decision-making."

– Thomas C. Melzer, President, Federal Reserve Bank of St. Louis

"... in the long run the most significant contribution monetary policy can make to achieving maximum sustainable growth in real output is to foster price stability."

– Gary H. Stern, President, Federal Reserve Bank of Minneapolis

"I think we all agree that the goal of monetary policy is to promote maximum sustainable growth over time...But just as important, and consistent with this goal, the Federal Reserve must work toward ensuring an environment of price stability."

– Thomas M. Hoenig, President, Federal Reserve Bank of Kansas City

"...in the long run the most significant contribution we can make to economic growth is by providing a low-inflation environment, and we have made progress in that area..."

– Robert T. Parry, President, Federal Reserve Bank of San Francisco

Table 1

FOMC Central Tendency Projections

	Variable	Feb. 93	July 93	Feb. 94	July 94	Actual
1993	Nominal GDP	5½–6	5–5¾			5.0
	Real GDP	3–3¼	2¼–2¾			3.1
	CPI	2½–2¾	3–3¼			2.7
	Unemployment rate	6¾–7	6¾			6.5
1994	Nominal GDP		5–6½	5½–6	5½–6	6.5
	Real GDP		2½–3¼	3–3¼	3–3¼	4.1
	CPI		3–3½	About 3	2¾–3	2.7
	Unemployment rate		6½–6¾	6½–6¾	6–6¼	5.6
1995	Nominal GDP				5–5½	
	Real GDP				2½–2¾	
	CPI				2¾–3½	
	Unemployment rate				6–6¼	

Note: Unemployment rate refers to the average level for the fourth quarter. All other data represent fourth quarter-to-fourth quarter percentage changes.

icant for economic and financial planning."[9]

However, many questions remain unresolved: What price index should be used for measurement? What rate of inflation corresponds to "price stability"? Should the Fed pursue objectives stated in terms of price levels or inflation rates? What operating procedures should be used to achieve the objective? What is the relevant time frame for achieving and maintaining price stability?

The emphasis on the benefits of long-run price stability suggests the potential efficacy of establishing long-run objectives for monetary policy. Under the present structure of policy formulation, the only quantitative method of communicating long-term expectations regarding the objectives of policy is the bi-annual economic projections of the Committee, which are presented by the Chairman of the Board of Governors in each of the Humphrey-Hawkins reports to Congress. Table 1 reports the central tendency measures of these projections reported in 1993 and 1994. Note that these projections extend only 12 to 18 months. More importantly, it is unclear how the forecasts submitted by FOMC members incorporate anticipated monetary policy actions. Tinsley and others (1981) refer to the nature of these projections as "economic weather forecasts with provisions for cloudseeding." To the extent that the Fed's policy actions effect economic outcomes over this time horizon, the distinction between Committee members' expectations and objectives are somewhat unclear in these projections.

The notion of price stability as the ultimate goal of monetary policy and the recognition of the importance of long-term planning horizons have led some to advocate the introduction of some form of explicit long-range price level or inflation target to the monetary policy process.[10] Recent policy reforms in New Zealand, Canada and Great Britain have moved in this direction, with apparent success to date. Advocates of such a policy for the United States emphasize the importance of credibility in monetary policy; that is, individuals and businesses are more likely to have faith in the Fed's ability to maintain price stability when there is a clear commitment to a specific objective.[11]

Indeed, the importance of inflation expectations and the role of Fed credibility in the formation of those expectations are issues which have been emphasized in recent statements by Chairman Greenspan: "The effects of policy on the economy critically depend on how market participants react to Federal Reserve actions as well as on expectations of our future actions."[12] As an example of the importance of expectations, Greenspan has suggested that a significant feature of the economy's slow emergence from the 1990-91

[9] Statement before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 19, 1993. *Federal Reserve Bulletin* (April 1993, p. 300).

[10] See, for example, *1994 Annual Report*, Federal Reserve Bank of St. Louis. For an example of a specific operational plan for achieving price stability, see Gavin and Stockman (1992).

[11] See, for example, Angell (1994) and Jordan (1993).

[12] Statement before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 19, 1993. *Federal Reserve Bulletin* (April 1993, p. 293).

Table 2

Monetary Aggregate Objectives

	Ranges (percentage growth rates)			
Date of Meeting	Target Period	M2	M3	Debt
Feb. 2-3, 1993	1992:Q4 – 1993:Q4	2 to 6	½ to 4½	4½ to 8½
July 6-7, 1993	1992:Q4 – 1993:Q4	1 to 5	0 to 4	4 to 8
	1993:Q4 – 1994:Q4	1 to 5	0 to 4	4 to 8
Feb. 22, 1994	1993:Q4 – 1994:Q4	1 to 5	0 to 4	4 to 8
July 20, 1994	1993:Q4 – 1994:Q4	1 to 5	0 to 4	4 to 8
	1994:Q4 – 1995:Q4	1 to 5	0 to 4	3 to 7

recession was a need to restructure balance sheets, which in turn was partly attributable to inflation expectations: "...households and businesses apparently were skeptical that inflation would continue to decline and...may even have expected it to rebound. As a consequence, many may have shaped their investment decisions importantly based on expectations of inflation-induced appreciation of asset prices rather than on more fundamental economic considerations."[13]

The idea that monetary policy should be charged with a single specific objective of price stability is not new. In 1989, Representative Steven Neal, D.-North Carolina, introduced legislation which would have mandated such a framework. At the time, the Neal proposal was met by favorable reactions from Chairman Greenspan and other FOMC members. More recently, Senator Connie Mack, R.-Florida, has indicated his intention to introduce legislation in 1995 for the purpose of modifying the Humphrey-Hawkins framework to eliminate references to employment and interest rate objectives, and to direct the Federal Reserve to limit CPI inflation to less than 2 percent per year. Chairman Greenspan has responded that he favors such legislation in principle, but has demurred on the issue of a numerical objective: "I have always argued that it would be useful for us...to be required to focus crucially, if not solely, on domestic price inflation...[but] I would be more inclined to go to a more general type of requirement for the central bank...."[14]

The issue of whether to charge the Federal Reserve with a specific long-run price stability mandate is likely to remain as one of the crucial issues in monetary policy in 1995 and beyond.

INTERMEDIATE TARGETS: THE DE-EMPHASIS OF M2

Perhaps the most fundamental modification to the intermediate targeting strategy witnessed over the past two years has been the continuing de-emphasis of the monetary targets as operational objectives. This is not to say that the aggregates are now disregarded altogether as indicators of policy, but rather that the prominence they once held in discussions of policy has diminished significantly.

Table 2 reports the ranges specified by the FOMC for money and credit growth in 1993 and 1994, and Figure 2 displays actual measures of the monetary aggregates relative to these target ranges. Despite the lessened emphasis on attaining monetary aggregate targets as a policy objective (discussed further below), the aggregates finished both years within the specified growth ranges.[15]

There is good reason to consider measures of the money stock as important indicators of the thrust of monetary policy. Both theoretically and empirically, the growth rate of money and the rate of inflation are known to be closely related—at least over long periods. This relationship can be clearly observed in comparisons of inflation rates and money growth rates across countries, and consideration of trends within a single country over extended periods of time.[16] Over shorter time horizons, however, the relationship is much less apparent. This is at least partly attributable to the fact that measured monetary aggregates are, at best, an approximation of economists' conceptual notion of "money." From month to month or quarter to quarter, substitution among various assets often makes the growth rates of the aggregates difficult to interpret. Moreover, the rapid pace of financial innovation in recent years has changed the nature of the aggregates, further complicating their interpretation.

The FOMC began to consider monetary aggregates as operational objectives of policy explicitly in its directives in 1970.[17] The status of the aggregates took on more prominence over the years, and their role as intermediate

[13] Statement before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 19, 1993. *Federal Reserve Bulletin* (April 1993, p. 293).

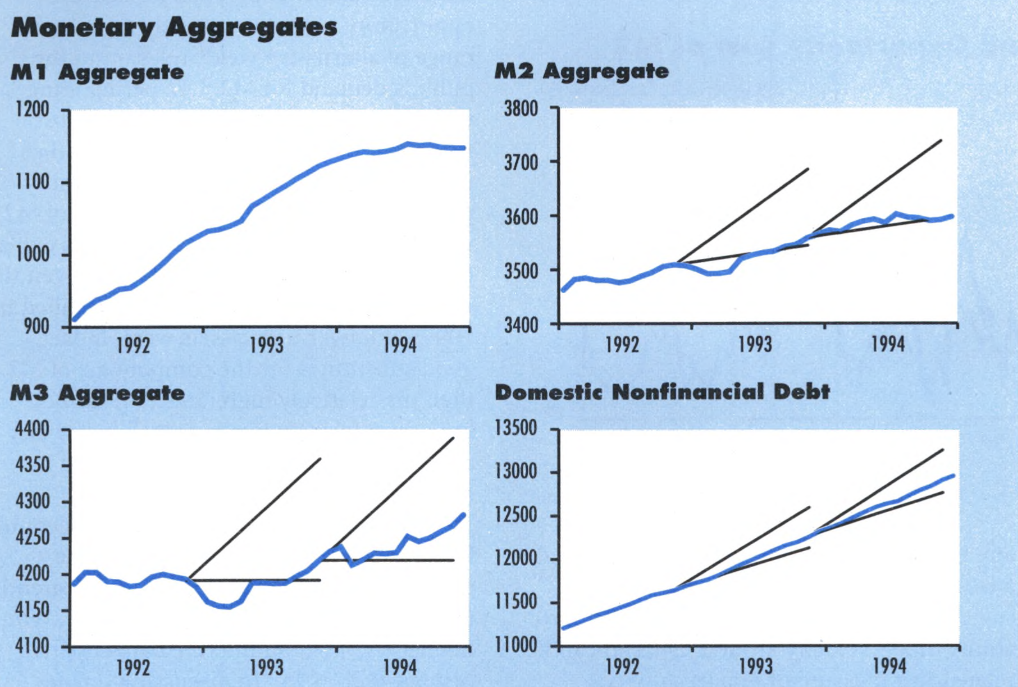
[14] Statement before the Joint Economic Committee, U.S. House of Representatives (December 7, 1994).

[15] During the first half of 1993, both M2 and M3 were running below the growth ranges originally specified by the Committee in February 1993. Reflecting uncertainty regarding the factors distorting the aggregates' growth rates, the ranges were lowered in July of 1993 (see Table 2).

[16] See Poole (1994).

[17] Maisel (1973) provides an insider's view of this period of monetary policymaking.

Figure 2



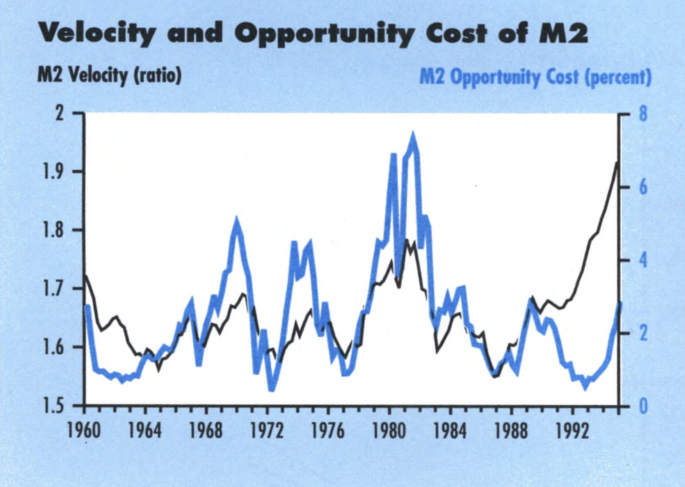
targets was written into the congressional mandates beginning with House Concurrent Resolution 133 in 1975 and later in the 1978 Humphrey-Hawkins legislation. The use of monetary aggregates as intermediate targets in the United States reached a high point during the period from October 1979 until the autumn of 1982, when the FOMC placed greater emphasis on monetary growth in an effort to establish a credible policy of halting and reversing the rising trend of inflation. While both M1 and M2 were cited as operational objectives, primary attention at the time was focused on the narrow aggregate M1. By the mid-1980s, however, the relationship of M1 to overall economic activity had apparently changed so much that it seemed less desirable as an intermediate target. In fact, reference to M1 was removed from the FOMC's policy directives starting with the October 1982 meeting, and the Committee stopped reporting annual growth objectives for M1 in 1987.[18]

The issue of which monetary aggregate is appropriate for guiding policy has a long and controversial history in discussions of monetary policy. Some economists, emphasizing the transactions role of money, have typically favored narrower measures such as M1. Others, who stress the additional role of money as a store of value, suggest that broader aggregates like M2 are more appropriate as indicators of available purchasing power. While such theoretical considerations are certainly considered by policymakers, the FOMC's choice of intermediate target has typically appeared to be guided more by observations on the consistency and stability of relationships between the aggregates and economic activity.

In the absence of reliable information from M1 after the mid-1980s, the broader aggregate M2 naturally took on greater prominence. In the early 1990s, however, the relationship between M2 and overall economic activity also began to show signs of deterioration. One way of summarizing this relationship is to consider the *velocity* of M2—the ratio of the total dollar value of GDP to M2. Figure 3 illustrates the historical behavior of M2 velocity. Until recently, this measure has shown little tendency to display

[18] A discussion of the problems encountered with M1 is beyond the scope of this article. Some of these issues are explored in Stone and Thornton (1987).

Figure 3



any trend rate of growth, fluctuating around a constant value of approximately 1.65.

As shown in Figure 3, much of the variability of M2 velocity around its trend can be related to a measure of opportunity cost. The opportunity cost measure illustrated in Figure 3 is defined as the difference between the interest rate on three-month Treasury bills (considered to be an alternative to holding M2 assets) and a weighted average of the rates of return on assets included in M2. When the opportunity cost of holding M2 is high (that is, when the return on M2-type assets is relatively low), the growth rate of M2 tends to be lower than it otherwise would be as people take advantage of other, higher-yielding alternatives. Hence, the velocity of M2 tends to rise above its trend.

It is clear from Figure 3 that this relationship has recently departed from its typical historical pattern. While the measured opportunity cost of holding M2 has been quite low during the early 1990s, M2 growth has been uncharacteristically slow so that velocity has risen far above its average level.

As the breakdown of this relationship became apparent in the early 1990s, Federal Reserve officials searched for explanations. In a staff study presented to the FOMC at the meeting of November 17, 1992, Feinman and Porter (1992) suggested one possible explanation which seemed to account for some of the anomalous behavior of M2 velocity: They pointed out that the use of the three-month T-bill yield to measure opportunity cost may not fully capture the range of alternative yields relevant to the public's demand for M2.[19] Experimenting with a broader range of opportunity cost measures, Feinman and Porter found that using loan rates and longer-term Treasury yields helped to explain the behavior of M2 velocity in the 1980s and 1990s. This explanation seemed particularly relevant given the steepness of the yield curve that prevailed in 1992: If longer-term assets were, in fact, good substitutes for the components of M2, then the relatively high rates of return on long-term instruments may well have been attracting funds out of M2, depressing its growth rate.

Although this insight helped to account for unusually slow M2 growth to some extent, its explanatory power was apparently insufficient to sustain FOMC members' confidence in M2 as an intermediate target beyond mid-1993. In discussing the de-emphasis of M2 at the Humphrey-Hawkins hearings in July 1993, Chairman Greenspan described how quickly this confidence had evaporated: "The evidence as of, say, the end of last year, would suggest that it was probably correct to assume that M2 was becoming increasingly faulty. Six months later, it's becoming extraordinarily persuasive."[20]

As further observations became available, the yield curve explanation became even more untenable as a significant explanation for the rapid growth of M2 velocity. In particular, the sharp flattening of the yield curve in 1994 appeared to be associated with little if any slowdown in velocity growth.

Although the slow growth of M2 in recent years is not fully explicable, at least two additional transitory special factors have contributed to the weakness. First, the large decline in interest rates during 1991 and 1992 stimulated extensive refinancing of long-term debt, particularly mortgages. In the refinancing process, mortgage servicers tended to hold funds in highly liquid deposits prior to transferring the balances to investors holding the underlying mortgage-backed securities. The large volume of funds moving through liquid deposit accounts

[19] The FOMC's discussion of the Feinman and Porter study was reported by the *American Banker* (see Cummins, 1992).

[20] Statement before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate (July 22, 1993, p. 34).

associated with this activity had the effect of boosting the measured growth rate of the monetary aggregates. As this refinancing activity declined in 1994, the associated run-off of liquid funds tended to dampen monetary growth rates.[21] This factor is clearly temporary in nature, and it is likely that inter-aggregate flows associated with refinancing activity had subsided by mid-1994.

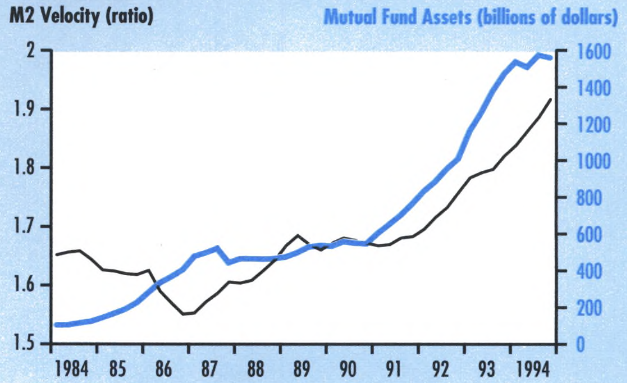
A second possible factor contributing to uncharacteristically slow M2 growth is the recent surge in popularity of bond and equity mutual funds. Figure 4 illustrates net assets of these instruments over the past several years. A significant portion of these funds appeared to be flowing from time deposits and money market mutual funds, which are both included in M2. Figure 4 illustrates the correspondence between the recent period of sharply rising M2 velocity and the period of dramatic mutual fund growth. To the extent that portfolio shifts from M2 assets into mutual funds has accounted for the anomalous behavior of M2 growth, an aggregate that includes mutual funds along with M2 assets (called M2 Plus) could potentially perform better than the conventional M2 definition. Researchers at the Board of Governors investigated this possibility, and the matter came up for discussion at the FOMC meeting of July 6-7, 1993. This research suggested that although the velocity of M2 Plus was somewhat less anomalous than that of M2, the inclusion of mutual funds did not fully eliminate the recent velocity puzzle.[22] Accordingly, the minutes of the FOMC report that "after examining the properties of this measure and reviewing its past behavior in relation to key indicators of economic performance, the members concluded that it would not enhance the formulation or implementation of monetary policy, at least at this point."[23]

Subsequent experience appeared to have borne out the Committee's assessment. As illustrated in Figure 4, flows into mutual funds have slowed dramatically during 1994 as interest rates have risen. M2 growth, however, has remained uncharacteristically slow, with its velocity reaching record highs toward the end of the year.

In recognition of these unusual factors

Figure 4

M2 Velocity and Net Assets of Bond and Equity Mutual Funds



affecting the growth rate of the monetary aggregates, the FOMC lowered its growth objectives for M2 and M3 at its July, 1993 meeting (see Table 2). In his subsequent report to Congress, Chairman Greenspan indicated that the Committee had also decided to de-emphasize its consideration of M2 as a policy target: "At least for the time being, M2 has been downgraded as a reliable indicator of financial conditions in the economy, and no single variable has yet been identified to take its place."[24]

The lack of any particular measure to fill the role previously played by monetary aggregates has fundamentally altered the ostensible control strategy of the intermediate targeting approach, with members of the Committee left to rely on "ongoing assessments of the totality of incoming information and appraisals of the probable outcomes and risks associated with alternative policies."[25] More importantly, the ability of policymakers to communicate long-term policy intentions is greatly diminished by the absence of meaningful monetary targets. Although monetary targets have never been the sole guide for FOMC policy decisions, they did provide a useful framework for assessing short-run policy adjustments in a context of longer-run objectives. In the absence of intermediate targets, public attention has become more focused on short-term adjustment in the federal funds rate and discount rate.

[21] See Anderson (1993).

[22] See Collins and Edwards (1994) and Orphanides, Reid and Small (1994).

[23] Minutes of the Federal Open Market Committee Meeting of July 6-7, 1993. *Federal Reserve Bulletin* (October 1993, pp. 944-5).

[24] Statement before the Subcommittee on Economic Growth and Credit Formation of the Committee on Banking, Finance and Urban Affairs, U.S. House of Representatives, July 20, 1993. *Federal Reserve Bulletin* (September 1993, p. 852).

[25] Statement by Alan Greenspan, Chairman, Federal Reserve Board, before the Subcommittee on Economic Growth and Credit Formation of the Committee on Banking, Finance and Urban Affairs, U.S. House of Representatives, February 22, 1994. *Federal Reserve Bulletin* (April 1994, p. 304).

Table 3

FOMC Directives and Measures of Monetary Policy Stance

Meeting	Directive for Reserve Pressure	Intermeeting Stance Toward: Lesser Restraint	Intermeeting Stance Toward: Greater Restraint	Result from Change in Reserve Pressure...: Date of Change	Result from Change in Reserve Pressure...: Funds rate "target"*	Result from Change in Reserve Pressure...: Discount rate
1993						
Feb. 2-3	maintain	would	would	N/A	3.00	3.00
Mar. 23	maintain	would	would	N/A	3.00	3.00
May 18	maintain	might	would	N/A	3.00	3.00
Jul. 6-7	maintain	might	would	N/A	3.00	3.00
Aug. 17	maintain	might	might	N/A	3.00	3.00
Sep. 21	maintain	might	might	N/A	3.00	3.00
Nov. 16	maintain	might	might	N/A	3.00	3.00
Dec. 21	maintain	might	might	N/A	3.00	3.00
1994						
Feb. 3-4	increase slightly	might	might	2/4/94	3.25	3.00
Mar. 22	increase slightly	might	might	3/22/94 &	3.50	3.00
				4/18/94	3.75	3.00
May 17	increase somewhat	might	might	5/17/94	4.25	3.50
Jul. 5-6	maintain	might	would	N/A	4.25	3.50
Aug. 16	increase somewhat	would	would	8/16/94	4.75	4.00
Sep. 27	maintain	might	would	N/A	4.75	4.00
Nov. 15	increase significantly	would	would	11/15/94	5.50	4.75
Dec. 20	maintain	might	would	N/A	5.50	4.75

* Federal funds rate expected to be consistent with desired reserve restraint.

INSTRUMENT SETTINGS: IN SEARCH OF NEUTRALITY

Although developments in the evolution of the FOMC's policy framework described above are significant, it is the meeting-to-meeting actions of the Committee and their effect on short-term interest rates which have attracted the attention of the public. From 1989 through 1992, the FOMC endorsed a policy of easing reserve restraint, permitting rapid growth of bank reserves and facilitating 25 distinct declines in short-term interest rates, cumulating in nearly a 7 percentage point drop from previous peaks. During 1993, the Committee called for "maintaining the existing degree of pressure on reserve positions" at each of its meetings, and the federal funds rate remained fairly constant at around 3 percent. In 1994, on the other hand, the Fed announced actions to increase reserve pressure on six separate occasions, with the cumulative effect of these actions reflected in an increase of around 2½ percentage points in the federal funds rate. Table 3 summarizes the actions taken by the FOMC at its meetings over the 1993-94 period. The appendix to this article summarizes the discussions that took place at those meetings.

As is always the case when the FOMC's policy decisions are associated with interest rate increases, the Fed has been criticized in 1994 for hampering the economy by pursuing overly "tight" monetary policy. However, it is not clear that the policy moves taken in 1994 should be considered particularly restrictive. Rather, the stated intentions of the Committee have been to move the stance of policy from one of "accommodation" to "a more neutral posture."

The steady policy pursued in 1993 was recognized by Committee members as being purposefully accommodative. Lacking any

MEMBERS OF THE FOMC IN 1993 AND 1994

At any given time, the Federal Open Market Committee consists of 12 voting members. The Committee includes all seven members of the Board of Governors of the Federal Reserve System, as well as five of the 12 presidents of the regional Federal Reserve banks. Reflecting the importance of the Federal Reserve Bank of New York in policy implementation, the president of that Reserve Bank is always a voting member and is, in fact, elected as Vice Chairman of the Committee (the Chairman of the Board of Governors is elected as Chairman of the FOMC). The remaining four positions rotate among the presidents of the other 11 Federal Reserve banks. Although only a limited number of Federal Reserve Bank presidents are voting members of the Committee, all 12 attend the meetings and participate in the discussions.

In addition to the usual rotation of Federal Reserve Bank presidents as voting members of the Committee, the Committee's composition in 1993 and 1994 changed due to changes in the membership of the Board of Governors and the presidency of the New York Fed. Listed below are the voting members of the FOMC in 1993 and 1994.

1993	1994
Alan Greenspan Chairman, Board of Governors	**Alan Greenspan** Chairman, Board of Governors
E. Gerald Corrigan/William J. McDonough* President, Federal Reserve Bank of New York	**William J. McDonough** President, Federal Reserve Bank of New York
David W. Mullins, Jr. Vice Chairman, Board of Governors	**Alan S. Blinder†** Vice Chairman, Board of Governors
Wayne D. Angell member, Board of Governors	**Janet L. Yellen‡** member, Board of Governors
John P. LaWare member, Board of Governors	**John P. LaWare** member, Board of Governors
Lawrence B. Lindsey member, Board of Governors	**Lawrence B. Lindsey** member, Board of Governors
Susan M. Phillips member, Board of Governors	**Susan M. Phillips** member, Board of Governors
Edward W. Kelley, Jr. member, Board of Governors	**Edward W. Kelley, Jr.** member, Board of Governors
Edward G. Boehne President, Federal Reserve Bank of Philadelphia	**J. Alfred Broaddus, Jr.** President, Federal Reserve Bank of Richmond
Silas Keehn President, Federal Reserve Bank of Chicago	**Robert P. Forrestal** President, Federal Reserve Bank of Atlanta
Robert D. McTeer, Jr. President, Federal Reserve Bank of Dallas	**Jerry L. Jordan** President, Federal Reserve Bank of Cleveland
Gary H. Stern President, Federal Reserve Bank of Minneapolis	**Robert T. Parry** President, Federal Reserve Bank of San Francisco

* The last FOMC meeting attended by Mr. Corrigan was May 18, 1993. Mr. McDonough began his tenure with the FOMC at the meeting of August 17, 1993. At the meeting of July 6-7, 1993, Mr. James H. Oltman, First Vice President of the New York Fed, served as alternate for Mr. Corrigan.

† Mr. Blinder's tenure on the FOMC began with the meeting of July 5-6, 1994.

‡ Ms. Yellen's tenure on the FOMC began with the meeting of August 16, 1994.

clear guidance from the behavior of monetary aggregates, this characterization of policy was based on the observation that short-term interest rates remained extraordinarily low, particularly in relation to the underlying rate of inflation. With short-term interest rates and inflation both holding at about 3 percent, short-term real interest rates (inflation adjusted) were close to zero. The Committee members viewed the maintenance of such low levels of interest rates as being an unwise and unsustainable policy over the long run: "...history strongly suggests that maintenance of real short-term rates at levels prevailing [in 1993] ultimately would have fueled inflationary pressures."[26]

This policy was maintained in an effort to alleviate a number of special factors which appeared to be inhibiting a strengthening of the economic recovery. In his testimony before Congress in February 1993, Greenspan cited a need for balance sheet restructuring by households and firms, difficult adjustments associated with business restructuring, and the contractionary effects of cuts in federal defense spending.

Throughout 1993, the members of the Committee were circumspect regarding the accommodative nature of policy. At both the May and July meetings, the Committee endorsed a policy which—although calling for no immediate change in the stance of policy—specified a bias toward the possibility of increasing the degree of reserve restraint (see the appendix). The Minutes of the July meeting reveal that some members "commented that while the need for any policy adjustment during the period ahead seemed somewhat remote, the next policy move was more likely to be in the direction of some firming than toward easing."[27]

At a hearing before the Joint Economic Committee of Congress in late January 1994, Chairman Greenspan clearly indicated that a move toward greater reserve restraint was not a matter of if, but of when: "At some point, absent an unexpected and prolonged weakening of economic activity, we will need to move [short-term interest rates] to a more neutral stance."[28] At the next meeting of the FOMC, the first step in that direction was taken. Because this move was the first tightening of policy to be undertaken in some time, the Committee agreed to a proposal to have the Chairman announce the move. "The purpose of such an announcement, which would be a departure from past Committee practice, was to avoid any misinterpretation of the Committee's action and its purpose."[29] (See the shaded insert titled "Policy Disclosure.")

As the year progressed, further increases in the degree of reserve pressure were undertaken on five additional occasions, three of which were accompanied by increases in the discount rate (see Table 3 and the appendix). The Committee proceeded with the tightening in this step-by-step manner in recognition of the difficulty of knowing precisely what trading range for the federal funds rate was appropriate: "...it is an open question whether our actions to date have been sufficient to head off inflationary pressures and thus maintain favorable trends in the economy."[30]

At the same time, Committee members expressed a desire to move decisively enough to head off emerging inflationary expectations. In the discussion surrounding the ½ percentage point increase in the fed funds rate and discount rate taken on August 16, members noted that "a more decisive policy move might reduce the need for further tightening later... by helping to curb inflationary expectations more effectively."[31]

In fact, the objective of subduing inflationary expectations was a prominent consideration in the FOMC's policy deliberations in 1993 and 1994. One of the indicators used to discern these expectations is the slope of the yield curve, the steepness of which had been of concern to policymakers for some time. As early as February 1993, Greenspan had pointed out that "The steep slope of the yield curve and the expectations about future interest rates that the slope implies suggest that investors remain quite concerned about the possibility of higher inflation... ."[32]

Although conclusions about inflationary expectations embedded in the yield curve should be interpreted cautiously, the reaction of the term structure of interest rates to the policy moves taken in 1994 provides an interesting perspective on those events. As illustrated in Figure 5, the initial increases in short-term interest rates during 1994 were accompanied by shifts in the entire term

[26] Statement by Alan Greenspan, Chairman, Federal Reserve Board, before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, July 20, 1994. *Federal Reserve Bulletin* (September 1994, pp. 793-4).

[27] Minutes of the Federal Open Market Committee Meeting of July 6-7, 1993. *Federal Reserve Bulletin* (October 1993, p. 946).

[28] Statement before the Joint Economic Committee, United States Congress, January 31, 1994. *Federal Reserve Bulletin* (March 1994, p. 233).

[29] Minutes of the Federal Open Market Committee Meeting of February 3-4, 1994. *Federal Reserve Bulletin* (May 1994, p. 408).

[30] Statement by Alan Greenspan, Chairman, Federal Reserve Board, before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, July 20, 1994. *Federal Reserve Bulletin* (September 1994, p. 794).

[31] Minutes of the Federal Open Market Committee Meeting of August 16, 1994. *Federal Reserve Bulletin* (November 1994, p. 996).

[32] Statement before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 19, 1993. *Federal Reserve Bulletin* (April 1994, p. 294).

POLICY DISCLOSURE[1]

Another issue with which the Committee grappled throughout 1993 and 1994 was the timing of, and extent to which, policy decisions should be announced to the public. Traditionally, the policy decisions of the FOMC have been closely guarded secrets, with minutes of each meeting issued only after the subsequent meeting had concluded (so that the current operational directive was never made public). The purpose of this confidentiality was to avoid the possibility of financial market instability in the wake of policy changes, as well as to give the FOMC more flexibility in the implementation of policy. This practice has always been controversial, and criticism of the Fed's traditional secrecy had recently intensified, particularly among some members of Congress. The FOMC reconsidered the disclosure issue during 1993, and experimented with announced policy changes during 1994.

The issue of public disclosure was discussed at the first FOMC meeting of 1993, as the Committee considered a preliminary report of a subcommittee that had "been established to examine various issues relating to the release of information about Committee meetings and decisions." The members agreed that the public should be fully informed about policy decisions, but expressed concern that "release of information should not be allowed to compromise the overriding objective of making and implementing the best possible decisions."

At the July 6-7, 1993, meeting, the issue arose again in the context of "media reports of the purported results of the May meeting before the Committee had made public any information about that meeting." On that occasion, the members "agreed that particular care needed to be taken for some period before and after each of its meetings" to prevent leaks.

An extended discussion of alternatives for releasing detailed information on the deliberations of the Committee took place at the meeting of November 16, 1993. The Committee agreed to authorize "lightly edited" transcripts of past meetings and to release the transcripts to the public five years after the meetings, "subject to the redaction of especially sensitive materials."

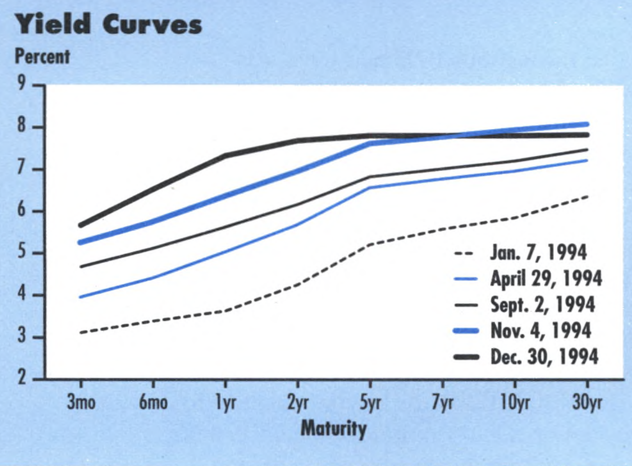
The issue of public announcements took on greater prominence at the first meeting of 1994, when the Committee decided to announce the short-term policy decision promptly after the meeting. The purpose of this announcement was to "avoid any misinterpretation of the Committee's action and its purpose. Because this would be the first tightening policy action...[since early 1989,] it was likely to attract considerable attention." Committee members were careful to point out that they did not consider this announcement to set any precedents for future announcements.

Nevertheless, each of the subsequent changes in policy during 1994 were followed by a brief announcement at the conclusion of the meeting. The announcements were generally brief, but gave qualitative information regarding the nature of the policy decisions, and also gave an indication as to the magnitude of federal funds rate alterations that would be associated with the changes. For instance, a statement following the meeting of August 16, 1994, combined the announcement of a ½ percentage point increase in the discount rate with an announcement that the FOMC had decided that "this increase would be allowed to show through completely into interest rates in reserve markets".

At the meeting of July 5-6, 1994, the Committee addressed the issue of announcing the outcome of a decision to leave policy unchanged. The members agreed to "provide a brief and informal indication that the meeting had ended and that there would be no further announcements." A similar announcement of "no further announcements" was released at the conclusion of the September and December meetings. In early 1995, the Committee endorsed the practice of having the Chairman issue a brief statement describing policy actions after each meeting as a regular practice.

[1] All quotes in this shaded insert are taken from various issues of the *Federal Reserve Bulletin*.

Figure 5



structure. By April 29, after the first three ¾ point increases in the federal funds rate, the three-month and 30-year yields had risen by roughly equivalent magnitudes. Yields on intermediate-term maturities had risen by somewhat greater amounts, suggesting that investors expected that further increases in short-term rates were likely in the near future. By early November, the yield curve had shifted further, but with the spread between long-term and short-term yields narrowing: From the beginning of the year, three-month yields had risen by more than 2 percentage points, while the yields on 30-year bonds had risen about 1¾ percentage points. The response of the term structure to the 75 basis point increase in the federal funds rate on November 15 is even more striking. Longer maturity yields actually *declined* following that change, and continued to trend downward until the end of the year. This unusual pattern of rate movements—and the flattening of the yield curve that they represent—suggest that by the end of 1994, inflationary expectations were responding favorably to the cumulative impact of the FOMC's policy moves.

CHARACTERIZING POLICY CHANGES: A SEA CHANGE OR MERELY A COURSE CORRECTION?

As described in the previous section, the FOMC acted to "increase the degree of pressure on reserve positions" on six separate occasions in 1994, after leaving policy unchanged over the course of 1993. The most readily observable response to these developments has been the rise in short-term interest rates. It is often asserted that the Fed is responsible for pushing short-term interest rates higher, and that both the intent and the effect of these rate increases is to slow economic growth. On the other hand, interest rates reflect the balance of supply and demand in credit markets. Hence, when economic activity is accelerating and credit demands rising, market forces should be expected to push interest rates higher and the Fed's actions in the market for bank reserves could be interpreted as allowing those market forces to work. For economists evaluating the impact of the FOMC's policy decisions, the distinction between these two perspectives is of great importance. Is the Fed actively attempting to manipulate the course of the economy, or merely adjusting the settings of its policy instruments to meet evolving economic conditions?

One can take several approaches to addressing this question, none of which is entirely satisfactory. Perhaps the simplest approach is to examine the behavior of the raw data summarizing FOMC policy actions—the instruments or proximate targets of policy. Figure 6 illustrates the recent behavior of the federal funds rate, the most widely monitored measure of the stance of monetary policy. After declining from 1989 through 1992, the funds rate remained fairly stable at around 3 percent during 1993 and then gradually rose to 5.5 percent during 1994. It is the increase in this key short-term rate which most observers point to as a measure of the deliberate tightening of monetary policy in 1994.

However, a perusal of the behavior of longer-term interest rates illustrated in Figure 7 shows that many interest rates began to rise *before* the FOMC's first policy adjustment in February 1994. Long-term interest rates reached their lows during September and October of 1993, and rose through most of 1994. Figure 8 suggests a reason for the upward pressure on rates: Demand for credit, represented by the volume of commercial bank loans, picked up dramatically during the latter part of 1993. Taking these developments into consideration, the FOMC's policy approach in 1994 might be more accurately described as one of not preventing a natural increase in interest rates, rather than one of deliberately pushing rates higher.

Another raw measure of the thrust of monetary policy is the growth rate of nonborrowed reserves. Although the FOMC itself does not presently define its policies in terms of reserve growth, the supply of nonborrowed reserves is directly affected by the Fed's open market operations. Changes in the demand for reserves largely reflects fluctuations of the checkable deposits component of M1. As illustrated in Figure 9, a reserve-based view suggests that policy in 1993 was not as static as suggested by the stability of the fed funds rate. Rather, to maintain a stable funds rate, reserve growth was allowed to fluctuate rather widely throughout the year. Figure 9 also shows that by recent historical standards, the average growth rate of reserves in 1993 was quite rapid. Reserve growth dropped off sharply during 1994, turning negative in the latter part of the year.

Economists who take a narrow-money approach view the rapid growth in nonborrowed reserves, the monetary base and M1 in 1993 as suggesting that policy was not neutral. Such a view is based on the notion that rapid growth in money will, with a lag, cause rapid growth in aggregate demand. According to this view, policy might be characterized as being highly expansionary in 1992 and 1993, with an abrupt reversal in 1994. Such stop-and-go policy, illustrated in Figure 9 by wide fluctuations in the growth of nonborrowed reserves, is thought by some to exacerbate the business cycle.

Given these somewhat disparate indications from the proximate targets of monetary policy and the ambiguity of distinguishing between deliberate changes in the stance of policy from endogenous responses to broader economic developments, economists have sought to develop more specific methods of identifying major Federal Reserve policy shifts and distinguishing them from minor policy adjustments. One approach, pioneered by Friedman and Schwartz (1963) and recently extended by Romer and Romer (1989), is the "narrative approach." This approach seeks to identify discrete shifts in policy by examining qualitative measures of policy: for instance, the statements issued by the FOMC and its members. Romer and Romer developed criteria for distinguishing turning points in policy, which identify a policy "shock" as a situation "in which the Federal Reserve attempted to exert a contractionary influence on the economy in order to reduce inflation."[33] These events can be thought of as deliberate changes in the overall thrust of policy.

Although many observers might characterize the FOMC's policy decisions in 1994 as constituting such a policy shock, it is hard to justify this conclusion using the Romer and Romer criteria. In particular, the Romers exclude from their classification episodes in which the FOMC acted to prevent the emer-

Figure 6

Federal Funds Rate and Discount Rate

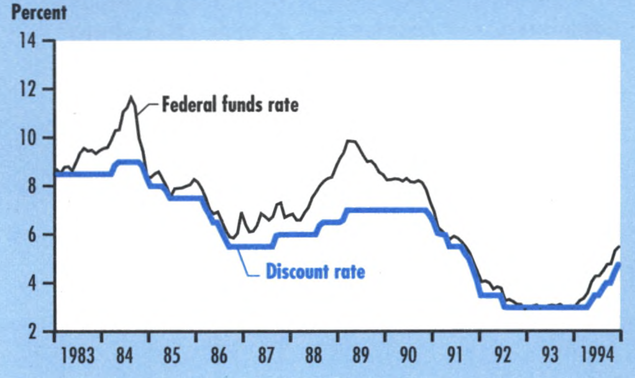
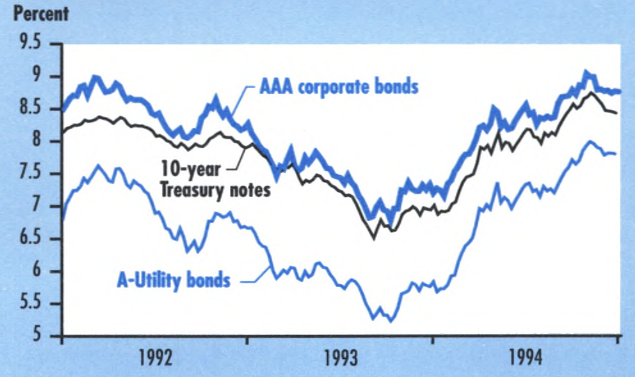


Figure 7

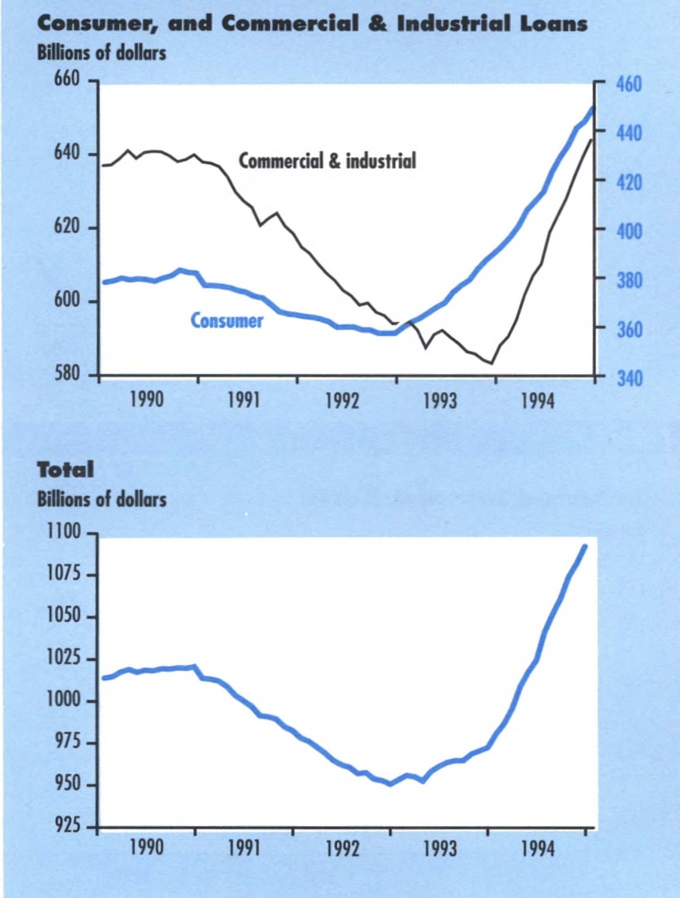
Selected Interest Rates



[33] Romer and Romer (1989, p. 134).

Figure 8

Commercial Bank Loans



gence of inflationary pressures (as opposed to responding to current inflation). For example, they specifically exclude an episode in 1966, in which "the Federal Reserve's stated intent was clearly not to reduce aggregate demand, but rather to prevent outward shifts in aggregate demand that it believed would otherwise have occurred."[34] The similarity to recent events is evidenced by the widespread interpretation of the Fed's 1994 policy actions as being preemptive in nature. Just as the Romers describe for 1966, "the perception of the economy's strength was based not just on current data but also on projections... ."[35] Ex post, analysts who follow a narrative approach to characterizing Fed policy might consider 1994 to constitute a policy shock, but it is not apparent that it is when one applies the ex ante criteria of the Romers.

Another approach to characterizing policy follows a statistical methodology to isolate what is known as a Federal Reserve reaction function. By examining historical data, this approach attempts to identify components of FOMC policies which are predicable reactions to emerging economic data. After controlling for these factors, the movements in the Fed's instruments which remain unexplained are interpreted as constituting policy innovations or shocks.

Figure 10 illustrates the identification of innovations using a model suggested by Bernanke and Blinder (1992). In the model used to generate the shocks illustrated in Figure 10, the federal funds rate is used as the measure of policy, and the Fed's reaction function is assumed to depend on a measure of inflation (as measured by the CPI) and a measure of real economic activity (the unemployment rate for males ages 25-54). The FOMC's reaction function is estimated to depend on inflation and unemployment over the prior six months, with the remaining movements of the fed funds rate taken to be exogenous policy innovations (that is, deliberate acts by the FOMC, rather than standard responses to emerging economic developments).[36]

The series of innovations illustrated in Figure 10 is much more variable than one might ordinarily associate with deliberate FOMC policy changes.[37] The innovations appear more to reflect random variability in the series than deliberate, discrete policy changes. It could be argued, however, that it is the *cumulative* effect of small innovations to the funds rate which are important in evaluating the overall thrust of monetary policy.

Figure 11 shows the cumulative impact of the innovations identified in Figure 10. When the shocks are added up over time, they provide a more readily interpretable account of the thrust of monetary policy, with easily identifiable turning points. For example, this cumulative measure suggests that policy was roughly constant from 1985 through 1987 (a period when the fed funds rate itself was generally falling), then tightened rather dramatically during 1988. The period from 1989 through 1992 is characterized by a gradual easing of policy. Note, however, that the stability of the fed funds rate during 1993

[34] Romer and Romer (1989, p. 138).

[35] Romer and Romer (1989, p. 138).

[36] Technically, the shocks in Figure 10 are the innovations to the funds rate equation in a three-variable, unrestricted vector autoregression (VAR), estimated using six lags of monthly data.

[37] This criticism of the VAR approach to estimating policy functions has been made before; see, for example, Cecchetti (1994).

is *not* associated with an unchanging policy thrust using this measure. Rather, the relatively low level of the funds rate in 1993 is associated with a series of negative shocks which, when cumulated, suggest that the policy was increasingly stimulative throughout the year.

In 1994, innovations to the funds rate were generally positive. Note, however, that the cumulative impact of innovations in 1994 did not nearly approach the level of restraint implied by this measure of policy for 1987, when the federal funds rate itself rose by far less than it did last year. It also should be noted that Figure 11 provides little information on which to judge the absolute position of a neutral policy stance. Although the cumulative position of the shocks end near zero, this level should be interpreted as representative of the average degree of reserve restraint over the estimation period, 1959-94. (In fact, that the cumulated residuals end the period at zero is true by construction.) This period was characterized by an average inflation rate of 4.75 percent and an unemployment rate of more than 6 percent. Hence, this level of cumulative adjustment in the funds rate is neutral only if these outcomes are deemed desirable (and if the estimated equations are, in fact, stable over time).

CONCLUSION

In spite of the marked contrast between the character of policy actions of the FOMC in 1993 versus 1994, in a broader context the actions of the Committee can be interpreted as part of a continuing process of evolution in the strategy and tactics of the conduct of monetary policy. The two-year period was characterized by a continuing rhetoric supporting the pursuit of long-term price stability, with policy actions taken in the context of this objective.

The changing nature of the U.S. financial structure and the general economic environment, however, have made the rigorous pursuit of monetary aggregate objectives more difficult to justify, and the past two years have witnessed the Committee grappling with issues regarding the appropriate conduct of policy in the absence of reliable signals from various money stock measures.

Figure 9

Nonborrowed Reserves Growth

Percent Change Over Previous 12 months

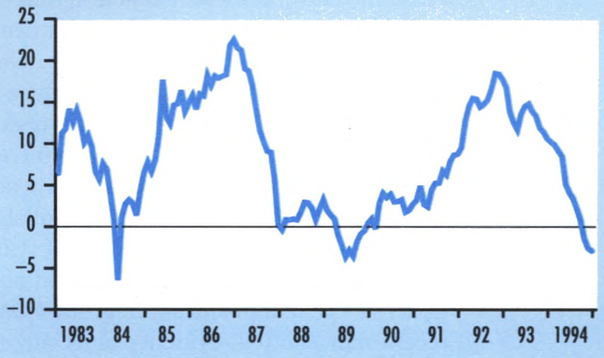


Figure 10

Federal Funds Rate Innovations

Percent

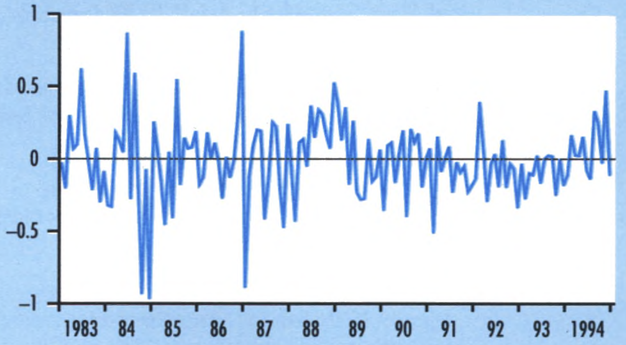
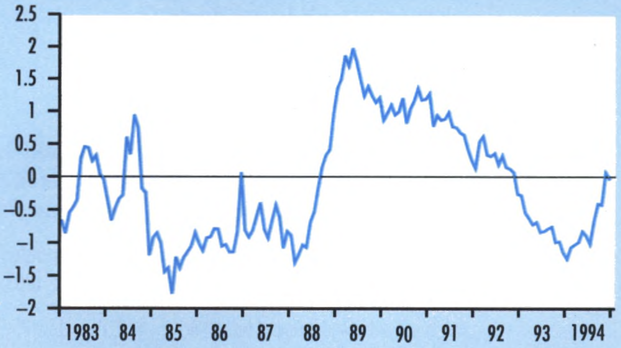


Figure 11

Cumulative Funds Rate Innovations

Percent



In the process of making tactical decisions, the members of the Committee reached a consensus early in 1994 that the existing policy stance was one which had remained overly accommodative, and policy actions during 1994 have been made in the context of adjusting policy to a less-accommodative posture. Unlike many other periods when the Committee reacted in response to emerging price pressures, the policy adjustments in 1994 were intended to be preemptive moves, designed to head off what the members viewed as a substantial risk of rising inflation. Hence, the lack of visible signs of an increase in inflation should not be taken as a lack of justification for the FOMC's recent stance, but as evidence of its success.

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Appendix

SUMMARY OF FOMC MEETINGS IN 1993 AND 1994[1]

February 2-3, 1993

At the outset of 1993, the information available to the FOMC suggested that economic activity had picked up sharply toward the end of the previous year. Committee members cited numerous conditions that led them to believe that the expansion would continue throughout 1993: "Structural impediments to the expansion seemed to be diminishing as the financial condition of households, business firms, and financial institutions continued to improve." Deficit reduction programs, expected to be announced by President Clinton, were additional signs that interest rates could fall.

Nevertheless, it was noted that "the outlook remained subject to a good deal of uncertainty." The Committee agreed, unanimously, that immediate policy should be "to maintain the existing degree of pressure on reserve positions." The directive left open the possibility of accepting either greater or lesser reserve restraint, should conditions during the intermeeting period warrant.

March 23, 1993

A review of recent economic activity at the March meeting found the expansion continuing at a moderate pace in the first few months of 1993, after strong gains during the latter part of 1992. Short-term market interest rates remained relatively unchanged though long-term rates fell substantially. It was noted that in early March, "Treasury bonds and conventional fixed-rate mortgages reached their lowest levels since 1973."

The policy directive adopted by the Committee called for "maintaining the existing degree of pressure on reserve positions." Again, the Committee decided upon a symmetric directive for guiding policy during the intermeeting period.[2]

Governors Angell and Lindsey dissented from the Committee's decisions because they were concerned about the inflation outlook. They favored "an immediate move to tighten reserve conditions...Such an action was desirable not only to arrest the possible emergence of greater inflation but especially to promote further disinflation."

May 18, 1993

At the May 18 meeting, the FOMC was presented with staff projections which suggested that "economic activity would grow at a moderate pace and that such growth would foster a gradual reduction in margins of unemployed labor and capital." This analysis included portions of the Clinton Administration's fiscal package pertaining to the long run. The Committee also saw "evidence of a slower economic expansion and a higher rate of inflation since late 1992... ."

"In the view of a majority of the members, wage and price developments over recent months were sufficiently worrisome to warrant positioning policy for a move toward restraint should signs of intensifying inflation continue to multiply." Nevertheless, "some members preferred to retain a directive that did not incorporate a presumption about the likely direction of a change in policy...during the intermeeting period. They were concerned that adopting a biased directive might prove to be an overreaction to temporary factors and to a short-lived upturn in inflationary sentiment that was not warranted by underlying economic conditions." In the end, the Committee adopted an asymmetric directive which suggested an inclination toward greater reserve restraint rather than lesser.

There were two dissents from this decision, which reflected widely divergent perspectives. Mr. Boehne saw the adoption of a biased directive as being unwarranted, since "underlying economic conditions did not point toward an extended period of higher inflation." In contrast, Mr. Angell dissented "because he believed that the persisting indications of rising inflation...called for a prompt move to tighten monetary policy."

July 6-7, 1993

In the discussion of short-term policy at the July meeting, mixed signals on the

[1] All direct quotations cited in this appendix are drawn from the "Minutes of the Federal Open Market Committee," as reported in various issues of the *Federal Reserve Bulletin*.

[2] A "symmetric" directive is worded even-handedly with respect to possible modifications to policy during the intermeeting period. A so-called "asymmetric" directive is one which suggests a preferred direction for policy changes, and is indicated by the use of the words "might" and "would," with "would" considered to be the stronger of the two terms. For example, a directive which states "somewhat greater reserve restraint would be acceptable, and somewhat lesser reserve restraint might be acceptable" leans in favor of greater reserve restraint. See Ritter (1993).

performance of the economy and questions about fiscal policy "contributed to considerable uncertainty about the outlook." Some members were concerned, however, that "despite the very sluggish behavior of the broad measures of money thus far this year, monetary policy was relatively expansive as evidenced by a variety of other indicators including the growth in narrow measures of money and reserves and the very low levels of money market interest rates." Several members went on to point out that in the face of worsening inflation expectations, an unchanged policy could be more accommodative than intended.

Most members indicated that there was "little or no reason to change monetary policy in either direction." Consequently, the degree of pressure on reserve positions was left unchanged. The Committee also retained the asymmetric bias towards restraint that was adopted at the previous meeting. Mr. Angell dissented, preferring an immediate tightening of reserve restraint.

August 17, 1993

At the August meeting, the members of the FOMC saw little information in recent developments which would alter the "outlook for moderate and sustained growth in economic activity." Although many members noted that current policy was associated with very low short-term interest rates, there was also "no compelling evidence that current monetary policy was fostering credit flows usually associated with speculative excess or impending increases in price pressures."

With these considerations in mind, Committee members agreed "to the desirability of a steady policy course." Accordingly, the Committee voted to "maintain the existing degree of pressure on reserve positions." The directive gave no indication of a preference for altering this stance in either direction during the intermeeting period.

September 21, 1993

At the September meeting, Committee members noted that general economic activity remained moderate at best, with considerable disparities existing across locales and industries. Deficit-reduction legislation that was passed in July "implied increased fiscal restraint but also appeared to have improved confidence in financial markets."

A number of factors were cited as sources of concern. New taxes associated with the deficit reduction legislation and uncertainties about health care reform were said to have generated "cautious attitudes among business executives." The outlook for net exports was also "cited as a negative factor."

The Committee decided to maintain the short-term policies of the August meeting.

November 16, 1993

Information reviewed at the November meeting continued to suggest the maintenance of a sustained, but moderate expansion. Some evidence of strengthening was cited. The Committee, however, noted that "economic activity clearly remained sluggish or even depressed in some parts of the country and overall business attitudes could still be described as cautious." Fiscal policy developments—in particular, uncertainty regarding health care reform and the ongoing retrenchment of defense spending—continued to be cited as factors which were likely "to inhibit the expansion over the year ahead." In hindsight, this view might be characterized as being overly pessimistic: The fourth quarter of 1993 turned out to be one of the strongest quarters for economic growth in recent memory, with real GDP rising at a rate of 6.3 percent. Data revealing this strength, however, were not generally available until early 1994.

In this context, the members of the Committee unanimously agreed to support a directive which called for "maintaining the existing degree of pressure on reserve positions and that did not include a presumption about the likely direction of any adjustment to policy during the intermeeting period."

December 21, 1993

By December, indicators were beginning to suggest that economic activity had picked up in recent months, with strength observed in consumer spending, durable equipment purchases, construction and industrial production (particularly in the automotive sector). Meanwhile, price indexes "pointed to little change in inflation trends." In their comments about recent developments, Committee members observed that the positive signs "had fostered appreciable improvement in business and consumer sentiment... ." Members also recognized, however, that the strengthening was not geographically uniform and that a number of factors continued to exert constraining influences. Particular concerns cited included "balance-sheet rebuilding, business restructuring and downsizing activities, and the downtrend in defense spending."

In discussing the directive for the upcoming period, most members "indicated that they could support a directive that called for maintaining the existing degree of pressure on reserve positions," with no bias toward adjusting conditions one way or the other during the intermeeting period.

Messrs. Angell and Lindsey both dissented, citing the belief that current policy was overly accommodative, and "needed to be adjusted promptly toward a more neutral stance." Mr. Angell also stressed that the Committee should focus on "forward-looking indicators such as the price of gold and the estimate of the natural rate of interest provided by the yield on five-year Treasury notes. He favored an immediate increase of 50 basis points in the federal funds rate...Mr. Lindsey commented further that a modest policy move now would appropriately signal the Committee's concern about the potential for inflation."

February 3-4, 1994

By the time of the FOMC's first meeting of 1994, incoming economic data revealed that a sharp increase in economic activity had taken place in late 1993 and that the data available for the early weeks of the year "suggested appreciable further gains."

During the Committee's discussion, "members generally expressed concern about a buildup in inflationary pressures...especially if what they currently viewed as a very accommodative monetary policy were maintained." With regard to policy for the upcoming period, members "favored an adjustment toward a less accommodative policy stance, though views differed to some extent with regard to the amount of the adjustment."

After discussing options involving the magnitude of possible policy adjustments, "all the members indicated that they could accept the proposed slight policy adjustment at this point, but many observed that additional firming probably would be desirable later." The directive adopted by the Committee at this time, however, retained an unbiased instruction with regard to possible intermeeting adjustments.

During the subsequent intermeeting period, federal funds traded at a rate of around 3¼ percent—approximately ¼ percent higher than the rate that had prevailed throughout 1993.

March 22, 1994

Information reviewed at the March meeting indicated that the economy "expanded appreciably further in the early months of 1994, despite unusually severe winter weather."

In discussing policy for the upcoming period, "all the members supported a further move toward a less accommodative policy stance." As a conceptual objective, it was agreed that policy should strive toward reaching a "more neutral position." The members generally concluded that "such a policy stance was still some distance away, and the key issue facing the Committee was not whether but by how promptly the necessary adjustment should be completed."

After a discussion of the possible magnitude of policy adjustments for the upcoming period, the Committee decided to duplicate its previous policy move, seeking to increase slightly the existing degree of pressure on reserve positions, with no explicit asymmetry in the intermeeting stance. "Messrs. Broaddus and Jordan dissented because they preferred a stronger move toward a more neutral policy stance." They viewed recent increases in long-term interest rates as indicating rising inflation expectations, and perceived that "the principal policy risk had become one of remaining accommodative for too long a period."

Subsequently, incoming data suggested considerable strength in the economy and "indications that financial markets were less likely to be destabilized by a further policy action." Against this background, on April 18, "the degree of accommodation in reserve pressures was reduced a little further." Each of the policy moves resulted in federal funds rate increases of about ¼ percent.

May 17, 1994

At the meeting of May 17, 1994, the Committee reviewed evidence "of considerable momentum in the economic expansion." Members noted that "the expansion over the first half of the year was likely to be a little stronger than had been expected at the time of the March meeting."

In the context of current policy, Committee members "favored prompt further action to remove much of the remaining accommodation in the stance of monetary policy, at least as measured by real short-term interest rates." Consequently, the Committee adopted a directive which called on the Open Market Desk to "increase somewhat the existing degree of pressure on reserve positions." A symmetric policy toward intermeeting period adjustments was adopted. It was agreed that "the adjustment should fully reflect the ½ percentage point increase in the discount rate that the Board of Governors was expected to approve later in the day."[3]

July 5-6, 1994

Information reviewed at the July meeting indicated that the economy grew substantially in the second quarter, but that expansion was expected to slow somewhat over the balance of the year. Given uncertainty regarding the extent of the economy's slowing and the effects of previous policy moves, most FOMC members considered "that it would be prudent for the Committee to assess further developments before taking any action."

Consequently, the policy directive adopted for the upcoming period called for "maintaining the existing degree of pressure on reserve positions," although it also included a bias toward the possibility of increasing the degree of reserve pressure prior to the next meeting. "Mr. Broaddus dissented because he believed that additional near-term tightening was necessary to contain inflation."

August 16, 1994

Although the pace of the economic expansion remained substantial, information reviewed by the Committee in August suggested some slowing. Staff forecasts suggested "that the economy was operating close to its long-run capacity."

The Committee generally agreed that "a prompt further tightening move was needed to provide greater assurance that inflationary pressures in the economy would remain subdued." Consequently, the FOMC approved a directive which called for "increasing somewhat the degree of pressure on reserve positions." It was agreed that if the Board of Governors approved a ½ percentage point increase in the discount rate (as was expected), that action should be allowed to be reflected fully in reserve market conditions. Given that members generally expected "that a further policy action was not likely to be needed for some time," the directive adopted by the Committee included a symmetric instruction regarding possible intermeeting adjustments.

September 27, 1994

Data reviewed at the September meeting suggested that "the pace of economic expansion remained substantial, though it appeared to have moderated slightly in recent months." Moreover, staff projections "suggested that growth in economic activity would slow appreciably over the next several quarters." Previous policy moves were seen to have "elicited only a mild response thus far in interest-sensitive sectors of the economy," and output growth was "near maximum sustainable levels." It was judged that "the risks of some rise in inflation rates probably had increased."

Nevertheless, most of the Committee members felt "that the recent evidence did not warrant an immediate further tightening," given that there had been an "appreciable tightening of policy approved in August." It was expected that incoming information during the intermeeting period might "provide a firmer basis for judging the course of the economy and the risks of greater inflation." Consequently, the Committee approved a directive that called for "maintaining the existing degree of pressure on reserve positions," but which also included "a shift from the symmetry in the August directive to asymmetry toward restraint."

Mr. Broaddus dissented from this directive, believing "that a prompt move to somewhat greater monetary restraint was needed at this point," given "signs of increasing price pressures and rising inflationary expectations."

[3] Changes in the discount rate are initiated by the individual Federal Reserve banks, but must be approved by the Board of Governors before becoming effective. This division of responsibility underlies the rather odd circumstances surrounding increases in the federal funds rate and discount rates in 1994. In each case, the FOMC endorsed a policy which incorporated expected changes in the discount rate, which had already been proposed by the Federal Reserve banks and which were approved by the Board of Governors as part of the overall policy change.

November 15, 1994

By the November meeting, incoming information suggested that "growth of the economy remained substantial," and "members commented on widespread statistical and anecdotal indications of considerably greater strength in the business expansion than they had anticipated earlier." In this context, members "saw a considerable risk of higher inflation."

In their discussion of near-term policy, "all the members agreed that the current stance of monetary policy presented unacceptable risks of embedding higher inflation in the economy." Although members "acknowledged the difficulty of judging the precise degree of monetary restraint that would be needed to attain the Committee's objectives," most members advocated "an unusually sizable firming of monetary policy." Others were reported to have "preferred a less forceful policy move," taking a more "cautious approach."

Ultimately, all members ended up supporting a directive calling for a "significant increase" in reserve pressure, which was to take account of a 3/4 percentage point increase in the discount rate. Given the relative forcefulness of this move, the Committee adopted a directive that was symmetric with regard to intermeeting adjustments, although it was noted that "a symmetric directive would not prevent an intermeeting adjustment if near-term developments differed substantially from expectations."

December 20, 1994

Information reviewed at the December meeting suggested "a further pickup in economic growth in recent months." The forecast presented by the staff suggested a marked slowing in economic activity over the next few quarters, but this outlook was predicated on the assumption "that monetary policy would not accommodate any continuing tendency for aggregate demand to expand at a pace that could foster sustained higher inflation." In their discussion of economic developments, Committee members "saw scant evidence at this point of any moderation in the growth of overall economic activity."

In their discussion of policy for the intermeeting period ahead, many members anticipated that "the need for further monetary restraint was highly likely." A majority, however, advocated no change in policy, at least through the beginning of 1995, preferring a pause in order "to assess the underlying strength of the economy and the impact of previous monetary restraint." Given the probable need for further tightening at some point, a majority agreed that the directive should express an asymmetry "tilted toward restraint."

Mr. LaWare dissented from this directive, favoring an immediate policy tightening. He cited "high and increasing levels of utilization in labor and capital markets" as indicating a risk of rising inflation, and feared that inaction by the Committee "could heighten inflationary expectations by raising concerns about the System's commitment to the objective of sustainable, noninflationary economic growth."

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Regulation, Market Structure, and the Bank Failures of the Great Depression

David C. Wheelock

The surge of bank failures in the United States during the 1980s focused the attention of policymakers and researchers on the causes of failure, especially on the role of government policy. Deposit insurance had left the banking industry more leveraged than it would otherwise have been, and encouraged individual banks to take greater risks as losses eroded their net worth. In response, regulators imposed risk-adjusted capital requirements and Congress enacted the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA), which mandated risk-based deposit insurance premiums and refined the risk-based capital standards.[1] Similarly, the enactment of The Interstate Banking and Branching Efficiency Act of 1994, which permitted interstate branching, stemmed from the view that branching restrictions hamper geographic diversification and had contributed to the high number of failures in regions suffering economic downturns.

The United States last experienced high numbers of bank failures during the Great Depression, when some 9,000 banks failed. Researchers have blamed various government policies, especially branching restrictions, for contributing to banking instability during the Depression. There has, however, been little empirical study of the effects of banking market structure and regulation on failures during this period, a gap which this article attempts to fill.

Previous studies have taken little notice of the wide interstate variation in the number of failures and failure rates during the Great Depression. This article investigates whether this variation can be explained solely by differences in the extent to which income declined, or whether various state banking policies or differences in market structure contributed to interstate variation in failure rates. It also investigates why banking market structures differed across states. The analysis indicates that, after controlling for the extent to which economic activity declined, the proportion of deposits in failed banks was lower in states where branch banking was more prevalent. In addition, both the bank failure rate and proportion of deposits in failed banks varied inversely with the relative number of federally chartered (national) banks in a state. Finally, the study shows that the state deposit insurance systems of the 1920s had lingering effects on banking market structures even after insurance had ended. Thus, as researchers have found for the 1980s, government policies, such as branching restrictions and deposit insurance, appear to have had measurable impacts on market outcomes and bank failures during the Great Depression.

BANK FAILURES IN THE DEPRESSION: CAUSES AND CONSEQUENCES

From 1929 to 1933, U.S. gross national product declined 29 percent (in constant dollars), the price level fell 25 percent, the unemployment rate reached 25 percent, and some 9,000 banks suspended operations because of financial distress. A bank that suspended operations need not have "failed," in that a receiver need not have been appointed to liquidate the bank. Suspended banks, however, include only those that closed on

[1] FDICIA also limited the discretion of regulators to permit insolvent banks from continuing to operate. Some researchers argue that the closure policy known as "too-big-to-fail" had encouraged excessive risk-taking because it had the effect of expanding deposit insurance coverage beyond $100,000 per account at banks that regulators deemed too large to close. See Keeley (1990) for further analysis of the role of deposit insurance during the 1980s.

account of financial difficulty. Following much of the literature, I use the terms "suspension" and "failure" interchangeably.

Economists have debated the causes of the Depression since the 1930s. In the past 30 years, this debate has focused on the role of bank failures. In *Monetary History of the United States,* Friedman and Schwartz (1963) argue that banking panics in the autumn of 1930, and the spring and autumn of 1931 sharply reduced the supply of money, which, in turn, caused economic activity to decline. Other researchers, however, such as Temin (1976), contend that bank failures occurred largely as a result of falling national income. In Temin's view, the economic downturn reduced the demand for money, and bank failures were the means by which the money supply fell to accommodate that decline.

The debate over the role of bank failures and monetary forces in causing the Great Depression continues to simmer, and is reviewed by Wheelock (1992b). A recent view, originating with Bernanke (1983), proposes a non-monetary explanation of how bank failures contributed to the Depression. Bernanke argues that apart from their impact on the money supply, bank failures depressed output by raising the cost of credit intermediation.

Much of the research on the causes and consequences of bank failures during the Depression has had a macroeconomic orientation, with little emphasis on the role of regulation or market structure. Some researchers, however, have argued that the prevalence of unit banking left the U.S. banking system especially vulnerable to failures during the Depression, and that nationwide branching helped limit failures and banking panics in other countries. For example, the conventional view is that nationwide branching protected the Canadian banking system during the Depression (for example, see White, 1984; or Grossman, 1994), though Kryznowski and Roberts (1993) estimate that on a market value basis, all Canadian banks were insolvent at some point during the Depression. This focus on branching vs. unit banking has been national, with little consideration of whether differences in state branching laws, other banking regulations or market structure contributed to interstate differences in bank failure rates. Regional variation in failures has largely been ignored or simply attributed to differences in the extent to which income declined.

Several studies have attempted to determine whether the causes of bank failures during the Depression were like those of failures during the 1920s. For example, Temin (1976) finds that, like the 1920s, declining agricultural income explains many of the failures of 1930 and 1931. White (1984) shows that the characteristics of banks that failed in 1930 were like those of previous failures. Calomiris and Mason (1994) present similar findings for failures during the Chicago banking panic of June 1932. On the other hand, Wicker (1980) shows that many failures in 1930 stemmed from the collapse of one Southern financial institution, Caldwell and Company, which he concludes was largely independent of the decline in economic activity. Stauffer (1981) offers further evidence that bank failures were independent of the decline in activity by showing that in the 11 cotton-producing states with significant declines in output, bank failures were more closely related to banking market structure than to changes in local income. Whether this was also true of other states, however, is unclear.

INTERSTATE VARIATION IN BANK FAILURES AND FAILURE RATES

This article investigates the interstate variation in bank failures during 1929-32. The failures of 1933 are not studied here because the bank holiday in March 1933, and subsequent institutional changes, substantially altered the timing and likely causes of failures. All banks were shut during the bank holiday, and only those licensed by regulators were permitted to reopen. Not all banks that would reopen had done so by the end of 1933, and some that did were later found to be insolvent. This suggests that the determinants of bank failures in 1933 should be studied apart from those of other Depression years. Similarly, I leave for future research the causes of failures during the remainder of the 1930s.

Figure 1 shows the distribution of bank failures across the United States during 1929-32 (see the appendix for data sources). Rhode Island escaped the period without any bank failures. No other state had fewer than two failures. Other states with fewer than 10 bank failures include Vermont, Maine, New Hampshire, Delaware, New Mexico and Wyoming. Generally, Midwestern states suffered the highest numbers of bank failures. Illinois had 602 failures, the most of any state. Only three other states had more than 300 failures: Iowa with 476, Nebraska with 358 and Missouri with 328. The mean number of failures across all states was 120, and the median was 91 failures. For comparison, from 1980 to 1989, the two states with the most bank failures were Texas with 350 and Oklahoma with 105.

The number of failures can, of course, be a misleading statistic because the number of banks varies widely across states. Figure 2 maps the distribution of bank failure rates during 1929-32, in which the annual failure rate is defined as the total number of suspensions during a year divided by the number of banks operating at mid-year. Even though Illinois had the most failures, it did not have the highest failure rate. That dubious distinction went to Nevada, which had a yearly average failure rate of more than 16 percent, despite having just 19 bank failures during the period. Illinois, other Midwestern and Southern states with high numbers of bank failures, however, generally also had high failure rates. Besides Nevada, other states with high failure rates included South Carolina, Florida and Arkansas, each with a rate of 15 percent. At the other extreme, five New England states, plus New Mexico, Wyoming, New York, Massachusetts and New Jersey, all had failure rates under 3 percent. The mean failure rate among all states was 6.6 percent, while the median was 5.5 percent. For comparison, between 1980 and 1989, the average annual bank failure rate in the United States was 0.77 percent. Eight states had no failures during the period, while Alaska, Oregon and Texas had failure rates of 6.3 percent, 2.4 percent and 2.3 percent, respectively, the most of any states.

Figure 3 maps the average annual rate of deposits in failed banks during 1929-32, where

Figure 1

Number of Bank Suspensions, 1929-32

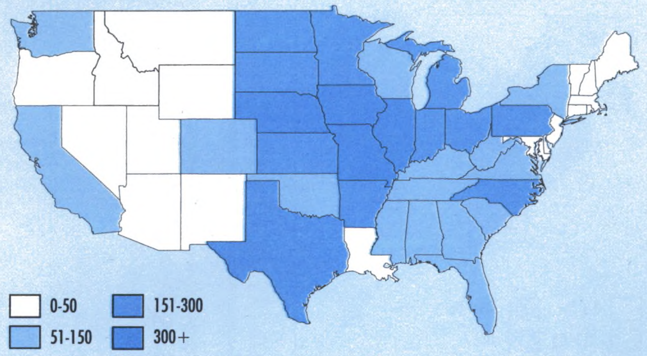
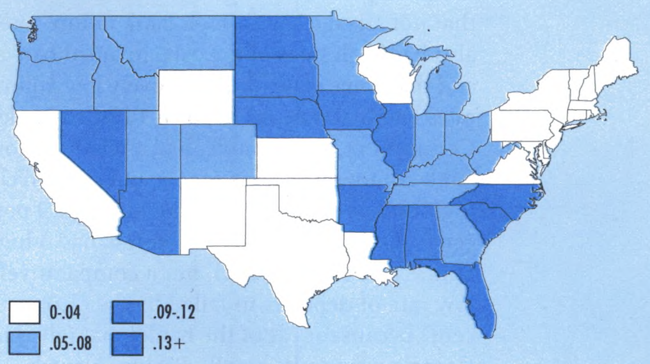


Figure 2

Bank Suspensions Per Active Bank, 1929-32

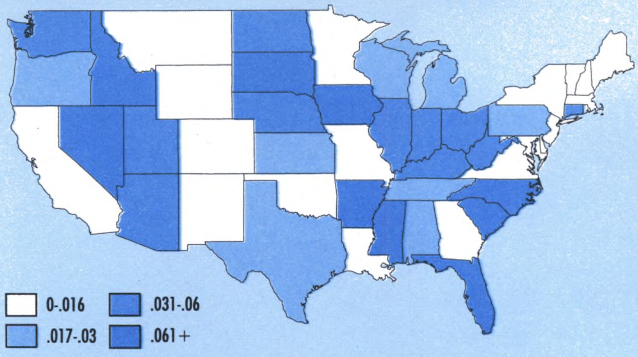


the annual rate of deposits in failed banks is the sum of deposits in failed banks during a year divided by the volume of deposits in all banks at mid-year. A state could have had a low number of bank failures, or a low failure rate, but a high rate of deposits in failed banks if those banks that did fail held a high share of the state's bank deposits. On the other hand, a high number of failures, or a high failure rate, did not necessarily produce a high rate of deposits in failed banks if failing banks held a comparatively low share of a state's deposits. Moreover, there is no reason to expect that the determinants of the bank failure rate and rate of deposits in failed banks will be the same.

During 1929-32, the rate of deposits in failed banks and the bank failure rate were highly correlated (a correlation coefficient

Figure 3

Deposits in Suspended Banks Per Dollar of Deposits in Active Banks, 1929-32



of 0.85) and Nevada again had the highest rate of deposits in failed banks at 16 percent. Still, comparison of Figures 2 and 3 reveals that not all states with high bank failure rates also had high rates of deposits in failed banks, and that some states with relatively low failure rates had high rates of deposits in failed banks. Connecticut, for example, had a relatively low bank failure rate (3.6 percent), but a relatively high rate of deposits in failed banks (3.9 percent). On the other hand, Georgia had a high failure rate (8.0 percent), but a comparatively low rate of deposits in failed banks (1.6 percent) because most of the banks that failed in Georgia were quite small. Besides Nevada, other states with high rates of deposits in failed banks included South Carolina, Florida, North Carolina, Iowa, Mississippi and Arkansas, all with rates above 7 percent. States with low rates of deposits in failed banks include those in the Northeast, California and scattered others. The mean rate across all states was 3.4 percent, while the median was 2.1 percent.

What explains interstate differences in bank failure rates and in the rate of deposits in failed banks? One hypothesis is that banking distress was more severe in regions suffering the largest declines in economic activity because banks in those regions likely experienced the largest losses on their loans and other assets. The extent to which per capita income fell during 1929-32 ranged from 32 percent in Massachusetts to 56 percent in Mississippi (both the mean and median declines were 44 percent). It seems reasonable to expect that failure rates were higher in states suffering the largest income declines.

Conceivably, income fell more in some states *because* of a high rate of bank failures. Some researchers argue that banking panics triggered the decline in national income, while others contend that bank failures merely reflected falling income caused by other forces. Ideally, an econometric analysis of the determinants of bank failure would treat the change in income as simultaneously determined with bank failures. The specification of such a system in this context presents a number of challenges and is therefore left to future research. Among the difficulties is a lack of suitable variables to serve as instruments for state-level changes in per capita income. For example, state income estimates prior to 1929 are not available. Readers are cautioned that the models presented here may be subject to simultaneous-equations bias.

As in the 1920s, the majority of banks that failed during the Depression were small rural banks whose prosperity depended largely on agriculture. Alston, Grove and Wheelock (1994) show that differences in farm foreclosure rates explain much of the interstate variation in bank failure rates during 1926-29. Other studies, including Friedman and Schwartz (1963) and Temin (1976), note a relationship between agricultural distress and bank failures in the 1930s, but do not examine whether falling agricultural income dominates other possible explanations of failures. An exception is Stauffer (1981), but he focuses exclusively on 11 Southern states. Moreover, even though falling agricultural income might explain a high number of bank failures during the Depression, because the rural banks that failed in such large numbers were typically quite small, agricultural distress might not explain the proportion of deposits in failed banks.

Apart from the severity of agricultural distress, the preponderance of failures among very small banks suggests that bank size itself, or some other characteristic of small banks, might explain their relatively high failure rate. The failure rate in 1930-31 of national and state-chartered banks was inversely correlated with bank size, declining from 25 percent of active banks on June 30, 1930, for banks with fewer than $150,000 of loans and investments, to 2 percent for banks with at least $50 million of loans and investments (Federal Reserve Board, non-dated publication, p. 67). If small banks were less diversified than large banks, either geographically or along product lines, they might have been more vulnerable to a downturn in a given market. For example, White (1986) argues that their greater involvement in the securities business might have left large banks better diversified and, hence, less likely to fail than small banks. Accordingly, a predominance of small, undiversified unit banks might explain the generally higher bank failure rates of the rural Midwest and South.

A lack of diversification might not explain entirely why the failure rate of small banks exceeded that of large banks. Typically, small banks had state charters and the failure rate of state-chartered banks during the Depression exceeded that of national banks. In 1929, the failure rates of national and state banks were 0.8 and 3.4 percent, respectively; in 1930, they were 2.2 and 7.1 percent; in 1931, 6.0 and 12.1 percent; and in 1932, 4.5 and 8.7 percent (Bremer, 1935, p. 46). Differences in regulation or supervision might explain the relatively high failure rate of state-chartered banks and, hence, of small banks. For example, in most states, national banks had higher minimum capital requirements and were subject to greater restrictions on real estate lending than state-chartered institutions.

Apart from differences in the regulation or supervision of national and state banks, other state banking policies might have affected state banking markets or failure rates. Branch banking restrictions, for example, can hamper diversification and, to the extent that the timing or magnitude of a decline in economic activity varies geographically, a bank with multiple offices might be able to offset losses in one region with profits in another. Although unit banking predominated in the United States in the 1930s, several states permitted at least limited branching within their borders. In 1930, nine states, including Arizona, California and North Carolina, permitted state-wide branching, and 12 others permitted limited branching. Banks in 18 states had no branches at all. As of June 1930, U.S. commercial banks operated 3,618 branches. Of these, 853 were in California, with some 300 belonging to the Bank of Italy (the forerunner of Bank of America). California had nearly twice as many branch offices as it had banks. Rhode Island was the only other state having more branches than banks.[2] If the opportunity to branch afforded banks greater diversification, or permitted them to operate at a more efficient scale, states that allowed branching might have had lower bank failure rates.[3]

A second policy that could have affected bank failure rates is deposit insurance. Eight states — Kansas, Mississippi, Nebraska, North Dakota, Oklahoma, South Dakota, Texas and Washington — enacted insurance systems for their state-chartered banks following the "Panic of 1907." In each system, insurance premiums were low and unrelated to failure risk, thereby creating a subsidy that appears to have caused more bank entry and greater risk-taking than would have otherwise occurred (see Calomiris, 1989, 1992; and Wheelock, 1992a, 1993).

Banks proliferated throughout the United States in the two decades before 1920. In 1900, the United States had 12,427 banks. By 1920, the number had reached 30,291, thanks in part to rapid growth in agricultural states during the commodity price boom of World War I (Board of Governors, 1959). The number of banks increased particularly fast in states with deposit insurance systems, such as North Dakota, which by 1920 had one bank for every 720 persons, the most of any state.

The wartime boom came to an end in 1920. Commodity prices collapsed, triggering widespread bank failures in rural areas. Subsequently, states with the highest numbers of banks per capita in 1920 suffered the highest failure rates, and members of state insurance systems had higher failure rates than uninsured banks. By 1929, each of the state insurance systems was either insolvent or closed by state authorities. Because none of the systems carried a state guaranty, depositors, rather than taxpayers, suffered losses if insurance premiums were inadequate. An exception was Mississippi, where the state assumed the obligations of its insurance system and issued bonds to reimburse depositors of failed banks. Further detail about the state insurance systems can

[2] Aggregate data on branch banking are from the Federal Reserve Board (December, 1930, p. 812). The data for the Bank of Italy are from Tippetts (1929, p. 335) and are for 1927.

[3] Although not common at the time, multiple-bank holding companies also could have provided some geographic diversification. This article, however, does not investigate whether holding companies affected state failure rates.

be found in Federal Deposit Insurance Corporation (1956) or Calomiris (1989).

Although states with deposit insurance systems had high numbers of bank failures during the 1920s, they still had significantly more banks per capita in 1929 than other states. Generally, the more banks per capita a state had in 1929, the higher its bank failure rate during 1929-32. (The correlation coefficient is 0.33, which is significant at the 0.05 level). Thus, by affecting the number of banks per capita or other aspects of market structure, or if banks that had been members of state deposit insurance systems continued to hold riskier portfolios, deposit insurance could have contributed to bank failures during the Great Depression.

INTERSTATE VARIATION IN FAILURE RATES: TESTING THE HYPOTHESES

The main objective of this article is to discern whether differences in state banking policies contributed to interstate variation in failure rates during the Great Depression. Accordingly, in modeling the determinants of bank failure rates during 1929-32, I control for cross-state differences in the level of economic distress by including the percentage change in per capita income, and the average annual farm and business failure rates as independent variables. I expect that the more per capita income fell and the higher the rates of farm and business failures, the higher were state bank failure rates and rates of deposits in failed banks.

To test whether within-state branching helped to limit failures, perhaps by enabling greater diversification or scale, I include the ratio of branches to operating banks in 1930 as another independent variable. I expect that failure rates and the rate of deposits in failed banks were lower where branching was more prevalent.

Next, I include dummy variables reflecting whether a state had a deposit insurance system during the 1920s. By affecting a state's banking market structure, deposit insurance could have had an impact on failure rates during the 1930s even though insurance no longer existed. Deposit insurance caused more entry and encouraged greater risk-taking than would have otherwise occurred and, hence, the banking systems of states with insurance might have been more vulnerable to a decline in economic activity. In other words, failure rates might have been higher because deposit insurance generated more banks than were economically viable once insurance had ended, or because banks that had been insured continued to hold especially risky portfolios.

Apart from its impact on the number of banks per capita, the collapse of state deposit insurance systems in the 1920s caused declines in the number of state-chartered banks relative to the number of national banks. In 1908, the Comptroller of the Currency ruled that national banks could not join state deposit insurance systems. This led to a relative increase in the number and deposit shares of state-chartered banks in the states enacting insurance systems. The decade-long shakeout of rural banks that followed the collapse of commodity prices in 1920 reduced the number of state banks. More than 5,700 banks failed in the '20s, and Alston, Grove and Wheelock (1994) show that rural failure rates were higher in states with deposit insurance systems, after controlling for the extent of agricultural distress. Moreover, Wheelock (1993) finds that the demise of deposit insurance caused especially large declines in the relative number of state-chartered banks, both because the rate of failure among insured state banks was high and because many state banks switched to national charters to escape state insurance systems. These effects were especially large in states where the insurance systems collapsed (or were closed by state authorities) early in the decade. For this reason, the impact of deposit insurance on market structure, and hence on failures during the 1930s, might differ in states where insurance ended early in the '20s from its impact in other insurance states. Therefore, I include one dummy variable, set equal to 1 in states in which insurance lasted to either 1928 or 1929 (Mississippi, North Dakota and Nebraska), and to zero otherwise. I set a second dummy equal to 1 in states in which insurance ended by the mid-1920s (Kansas, Oklahoma, South Dakota and Texas), and to

Table 1

Determinants of Interstate Variation in Bank Failure Rates

Dependent Variable: average failure rate, 1929-32, models 1-4;
Dependent Variable: log of the ratio of deposits to failed banks, 1929-32, models 5-8

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	−8.98 (1.83)*	−7.82 (1.73)*	−7.91 (1.77)*	−5.71 (0.72)	−7.22 (4.95)***	−6.54 (4.14)***	−6.38 (4.35)***	−3.47 (1.23)
Δ Per capita income	−23.57 (2.41)**	−26.93 (2.79)***	−24.16 (2.47)**	−19.92 (2.03)**	−5.79 (1.73)*	−4.40 (1.18)	−1.91 (0.53)	−1.66 (0.50)
Farm failure rate	0.21 (3.28)***	0.16 (2.63)**	0.11 (1.67)	0.16 (1.87)*	0.03 (1.11)	0.03 (1.27)	0.01 (0.33)	−0.004 (0.16)
Business failure rate	−0.73 (0.52)	−0.15 (0.11)	−0.03 (0.03)	−0.42 (0.26)	0.28 (0.71)	0.34 (0.87)	0.34 (0.95)	0.41 (1.09)
Branching ratio		−1.73 (1.33)	−1.33 (1.02)			−1.00 (2.21)**	−0.78 (1.82)*	
DI (MS, ND, NE)		2.30 (1.35)	2.31 (1.37)			0.16 (0.24)	0.13 (0.21)	
DI (KS, OK, SD, TX)		−3.61 (2.85)***	−2.99 (2.24)**			−0.38 (0.65)	0.06 (0.10)	
ln Banks per capita				−1.52 (1.02)				−0.09 (0.23)
ln National bank ratio			−1.50 (1.38)	−2.40 (2.11)**			−1.03 (2.76)***	−1.00 (2.73)***
ln Average bank size				−0.76 (0.85)				−0.41 (1.32)
Adjusted R^2	.85	.88	.88	.86	.10	.15	.27	.26

Note: The coefficients of models 1-4 are multiplied by 100; absolute values of t-statistics are in parentheses; ***, ** and * indicate statistical significance at the .01, .05 and .10 levels. The adjusted R^2 is presented for use in comparing alternative specifications but, because of the heteroscedasticity correction, does not indicate the proportion of the variation in the dependent variable explained by models 1-4.

zero otherwise. The insurance systems of these states had all ceased to function by 1926, though, in some cases, did not officially close until a later date. Although Washington had an insurance system, it collapsed after the failure of the first, and largest, insured bank in 1921. Because of its short life, I treat Washington as not having had insurance. Like other states where insurance ended early, however, many of Washington's state banks switched to federal charters.

If deposit insurance left states with more banks than were economically viable, or with banks having especially risky portfolios, the coefficients on one or both of these dummies should be positive in the failure rate regressions. On the other hand, if insurance caused the relative number of banks with federal

Table 2

Determinants of Interstate Variation in Bank Market Structure

Dependent Variables: log of banks per capita (equation 1); log of the ratio of national banks to all banks (equation 2); log of deposits per bank (equation 3)

	(1)	(2)	(3)
Intercept	−1.20 (2.29)**	−0.24 (0.46)	9.08 (26.22)***
ln Population density	−0.12 (2.53)**	−0.07 (1.54)	0.05 (1.61)
ln Farm population	0.06 (0.55)	−0.29 (2.61)***	−0.67 (9.00)***
Branching ratio	−0.77 (4.58)***	0.06 (0.38)	0.82 (7.33)***
DI (MS, ND, NE)	0.45 (1.88)*	−0.22 (0.94)	−0.31 (1.95)*
DI (KS, OK, SD, TX)	0.40 (1.93)*	0.33 (1.62)	−0.35 (2.54)**
Minimum capital	−0.003 (0.57)	0.007 (1.53)	−0.003 (0.78)
Adjusted R^2	.61	.32	.91

Note: Absolute values of t-statistics are in parentheses; ***, ** and * indicate statistical significance at the .01, .05 and .10 levels.

charters to be unusually high in these states, and if differences in regulation or supervision caused national banks to have lower failure rates than state-chartered banks, deposit insurance might have caused fewer Depression-era bank failures. Conceivably, the coefficients on the two insurance dummies could differ if the effects of insurance differed between states whose systems ended early and those in which insurance lasted until decade's end.

Table 1 reports regression estimates in which the average annual bank failure rate and the log of the average annual rate of deposits in failed banks are the dependent variables. I estimate models of the log of the rate of deposits in failed banks because the residuals from such models appear to be normally distributed, while those from models of the level of the rate of deposits in failed banks do not. Because the value of this variable for Rhode Island is zero, I omitted this observation when estimating the reported regressions. Assigning an arbitrarily small value to this observation and re-estimating the models does not, however, substantially alter the results.

In states with few banks, each bank failure has a larger impact on the failure rate than in states with many banks, which could cause the errors of the model to be larger in states with fewer banks. Hence, to correct for heteroscedasticity, each variable in the failure rate models has been multiplied by the square root of the average annual number of operating banks. Weighting gives more importance to those states, located mainly in the Midwest and South, that had large numbers of banks, and less to states with fewer banks (like those in the West and Northeast).

Models 1 and 5 include only measures of economic activity as independent variables. The more per capita income fell during 1929-32, the higher were both the failure rate and the rate of deposits in failed banks. Typically, states with large declines in per capita income also had relatively high farm failure rates, and the correlation coefficient between these two variables is -0.57, which is significant at the 0.01 level. Nevertheless, in the bank failure rate model (model 1), the coefficient on the farm failure rate is positive and statistically significant, indicating that a higher farm failure rate caused a higher bank failure rate. The coefficients on the business failure rate, on the other hand, are never statistically different from zero.

Models 2 and 6 include the branch banking ratio and deposit insurance dummy variables as additional regressors. In both models, the coefficient on the branching ratio indicates that bank failure rates were lower where branching was more prevalent, though only in model 6 is the coefficient statistically significant.[4] This suggests that, where permitted, branching lowered bank failure rates. Perhaps this occurred because branching banks were better diversified, or possibly because branching enabled banks to achieve economies of scale. States with more

[4] The branching ratio is positively correlated with both the percentage change in per capita income and business failure rate. If the latter is omitted, the coefficient on the branching ratio is larger and statistically significant in the bank failure rate regression.

branching tended to have larger banks. The correlation coefficient between the branching ratio and the log of deposits per bank is 0.72, which is significant at the 0.01 level.

The coefficients on the deposit insurance dummy variables in model 6 are not statistically different from zero. In model 2, however, the dummy for states where insurance ended by the mid-1920s (Kansas, Oklahoma, South Dakota and Texas) has a negative and significant coefficient. In these states, the average annual bank failure rate was some 3 percentage points lower because of deposit insurance. Apparently, deposit insurance affected market structure in a way that reduced failure rates. This might be explained by the comparatively large increase in the relative number of national banks, which had lower failure rates than state banks, in these states. Models 3 and 7 test for this possibility by including the log of the ratio of national banks to total banks as an additional independent variable. Doing so reduces somewhat the absolute size and statistical significance of the deposit insurance coefficient. Insurance appears to have had no effect on the national bank ratio in states where insurance lasted at least until 1928. The coefficient on deposit insurance for these states is positive and fairly large (though not statistically significant), suggesting that insurance affected bank failure rates in these states by causing excessive numbers of banks or risk-taking.

Models 4 and 8 further indicate how banking market structure affected bank failure rates during the Depression. I exclude branching and deposit insurance from these specifications because their effects on bank failures appear to have worked through their influence on market structure. Further analysis of the determinants of market structure is presented in the next section.

The market structure measures included in models 4 and 8 are the logs of banks per capita in 1929, the ratio of national to all banks in 1929, and the average volume of deposits per bank in 1929. Only the coefficients on the ratio of national to all banks is statistically significant. Its negative coefficients indicate that bank failure rates and rates of deposits in failed banks were smaller where national banks were relatively more prevalent. Multicollinearity might explain the absence of a significant relationship between bank size, or the number of banks per capita, and failure rates. The correlation coefficient between the logs of the national bank ratio and average deposits per bank is 0.49, which is significant at the 0.01 level, while that between the logs of the national bank ratio and number of banks per capita is -0.34, which is significant at the 0.02 level. The correlation between the national bank ratio and bank size makes it impossible to determine whether differences in regulation or supervision of state and national banks had an impact on failures, except as they might have influenced bank size. The absence of a significant relationship between bank size and failure rates, however, suggests that any influence size had on failures is reflected in the ratio of national banks to all banks.

The inclusion of banks per capita, the national bank ratio and average bank size in the bank failure rate model reduces the statistical significance of the percentage change in per capita income and the farm failure rate. The correlation coefficients between the market structure variables and the two measures of economic activity are all statistically significant at the 1 percent level. The states with the largest declines in per capita income and the highest farm failure rates also had the highest numbers of banks per capita, the lowest national bank ratios and smallest average bank sizes. Although the Depression affected the entire nation, rural farming regions were hit especially hard. Unfortunately, these states also tended to have banking markets consisting of many small, undiversified banks. Thus, it is difficult, if not impossible, to apportion the comparatively high bank failure rates of these states between changes in the level of economic activity and the vulnerability of their banking systems.[5] The evidence presented here, however, suggests that banking market structure affected the performance of state banking systems, and adds weight to other research associating banking distress and declining economic activity in the 1930s with banking system fragility (see Bernanke and James, 1991; Calomiris, 1993; and Grossman, 1994).

[5] Conceivably, income fell more and farm failure rates were higher in these states because their banking market structures were more vulnerable to bank failures. As noted previously, the measures of economic activity ideally would be treated as dependent variables in a simultaneous-equations framework to capture any impact of bank failures on economic activity.

THE DETERMINANTS OF BANKING MARKET STRUCTURE

The evidence presented in the preceding section shows that government policies affected bank failure rates during the Depression, at least in part, by causing differences in banking market structure across states. Further insight into the effects of government policies on market outcomes can thus be gleaned from studying interstate variations in banking market structure.

Wheelock (1993) investigates the impact of government policies on banking market structure during the 1920s. There, I show that the number of banks per capita was lower where branch banking was more prevalent, in states that imposed high minimum capital requirements on state-chartered banks, and in states with deposit insurance systems. In addition, the number of banks per capita was lower in more densely populated states. The costs of transportation and communication make the finding of an inverse relationship between population density and the number of banks per capita unsurprising. An inverse relationship between the prevalence of branching and the number of banks per capita is also not surprising. Where permitted, branch offices can serve markets that otherwise would require independent banks. To the extent that branches substitute for unit banks, the number of banks per capita will be lower. Finally, because deposit insurance subsidized entry, and was instituted only in unit banking states, it caused the number of banks per capita to be higher than it would otherwise have been.

Model 1 of Table 2 reports a regression of the log of banks per capita in 1929 on the log of population density, the branching ratio, the deposit insurance dummy variables, the log of the ratio of farm to total state population, and the minimum capital requirement imposed on state banks. Only the coefficients on the latter two variables are insignificant. As expected, the less densely populated a state was, the higher were banks per capita. In addition, in states where there were deposit insurance systems, or where branch banking was less prevalent, banks per capita were again higher.

The same variables are included in a model of the log of the ratio of the number of national banks to total banks. The most important determinant of this ratio is the ratio of farm to total state population: the greater the fraction of the population in agriculture, the lower the relative number of national banks. National banks were more prevalent in Northeastern manufacturing states and other states where agriculture was relatively unimportant. On the one hand, this reflects the lower population density of agricultural states, and that such states often set low minimum capital requirements for their state-chartered banks to ensure the presence of banking facilities in rural areas. Note that the coefficient on the minimum capital ratio is positive and, for a one-tail test, statistically significant at the 0.10 level. State-chartered banks also typically enjoyed fewer lending restrictions than national banks, especially on real estate loans. Consequently, state-chartered banks were able to serve more of the banking needs of agricultural borrowers.

In model 2, the coefficients on the two deposit insurance dummy variables differ significantly from one another. The coefficient on the variable for states where deposit insurance ended early in the 1920s (Kansas, Oklahoma, South Dakota and Texas) is positive and, for a one-tail test, statistically significant at the 0.10 level. The failure of large numbers of state banks, and the decision of others to switch to national charters, explain why deposit insurance had a positive influence on the national bank ratio in these states. Insurance lasted longer, and generally performed better, in Mississippi, North Dakota and Nebraska and, hence, there was no effect of insurance on the national bank ratio.

Finally, the coefficient on the branching ratio is not statistically different from zero. Until the McFadden Act of 1927 enabled national banks to open branches, virtually all branching was done by state-chartered institutions. The ability to branch might have increased the demand for state charters and, hence, all else equal, had a negative influence on the national bank ratio. On the other hand, it could have also held down state chartering because branch offices substituted for independent state banks.

Model 3 of Table 2 is a regression of the log of average deposits per bank in 1929. This variable is negatively correlated with the number of banks per capita and positively correlated with the national bank ratio. Hence, the estimates of this model are unsurprising. Banks were larger in more densely populated states and where agriculture was less important. Average bank size was also larger where branching was more prevalent. Apparently, branching enabled banks to achieve larger scale than they otherwise would. Finally, states which had deposit insurance systems tended to have, on average, smaller banks. These were uniformly rural states that prohibited branching. Deposit insurance provided a subsidy that, because of branching restrictions, led to the entry of many small unit banks. The demise of deposit insurance removed this subsidy and, at least in four states, contributed to a shift toward more banks with federal charters. Despite this, the negative impact of insurance on average bank size apparently remained in 1929.

CONCLUSION

In response to the bank failures of the Great Depression, Congress enacted federal deposit insurance, imposed new restrictions on the activities of commercial banks, and maintained a strict prohibition of interstate branching. Although these policies appeared to work well for many years, their weaknesses were exposed in the 1980s, prompting reforms. Looking back, economic historians have demonstrated the destabilizing effects of deposit insurance and branch banking restrictions in the 1920s. This article illuminates how these policies affected banking market structure and, ultimately, state-level bank failure rates during the Depression. Even though state deposit insurance had ended by 1929, its effects lingered into the 1930s, causing both higher numbers of banks per capita and higher ratios of national banks to total banks in states that earlier had insurance systems. At the same time, branching restrictions, where enforced, contributed to the small average size of unit banks and to their higher rate of failure during the Depression. Thus, as others have shown for the 1980s, the geographic distribution of bank failures during the Depression was in part a function of market structure and government banking policies.

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Appendix

SOURCES FOR STATE-LEVEL DATA

Bank failures and deposits in failed banks: Board of Governors (1943, pp. 284-85).

Branch bank offices: Federal Reserve Board (December 1930, pp. 811-12).

Business failure rate: Department of Commerce, *Statistical Abstract* (1930, 1931, 1932, 1933).

Farm failure rate: Department of Agriculture (1931, 1933).

Farm population: Department of Commerce (1932, p. 40).

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Population density: Department of Commerce (1931, p. 13).

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U.S. Official Forecasts of G-7 Economies, 1976-90

Michael Ulan, William G. Dewald and James B. Bullard

Forecasts are regularly used in making fiscal and monetary policy decisions. For many decisionmakers, the likely short-term effect of a proposed action is a major concern in deciding whether to implement a particular policy. Such decisions are typically made in the context of considerable uncertainty, not only about what the likely effects of a particular action might be, but also about the momentum and direction of aggregate economic variables in themselves. Thus, an important concern from a policy point of view is the extent to which forecasts are reliable representations of economic outcomes at relatively short horizons, such as a year.

The purpose of this article is to report facts concerning the accuracy of the U.S. official forecasts of real output growth and inflation from 1976 to 1990 for the Group of Seven (G-7) economies: Canada, France, Italy, Japan, the United Kingdom, the United States and West Germany. Though widely distributed within the government, the Administration forecasts had been classified and not available to the public. We obtained the forecasts for years through 1990 under a Freedom of Information Act request with the helpful cooperation of the Treasury Department.

The accuracy of these forecasts is measured against the standard of actual real output growth and inflation as subsequently published in the Treasury's World Economic Outlook (WEO). The Administration forecasts and their accuracy are reported along with a number of alternative forecasts. The primary comparison is to projections made for the G-7 by the Organization for Economic Cooperation and Development (OECD) and by Data Resources Incorporated (DRI). For the United States only, we also compare the Administration forecasts to those made by the Blue Chip consensus and the U.S. Federal Reserve "Greenbook."[1] For each country and for the G-7 nations taken as a whole, the outlooks are evaluated on the basis of the differences between predictions and outcomes. The predictions and outcomes are expressed in terms of year-over-year percentage changes. The statistics cited are the sum of squared errors, the mean squared errors, the root mean squared errors (RMSE) and the bias (sum of prediction minus outcome). We think these measures provide simple but effective summary statistics useful in evaluating forecast accuracy.

THE ADMINISTRATION FORECASTS

Administration Forecasts of Real Output Growth

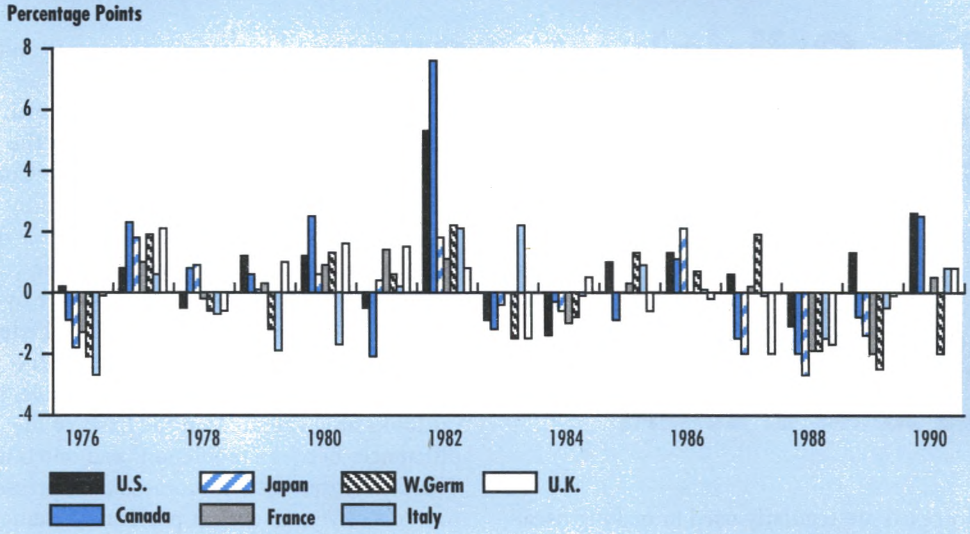
The errors in the Administration forecasts of real gross national product (GNP) (gross domestic product, GDP, in some cases) growth in the G-7 nations are shown in Figure 1. The summary statistics relating to the errors in these forecasts appear in Table 1. The sum of squared errors of the Administration's real output growth forecasts is largest for Canada, the United States and West Germany. Just under half of the forecast errors were of a different sign from the errors of the preceding year. The number of sign reversals of forecast error, not counting a zero error as a sign change, ranged from four for Japan to eight for the United States.

Like the other forecasters, the Administration simply missed the deep recessions in 1982 in the United States and Canada. The Administration forecasted 3.4 percent real

[1] The *Blue Chip Economic Indicators* newsletter is published monthly and surveys major forecasters of the U.S. economy. The Federal Reserve "Greenbook" is a document distributed to top-level staff and Federal Open Market Committee (FOMC) members shortly before each FOMC meeting. The FOMC is the primary policymaking arm of the Federal Reserve. Greenbook information is classified for five years following each FOMC meeting.

Figure 1

Administration Forecast Errors, Real Output Growth



output growth for the United States in 1982 and 3.2 percent for Canada. The outcome was a 1.9 percent decrease in output in the United States and a 4.4 percent decrease in Canada, one of the deepest recessions in either country since the end of World War II. In absolute terms, the 1982 forecast errors for U.S. and Canadian economic growth were two-to-three times as large as any for a non-North American G-7 economy over the 15 years covered here, as all of the largest absolute forecast errors were between 2 percentage points and 3 percentage points for the remaining countries. While output fell in some other G-7 economies in 1982, other nations did not experience a comparable reversal of fortunes.

There were, however, some large declines in real output growth in other countries in other years. Italy, for instance, experienced a 4.2 percentage point fall in its output growth rate (from 4.0 percent to -0.2 percent) between 1980 and 1981, and the United Kingdom witnessed a 4.3 percentage point decline (from 1.5 percent to -2.8 percent) between 1979 and 1980. Administration forecasts in these instances, however, were not so wide off the mark as for the U.S. and Canadian forecasts for 1982. Moreover, the error in the Administration's forecasts of real output growth in Italy and the United Kingdom was larger in non-turning-point years than during these turning-point episodes. In the case of Italy, the largest error was for 1976, when the nation's economy experienced a substantial upturn. In that year, the change in direction of the Italian economy (a total of 9.3 percentage points—from a decline of 3.7 percent in 1975 to output growth of 5.6 percent in 1976) was actually greater than the percentage point changes in the direction of real output growth in the U.S. and Canadian economies in 1982,

Table 1

Descriptive Statistics, Errors in Administration Forecasts of Real GNP/GDP Growth, 1976-90

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States	47.63	3.18	1.78	11.1
Canada	92.21	6.15	2.48	7.7
Japan	29.24	1.95	1.40	−1.2
France	15.79	1.05	1.03	−0.7
West Germany	39.25	2.62	1.62	−2.7
Italy	27.91	1.86	1.36	−2.3
United Kingdom	21.67	1.45	1.20	1.5
G-7 total	273.70	2.61	1.61	13.4

Figure 2

Administration Forecast Errors, Inflation

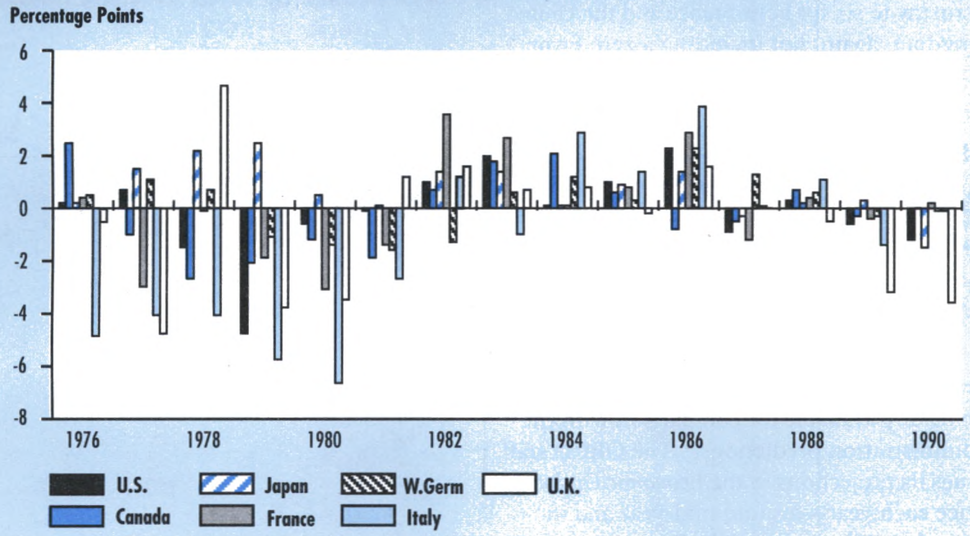


Table 2

Descriptive Statistics, Errors in Administration Forecasts of Inflation, 1976-90

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States	40.19	2.68	1.64	−2.1
Canada	33.97	2.27	1.51	−2.1
Japan	22.81	1.52	1.23	10.9
France	55.46	3.70	1.92	0.0
West Germany	18.70	1.25	1.12	2.8
Italy	174.65	11.64	3.41	−20.3
United Kingdom	103.25	6.88	2.62	−9.5
G-7 total	449.03	4.28	2.07	−20.3

but the error in the Administration forecast of Italian real GDP growth in 1976 was only -2.7 percentage points.

Administration Inflation Forecasts

The Administration forecast errors for inflation from 1976 to 1990 in the G-7 nations are shown in Figure 2, while Table 2 presents the associated summary statistics. The Administration forecasts of U.S. inflation in 1980 pertained to the GNP deflator rather than the consumer price index (CPI). Hence, for this year the forecast error is calculated with respect to the change in that measure rather than the CPI. The sum of squared errors is largest for Italy and the United Kingdom. The large error in the forecast of United Kingdom inflation in 1978 is attributable primarily to a decline in inflation in that year; inflation fell from 15.8 percent in 1977 to 8.3 percent in 1978. It subsequently rebounded to 13.4 percent in 1979. During 1978, there were price controls in force on some components of the CPI market basket and, at government urging, unions moderated their wage demands. In 1979, with the election of a Conservative government, the unions returned to no-holds-barred wage bargaining, and the government not only removed price controls but also increased the rate of value-added tax applicable to several items in the CPI market basket, boosting inflation during that year.

As Table 2 reveals, the Administration tended to underpredict inflation in Italy and the United Kingdom, countries with high average inflation rates, and to overpredict inflation in West Germany and Japan, countries with comparatively low inflation. Errors in one direction were followed by errors in the other direction about a third of the time—

less than was the case for real output growth. The number of reversals of sign of the forecast error ranged from three for Japan and West Germany to six for both France and the United Kingdom, again, not including a zero error as a change in sign.

COMPARISONS WITH ALTERNATIVE PREDICTIONS

Administration Forecasts and OECD Projections, Real Output Growth, 1976-90

The OECD's projections of economic growth for G-7 nations between 1976 and 1990 are readily available for comparison with the Administration predictions.[2] The OECD staff issues its projections in the *Economic Outlook* twice each year—around mid-year and in December. We compared the December OECD projections (prepared in mid-November) with Administration forecasts, although the latter were generally made earlier. Summary statistics covering the Administration's predictions and OECD projections over 1976-90 appear in Table 3.

The OECD makes several assumptions about members' economies in projecting each nation's economic growth. The organization assumes that the exchange rate of the nation's currency during a year remains at the level of November in the previous year (the month the projections were prepared), that fiscal policy will remain unchanged and that the price of oil relative to that of OECD exports of manufactures will remain constant. The reasoning behind these assumptions is that the OECD is "advising" its member governments where they are headed economically if they continue to pursue current policies, not taking into account prospective changes in policies. Hence, the OECD considers its product a projection rather than a forecast.

Table 3 shows that, for each G-7 nation except Italy, the sum of squared errors of the OECD real growth projection is smaller than that for the Administration's forecast errors. For both the OECD and the Administration, the smallest sum of squared errors was achieved in the case of France, while the country evidently posing the most difficulty over this period was

Table 3

Descriptive Statistics, Errors in Forecasts of Real Output Growth by Country, 1976-90

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	47.63	3.18	1.78	11.1
OECD	22.53	1.50	1.23	−4.0
Canada				
Administration	92.21	6.15	2.48	7.7
OECD	57.40	3.83	1.96	2.0
Japan				
Administration	29.24	1.95	1.40	−1.2
OECD	17.76	1.18	1.09	−6.2
France				
Administration	15.79	1.05	1.03	0.7
OECD	15.39	1.03	1.01	−3.7
West Germany				
Administration	39.25	2.62	1.62	−2.7
OECD	27.29	1.82	1.35	−5.0
Italy				
Administration	27.91	1.86	1.36	−2.3
OECD	40.37	2.69	1.64	−10.9
United Kingdom				
Administration	21.67	1.45	1.20	1.5
OECD	18.99	1.27	1.13	−7.4
G-7 total				
Administration	273.70	2.61	1.62	13.4
OECD	199.72	1.90	1.38	−35.2

Canada. For the Administration, the second worst case was the United States.

To what might one attribute the generally greater accuracy of the OECD projections compared with the Administration's forecasts? One factor might be that OECD projections of real output growth in the G-7 nations were made closer to the beginning of the forecast year. The OECD might also be in a better position to closely follow the economic performance of many nations by evaluating worldwide influences than is the Administration, whose forecasts are largely dependent on inputs from individual countries. On the other hand, the OECD procedure simply assumes unchanged fiscal policies, exchange rates and real oil prices. These might be factors that would lead to less accuracy in their projections to the extent that such factors have a predictable effect on real output growth.

[2] Since the OECD uses the personal consumption deflator rather than the CPI as its measure of inflation, its inflation projections are not considered here.

Table 4

Descriptive Statistics, Errors in Forecasts of Real Output Growth by Country, 1976-90 (largest error omitted)

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	19.54	1.40	1.18	5.8
OECD	15.77	1.13	1.06	−6.6
Canada				
Administration	34.45	2.46	1.58	0.1
OECD	28.24	2.08	1.42	−3.5
Japan				
Administration	21.95	1.57	1.25	1.5
OECD	12.92	0.92	0.96	−4.0
France				
Administration	11.79	0.84	0.92	1.3
OECD	10.55	0.75	0.88	−1.5
West Germany				
Administration	33.00	2.36	1.54	−0.2
OECD	21.77	1.56	1.25	*
Italy				
Administration	20.62	1.47	1.21	0.4
OECD	23.56	1.68	1.30	−6.8
United Kingdom				
Administration	17.26	1.23	1.11	−0.6
OECD	13.70	0.98	0.99	−5.1
G-7 total				
Administration	158.61	1.62	1.27	8.3
OECD	126.50	1.29	1.14	**

* Largest error is either -2.35 in 1976, implying a bias of -2.65, or 2.35 in 1982, implying a bias of -7.35.

** Bias is -30 if 1976 error is omitted, or -34.7 if 1982 error is omitted.

Both the Administration forecasts and the OECD projections of real growth display bias, according to our measure—but in opposite directions. The Administration's real output growth forecasts in total are biased upward, with the main contributors to the total being the errors associated with the United States and Canada. In contrast, except for Canadian economic growth, the OECD projections are biased downward—substantially for the cases of Italy and the United Kingdom.

Since one large error can mar an otherwise good performance, we also examined the data with the largest error omitted; the descriptive statistics are presented in Table 4. With one observation deleted, the sum of squared errors of both the Administration and OECD forecasts tend to be much smaller and much the same.

Our data set contained complete DRI forecasts of economic growth and inflation for all the G-7 countries for the period of 1983 to 1990. The summary statistics pertaining to these DRI forecasts are compared with those of the Administration and the OECD over the same period in Tables 5 and 6. Save for the real growth forecasts for Italy, Japan and the United States, the DRI forecasts over this evaluation period were more accurate than either the Administration forecasts or the OECD projections. DRI was also more accurate than the Administration in forecasting inflation for every country except Japan during this period.

ADMINISTRATION, BLUE CHIP, DRI, FEDERAL RESERVE AND OECD PREDICTIONS FOR CANADA AND THE UNITED STATES, 1977-90

Real Output Growth

The Blue Chip Economic Indicators consensus forecast of year-over-year real economic growth in the United States has been published monthly since 1976 (first forecasting 1977). A consensus forecast of the year-over-year change in the CPI has been published since 1979 (forecasting 1980). Both the number and the identities of participating private-sector forecasters have changed over time. Though DRI, OECD and Federal Reserve Greenbook forecasts for the United States are available for the full period for which we have Administration forecasts, we only compared the five forecasting records for the period for which the Blue Chip consensus has been available. As shown in Table 7, the Blue Chip, DRI, Federal Reserve and OECD projections of U.S. economic growth were each more accurate than the Administration forecasts over this period, with the OECD achieving the greatest overall accuracy. The Administration forecasts for Canadian real output growth

Table 5

Descriptive Statistics, Errors in Forecasts of Real Output Growth by Country, 1983-90

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	15.48	1.94	1.39	3.4
DRI	17.08	2.14	1.46	−5.4
OECD	17.53	2.19	1.48	−1.7
Canada				
Administration	16.69	2.09	1.44	−3.1
DRI	16.56	2.07	1.44	−5.6
OECD	18.74	2.34	1.53	−4.5
Japan				
Administration	18.18	2.27	1.51	−5.0
DRI	12.96	1.62	1.27	−7.8
OECD	11.07	1.38	1.18	−4.5
France				
Administration	8.99	1.12	1.06	−3.9
DRI	5.86	0.73	0.86	−3.0
OECD	8.92	1.12	1.06	−3.3
West Germany				
Administration	22.54	2.82	1.68	−4.8
DRI	10.07	1.26	1.12	−4.5
OECD	14.86	1.86	1.36	−5.5
Italy				
Administration	8.82	1.10	1.05	1.8
DRI	10.47	1.31	1.14	0.7
OECD	7.25	0.91	0.95	0.2
United Kingdom				
Administration	10.44	1.31	1.14	−4.8
DRI	6.31	0.79	0.89	−5.1
OECD	11.20	1.40	1.83	−5.1
G-7 total				
Administration	101.14	1.81	1.34	−16.4
DRI	79.31	1.42	1.19	−30.7
OECD	89.57	1.60	1.27	−24.3

Table 6

Descriptive Statistics, Errors in Forecasts of Inflation by Country, 1983-90

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	13.00	1.63	1.28	3.0
DRI	9.16	1.15	1.07	2.8
Canada				
Administration	9.48	1.19	1.09	3.6
DRI	4.61	0.58	0.76	2.7
Japan				
Administration	7.21	0.90	0.95	2.5
DRI	12.78	1.60	1.26	−0.2
France				
Administration	18.15	2.27	1.51	5.5
DRI	8.77	1.10	1.05	5.3
West Germany				
Administration	9.33	1.17	1.08	5.9
DRI	8.89	1.11	1.05	5.3
Italy				
Administration	29.76	3.72	1.93	6.8
DRI	11.46	1.43	1.20	3.6
United Kingdom				
Administration	27.18	3.39	1.84	−4.4
DRI	18.32	2.29	1.51	−2.0
G-7 total				
Administration	114.11	2.04	1.43	22.9
DRI	73.99	1.32	1.15	17.5

were less accurate than those of either DRI or the OECD.

For U.S. economic growth, there was a "rosy scenario" positive bias of the Administration forecasts which was approached in magnitude only by the negative bias of the Federal Reserve forecasts. As noted in the previous section, the exclusion of the observation for 1982 greatly improves the accuracy of the Administration forecasts. In fact, the same observation accounted for the greatest error in the forecasts of the Administration, the Blue Chip consensus and DRI. In September 1981, many forecasters predicted positive economic growth for the U.S. economy in 1982 even though it was already several months into a recession that would not bottom out for 14 months. The Greenbook and OECD forecasts, both of which, it is important to add, were made later in the year, were considerably better, predicting -0.6 and -0.5, respectively, versus an actual outcome of -1.9.

Table 8 shows the effects of omitting the largest error in computing the accuracy of these forecasts. The errors in the Administration, Blue Chip, DRI, Federal Reserve and OECD projections of U.S. real output growth for 1982 were 5.3, 4.5, 4.3, 1.3 and 1.4 percentage points, respectively. The largest Federal Reserve error was -2.5, recorded in 1981, while the largest OECD error was 2.6, recorded in 1990. The largest errors in the Administration, OECD and DRI forecasts of Canadian real output growth were 7.6, 5.4 and

Table 7

Descriptive Statistics, Errors in Forecasts of U.S. and Canadian Real Output Growth, 1977-90

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	47.59	3.40	1.84	10.9
Blue Chip	32.13	2.30	1.51	2.5
DRI	36.72	2.62	1.62	−0.6
Greenbook	29.29	2.09	1.45	−5.3
OECD	22.47	1.61	1.27	−3.7
Canada				
Administration	91.40	6.53	2.56	8.6
DRI	68.64	4.90	2.21	4.2
OECD	56.98	4.07	2.02	2.6

Table 8

Descriptive Statistics, Errors in Forecasts of U.S. and Canadian Real Output Growth, 1977-90 (largest error omitted)

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	19.50	1.50	1.23	5.6
Blue Chip	11.38	0.88	0.94	−2.0
DRI	18.23	1.40	1.18	−4.9
Greenbook	23.04	1.77	1.33	−2.8
OECD	15.71	1.21	1.10	−6.3
Canada				
Administration	33.64	2.59	1.61	1.0
DRI	26.39	2.03	1.43	−2.3
OECD	27.82	2.14	1.46	−2.8

6.5 percentage points, respectively. With the largest error omitted, the Blue Chip consensus ranks first in accuracy for the United States.

Inflation

As shown in Table 9, in contrast to the situation with respect to real output growth, the Administration was a marginally more accurate forecaster of U.S. inflation over the period 1980-90 than the Greenbook and also more accurate than the Blue Chip survey. DRI was the most accurate overall for the United States, and DRI also predicted Canadian inflation more accurately than the Administration. Summary statistics with the largest forecast error omitted are presented in Table 10. In this case, the Administration forecasts hold up very well against those of the other forecasters for the United States, as do DRI's inflation forecasts for Canada.

SUMMARY

Comparing Administration forecasts to Blue Chip consensus, DRI, Federal Reserve Greenbook and OECD predictions of real output growth in the U.S. economy, we find that the Administration tended to see the future more optimistically and less accurately than the other forecasters. Much, though not all, of that rosy perspective was connected with the failure of the Administration to forecast the output decline in 1982. Deleting that observation substantially enhances measured forecast accuracy, reducing the RMSE from 1.78 to 1.18 over the 1976 to 1990 period. U.S. official forecasts were better with respect to inflation, as the Administration was one of the best among those compared in forecasting U.S. CPI inflation between 1980 and 1990.

The Administration's forecasts of economic growth for almost all G-7 countries were less accurate than the OECD projections for the period 1976 to 1990. The biases in the Administration's forecasts tend to be positive; those in the forecasts of U.S. and Canadian real output growth are particularly large. The biases in the OECD projections tend to be negative; those associated with projections of Italian and U.K. real output growth are large. For the G-7 as a whole, the projections of the OECD are much more accurate than those of the Administration. Over the 1983 to 1990 period, DRI was more accurate than either the Administration or the OECD for four of the G-7 countries.

The differences between the forecast errors of the Administration and the forecast (or projection) errors of the other forecasters may arise from differences in the times at which the forecasts or projections were prepared, a situation that may have influenced the quality of the historical baseline available to forecasters and the values of exogenous

Table 9

Descriptive Statistics, Errors in Forecasts of U.S. and Canadian Inflation, 1980-90

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	14.37	1.31	1.14	3.3
Blue Chip	17.38	1.58	1.26	6.4
DRI	13.13	1.19	1.09	5.3
Greenbook	15.94	1.45	1.20	5.2
Canada				
Administration	15.02	1.37	1.17	1.2
DRI	11.06	1.01	1.00	−1.4

Table 10

Descriptive Statistics, Errors in Forecasts of U.S. and Canadian Inflation, 1980-90 (largest error omitted)

Country	Sum of Squared Errors	Mean Squared Error	RMSE	Bias
United States				
Administration	9.08	0.91	0.95	1.0
Blue Chip	11.62	1.16	1.08	4.0
DRI	9.13	0.91	0.96	3.3
Greenbook	11.53	1.15	1.07	3.1
Canada				
Administration	10.61	1.06	1.03	−0.9
DRI	7.06	0.71	0.84	0.6

variables assumed in predicting the future paths of the economies. Nonetheless, so far as we can ascertain, every forecast we have evaluated was a genuine prognostication of economic growth and inflation made in the closing months of a year with respect to the next year.

Appendix

DATA SOURCES

The data used in this article come primarily from the *World Economic Outlook* (*WEO*) prepared by the United States Department of the Treasury, *Blue Chip Economic Indicators*, DRI's various *Reviews*, the *OECD Economic Outlook* and the Federal Reserve's Greenbook. The Administration forecasts of G-7 nations' economic growth and inflation have been made since 1975 (for 1976). The forecasts evaluated in this article cover 1976 to 1990, the last year for which forecasts have been cleared by the Treasury for release to the public. This is also the last year for which the Greenbook forecasts are cleared for public release. With one major exception, the Administration forecasts for the U.S. economy are those of the Council of Economic Advisers.[1] Forecasts for the other G-7 economies are produced by Treasury financial attachés at U.S. embassies in the capitals of these nations. The attachés review the host-government and host-country private-sector forecasts for the economies of the nations to which they are posted and base their own forecasts on such information, together with their own judgments about the national economies. The Blue Chip consensus forecasts are the mean values of the forecasts of the firms covered in the Blue Chip surveys. The DRI forecasts are based on the outputs of the DRI model and the judgments of that firm's staff. The OECD projections are prepared by members of that organization's staff. The Federal Reserve forecasts are prepared by the staff of the Federal Reserve Board.

The Administration, Blue Chip, DRI and Federal Reserve forecasts, and the OECD outlooks have appeared several times each year and are frequently revised. The *WEO* forecasts evaluated in this article are the last predictions of both economic growth and inflation for the next year made during the previous year.[2] The Blue Chip and DRI forecasts for the U.S. and Canadian economies selected for comparison to the Administration forecasts were those published during the same months as the Administration forecasts. The DRI forecasts begin with those for 1976 and run through those for 1990. A complete set of DRI forecasts for all of the G-7 countries

[1] The Treasury thought the Council's forecast of U.S. economic growth in 1983 was too high and substituted the Blue Chip consensus forecast. (As it turned out, the Treasury—that is, Blue Chip—forecast was also too high, but not so high as the Council's.)

[2] The dates of the Administration forecasts for the next year range from September through December of the previous year.

is available for each year since 1983. The OECD projections are those published in December for the next year, beginning with the outlook for 1976. The Federal Reserve forecasts are those associated with the last Greenbook issued in a given calendar year (usually December).

GNP and GDP data are frequently revised. It was necessary to choose a fixed target to which to compare the forecasts. We used the Treasury Department's historical data, which it provided along with its forecasts in each issue of the *WEO*. Generally, historical data on GNP or GNP changes for a particular year continue to appear in the *WEO* for about 18 months following the end of that year. The last historical citation of the annual change in national GNP or GDP appearing in the *WEO* is the outcome to which the forecasts are compared.[3] Although CPI data tend not to be revised after they are issued, a similar procedure has been followed in selecting the inflation data with which to compare the forecasts. Because the Treasury presents no historical data for growth or inflation in 1978, we have compared its forecasts for 1978 with outcomes taken from the 1981 *International Financial Statistics* (*IFS*) yearbook.[4]

[3] In 1986, Canada changed the emphasis in its National Income and Product Accounts (NIPA) from GNP to GDP and stopped explicitly reporting historical real GNP data in its official bulletin, *National Income and Expenditure Accounts* (*NIEA*). When the Canadian NIPA focus shifted, the Administration began to forecast GDP instead of GNP for Canada and reported historical GDP data in the *WEO*. Since the 1985 and 1986 growth forecasts for Canada prepared by the Administration pertained to GNP, we obtained real GNP growth data for 1985 and 1986 with which to compare the forecasts.

[4] The Administration's 1980 inflation forecast for the United States, which appeared in the September 1979 *WEO*, pertained to the GNP deflator rather than the CPI. The deflator calculated on the basis of data appearing in the 1981 *IFS* yearbook was used to test the accuracy of this forecast. Given the Administration data, the September 1979 Blue Chip, DRI and Federal Reserve forecasts of the increase in the U.S. GNP deflator—rather than CPI inflation—are employed in this comparison.

REVIEW
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An Outsider's Guide to Real Business Cycle Modeling

Joseph A. Ritter

One exhibits understanding of business cycles by constructing a model *in the most literal sense: a fully articulated artificial economy which behaves through time so as to imitate closely the time series behavior of actual economies.*

Robert E. Lucas (1977)

During the last decade, guided by Lucas' principle, the real business cycle (RBC) model has become a standard tool for a large share of macroeconomists. The tool has found such widespread applicability that proponents of this approach to macroeconomic modeling (and those with proper sensitivity training) now prefer a more generic label: computable dynamic general equilibrium model. Other demographic groups often regard the customs and rituals of RBC proponents with some degree of bafflement. The goal of this article is to dispel some of the aura of mystery that surrounds—from an outsider's point of view—the specification, calibration, solution and evaluation of RBC models.[1] It is thus concerned more with the "how's" of RBC modeling than with the "why's" (or, for that matter, the "why not's").[2] Broader introductions to real business cycle modeling can be found in Blanchard and Fischer (1989, chapter 7), McCallum (1989), Plosser (1989) and Stadler (1994). The pioneering papers are Kydland and Prescott (1982) and Long and Plosser (1983).

Three criteria have guided the model-building process in the RBC literature. (1) Decisions of firms and consumers should be derived from fully specified intertemporal optimization problems with rational expectations. (2) The general equilibrium of the model must be fully specified. (3) Both the qualitative and quantitative properties of the model should be studied. Lucas argued in 1980, before work began on RBC models, that theoretical developments beginning with Hicks, Arrow and Debreu allowed modern economists to begin work which met the first two criteria. The dramatic fall in the price of capital (computers) has made it possible to meet the third criterion as well, allowing macroeconomists to explore their models in much greater depth (although this potential is not always realized). This article is concerned mostly with giving an outsider a feel for how the third requirement is met. It proceeds by describing the theory underlying a standard RBC model, explaining what constitutes an equilibrium, and then delving into the mechanics of solving a specific model (Hansen's landmark indivisible labor model) using a specific technique. I conclude with two illustrations of how the basic methodology can be extended to study fiscal and monetary policy.

THEORY

The typical RBC model is an Arrow-Debreu type economy, specifically a one-sector stochastic growth model. Many identical consumers who live forever maximize expected utility (derived from goods and leisure) subject to an intertemporal budget constraint. Competitive firms purchase factors in competitive markets. Uncertainty comes from a stochastic shock to the economy's production technology.

For simplicity, suppose that consumers own capital directly and rent it to firms. Firms buy capital and labor services from consumers and use them to produce a single output which can be used as either consumption or investment. Output is the numeraire. The firms' technology is described by an aggregate con-

[1] Outsiders would include, among others, those who (like the author) were educated where these models were not in favor and those who (like the author) finished school before these models held a large market share.

[2] In this spirit, the programs used in the article are available on the FRED electronic bulletin board. For more information, see the back cover of this issue.

stant-returns-to-scale production function which includes an exogenous aggregate technology shock, A_t: $A_t F(K_t, L_t)$, where K_t and L_t are the *aggregate* levels of capital and labor.[3] The A_t are usually taken to be serially correlated, but the exact specification can be postponed. These are simple competitive firms which will purchase labor and capital services at wage W_t and rental price R_t up to the point where their marginal products equal W_t and R_t, respectively:

$$(1) \quad W_t = A_t F_L(K_t, L_t), \quad R_t = A_t F_K(K_t, L_t).$$

Let $\bar{l}$ be a consumer's time endowment, l_t the amount of labor she supplies, c_t her consumption, k_t her holdings of capital and i_t her rate of gross investment. (Upper case will be reserved for aggregate variables.) The consumer takes prices W_t and R_t as given. Given a starting value k_0, she chooses paths, that is, contingency plans, for i_t and l_t to maximize

$$\mathrm{E}_0\left\{\sum_{t=0}^{\infty}\beta^t u(c_t, \bar{l} - l_t)\right\}$$

subject to a budget flow constraint

$$(2) \qquad c_t + i_t \leq R_t k_t + W_t l_t$$

and a description of how capital accumulates and depreciates:

$$(3) \quad k_t = (1-\delta)k_{t-1} + i_t, \qquad 0 \leq \delta \leq 1$$

For present purposes, it is more useful to frame the solution in terms of decision rules which prescribe i_t and l_t as functions of current state variables, k_t, K_t and A_t:

$$i_t = i(k_t, K_t, A_t), \quad l_t = l(k_t, K_t, A_t).$$

These decision rules depend only on the state variables which fully describe the position of the economy at the beginning of *t* and which, therefore, contain all of the information needed to decide optimal levels of i_t and l_t. A great deal of information about how the economy works—about the structure of the model, in other words—will be embedded in these functions when we find them.

In addition to capital, there may be many financial assets with a net supply of zero, but, since consumers are identical and the economy is closed, these assets would be redundant. Nevertheless, the prices of these assets are determined by the model; once equilibrium quantities are known, they can simply be substituted into the Euler equation for each asset to determine its price.

Since consumers and firms are identical, this artificial economy is mathematically identical to a representative agent economy in which one *price-taking* consumer sells labor and capital services to a single *price-taking* firm. On the surface, finding an equilibrium appears to be a very daunting task. Even though we have reduced the number of consumers and firms to one each, we still have an infinite number of goods: consumption and leisure in various states of the world at dates from 0 to infinity. However, a great deal is known about the theory underlying this type of economy (Stokey, Lucas and Prescott, 1989), and this theory provides important tools that allow simulations to be constructed.

A SOLUTION IN PRINCIPLE

For the representative consumer, the state of this economy at the beginning of *t* is summarized by the individual's capital stock k_t, the aggregate capital stock K_t and the state of technology A_t. Thus, the maximum lifetime utility attainable by the consumer will be a function *V* of k_t, K_t and A_t. $V(k_t, K_t, A_t)$ is the *value function* for the consumer's utility maximization problem.

The core of the problem is to find *V*. To start, substitute the budget constraint (2) into the consumer's utility function, then substitute marginal products for W_t and R_t as described by equation 1. The latter substitution implicitly defines the consumer's rational expectations of factor prices in terms of present and future values of aggregate labor and capital. In other words, the consumer does not care about K_t and L_t per se; they merely contain the same information as W_t and R_t.[4] We now have

$$\mathrm{E}_0\left\{\sum_{t=0}^{\infty}\beta^t u\Big(A_t F_K(K_t, L_t)k_t + A_t F_L(K_t, L_t)l_t - i_t, \bar{l} - l_t\Big)\right\}.$$

In period 0, the consumer is choosing i_0 and l_0. Rewrite utility as

[3] For a long time, the technology shock A_t was the driving force in most RBC models (hence, the "real"). Both proponents and opponents recognized this as the Achilles heel of this line of research. One response has been the development of models in which technology is not the only source of uncertainty (the last section contains two examples), though the criticism goes deeper than simply claiming that there are other kinds of shocks (see Stadler, 1994, section IV.A.).

[4] The exact sequence of substitutions here is designed to hammer the model into the mold required later for a specific numerical solution method. For example, i_t could easily be eliminated from the problem using 3, but that would be inconvenient later.

$$(4)\quad u(A_0F_K(K_0,L_0)k_0 + A_0F_L(K_0,L_0)l_0 - i_0, \bar{l} - l_0) + \beta E_1\left\{\sum_{t=1}^{\infty}\beta^t u\left(A_tF_K(K_t,L_t)k_t + A_tF_K(K_t,L_t)l_t - i_t, \bar{l} - l_t\right)\right\}$$

Examination of the second term in 4 reveals an important feature of the optimization problem; apart from the values of state variables, the consumer will solve exactly the same problem in period 1 as in period 0. For an optimal plan, this recursion is summarized in the Bellman equation for the consumer's problem at t:

$$(5)\quad V(k_t,K_t,A_t) = \max_{i_t,l_t}\left\{u(i_t,l_t,k_t,K_t,L_t,A_t) + \beta EV\left\{(k_{t+1},K_{t+1},A_{t+1})\middle|A_t\right\}\right\}$$

The maximization on the right is subject to the constraint (3) that connects investment and capital. Embedded in 5 is Richard Bellman's deep insight that if you know the value of your problem next period for the various values of state variables, it is a relatively simple matter—a static maximization—to figure out the optimal action now.

There are four kinds of variables in 5: individual decision variables (i_t, l_t); an individual state variable (k_t); economy-wide state variables (K_t, A_t); and an economy-wide variable determined in t (L_t).[5] The state variables are determined at the start of t or inherited from $t-1$. The contemporaneously determined economy-wide variable L_t appears because (for mathematical reasons evident below) we have substituted out W_t and R_t. These market-clearing prices would otherwise summarize the information contained in K_t and L_t that is relevant to the consumer's decision. Our task is to find a *recursive competitive equilibrium*, that is, decision rules $i(k_t, K_t, A_t)$ and $l(k_t, K_t, A_t)$ for the household, functions $I(K_t, A_t)$ and $L(K_t, A_t)$ determining aggregate investment and labor, and a value function $V(k_t, K_t, A_t)$ such that

$$(6)\quad V(k_t,K_t,A_t) = u\left(i(k_t,K_t,A_t), l(k_t,K_t,A_t), k_t, K_t, L(K_t,A_t), A_t\right) + \beta E\left\{V(k_{t+1},K_{t+1},A_{t+1})\middle|A_t\right\}$$

with

$$(7)\quad L(K_t,A_t) = l(K_t,K_t,A_t) \quad \text{and} \quad I(K_t,A_t) = i(K_t,K_t,A_t).$$

Condition 6 says that, given expectations $L(\cdot)$, decision rules $i(\cdot)$ and $l(\cdot)$ are optimal for consumers. The equations in 7 say that expectations of aggregate labor supply and investment are consistent with individual decisions. Only a small number of examples can be solved analytically (for example, Long and Plosser, 1983), so we must now turn to the computer.

A SOLUTION IN PRACTICE

To compare the time-series behavior of the model's equilibrium with the time-series behavior of actual economies—to evaluate its quantitative implications—requires that we simulate the model using specific functional forms and parameter values. The process of choosing parameter values, calibration, is deferred to the next section. The next few sections illustrate solution procedures by fully specifying, calibrating and solving Gary Hansen's (1985) indivisible labor model, an early landmark in the RBC literature. Hansen's relatively simple model provides a clear illustration, but should not be taken as the state of the art. The solution follows one of the popular linear-quadratic approximation methods.[6]

Functional Forms

Subsequently, the production function is assumed to be Cobb-Douglas:

$$A_tF(K_t,L_t) = e^{\lambda_t}K_t^{\theta}L_t^{1-\theta}.$$

The technology shock e^{λ_t} is driven by an AR(1) process:

$$(8)\quad \lambda_t = \gamma\lambda_{t-1} + \varepsilon_t, \qquad |\gamma|<1,$$

where the ε_t are independent and identically

[5] Hansen and Prescott (1995) would call L_t an "aggregate decision variable." Other solution methods would solve for pricing rules that specify W_t and R_t as functions of state variables rather than for an "aggregate decision rule" for L_t. In either case, the functions capture the substance of the assumption of rational expectations.

[6] Taylor and Uhlig (1990) compare a number of approaches to solving stochastic growth models. Other papers in the same issue of the *Journal of Business and Economic Statistics* provide short descriptions of the various solution methods.

distributed normal random variables that are independent of all $t-1$ variables.[7] It is easier to work with λ_t rather than A_t as a state variable from this point forward.

The utility function is specified in a somewhat unusual way that incorporates indivisibility of labor inputs, the contribution of Hansen's paper,

$$(9) \qquad U(c_t, \bar{l}-l_t) = \log c_t + B(\bar{l}-l_t),$$

where B is a constant. The Bellman equation 5 becomes

$$(5') \qquad V(k_t, K_t, \lambda_t) = \max_{l_t, i_t}\Big\{\log\Big(e^{\lambda_t}F_K(K_t, L_t)k_t + e^{\lambda_t}F_L(K_t, L_t)l_t - i_t\Big) + B(\bar{l}-l_t) + \beta E\Big\{V(k_{t+1}, K_{t+1}, \lambda_{t+1})\big|\lambda_t\Big\}\Big\}$$

Hansen showed that using a representative consumer with this utility function produces the same competitive allocations as individual consumers described in the following way. Each consumer works either l_0 hours or not at all, but gets paid in either case. The probability of working, chosen by the consumer, is α_t. Labor supply is determined indirectly by choosing α_t rather than directly by choosing l_t. Total labor time in the economy is thus $L_t = \alpha_t l_0$. If the utility function of individual consumers is

$$(10) \qquad U(c_t, \alpha_t) = \log c_t + A\alpha_t \log(\bar{l}-l_0),$$

with $A>0$, then the representative consumer will have utility 9. By making these modifications, Hansen hoped to improve on the rather poor performance of the basic model (with divisible labor) in matching facts about relationships among hours, employment, output and productivity.

Iterating to Find the Value Function

Hansen's model could be solved using the shortcut of finding a Pareto optimum, that is, solving the social planner's problem. That approach, which was used extensively in the early RBC literature, would work like this: Since agents are identical in this model, a Pareto optimum can be found by maximizing utility (9) subject to society's production possibilities, ignoring market structure. Production possibilities are described by the production function, the process generating technology shocks, and the capital accumulation equation. This is a much simpler problem. Since the model has no distortions, the Second Welfare Theorem applies: The Pareto optimal allocation can be supported as a competitive equilibrium. Thus, the solution to the social planner's problem replicates the outcomes of a decentralized competitive system.

Rather than taking the shortcut of solving the social planner's problem, this section follows the more general method described in Hansen and Prescott (1995) that also applies to models with distortions.[8] Two such models are briefly described in the section titled "Extending the Basic Model."

There are two keys to finding the value function V using functional equation 5 or 5′. The first is approximation, described shortly. The second is the Contraction Mapping Theorem, a fixed point theorem, which guarantees that for certain problems the following steps will converge to the value function V. The theorem does not actually apply to many RBC models, so there is no guarantee in general, but this approach usually converges anyway, finding the correct value function.

1. Choose an arbitrary function $V^0(k_{t+1}, K_{t+1}, \lambda_{t+1})$.
2. The problem on the right-hand side of 5 is now a static optimization. Solve it to get decision rules $i_t = i(k_t, K_t, \lambda_t)$ and $l_t = l(k_t, K_t, \lambda_t)$. Substitute these into the right-hand side to produce a new function, $V^1(k_t, K_t, \lambda_t)$.
3. Replace V^0 on the right-hand side of 5 with $V^1(k_{t+1}, K_{t+1}, \lambda_{t+1})$. Return to step two unless V^i and V^{i+1} are almost identical.

Unfortunately, in general, step 2 will not produce a function that can be written down in any compact way, particularly given the presence of the expectation in the middle of the right-hand side of 5. This problem is addressed in Hansen and Prescott's method by solving a quadratic approximation of the

[7] This specification differs slightly from Hansen's, which assumes that the technology is $\lambda_t F(K_t, L_t)$, with ε_t log-normally distributed. Choice of an AR(1) process might be considered part of calibration since a specification search is usually part of the overall process of estimating γ.

[8] The method described here and in the appendix differs in details from Hansen and Prescott's algorithm.

model, rather than the full model. Variations on the linear-quadratic approximation have been the most common method of solving dynamic general equilibrium models, starting with Kydland and Prescott (1982).

For simulation purposes, the model is approximated by a Taylor series expansion of the utility function (as it appears in 4 after all the substitutions) around the steady-state equilibrium values ($\bar{K}, \bar{L}, \bar{\lambda}$) that would occur if we set all the shocks to zero. In some models, the zero-shock equilibrium is not a steady state. In these cases, a simple change of variables usually produces the required steady state. If, for example, the population were assumed to be growing, the model would be formulated in per capita terms. For Hansen's model, (5′) becomes

$$(5'') \quad V(k_t, K_t, \lambda_t) = \max_{l_t, i_t}\Big\{Z_t'QZ_t + \beta E\big\{V(k_{t+1}, K_{t+1}, \lambda_{t+1})\big|\lambda_t\big\}\Big\}$$

where $Z_t = [1\ \lambda_t\ k_t\ K_t\ i_t\ l_t\ I_t\ L_t]'$. Including 1 as a state variable allows the quadratic approximation to be written as a single quadratic form (see the appendix).

The beauty of the quadratic approximation is threefold. First, one can guess (correctly) that the value function is quadratic. Second, it does not depend on the distribution of ε_t except for a constant that involves the covariance matrix of ε_t. Third, this constant is not essential for our analysis because it does not involve any of the state variables. Because the constant is not essential, we can ignore it and the expectation along with it. For details, see Sargent (1987, section 1.8), but it is not difficult to see that the iterations described above will always produce a quadratic if V^0 is quadratic.

Imposing Equilibrium Conditions

Most of the pieces of a solution method have already been described, but there is one missing, namely, how to handle L_t. This is neither a state variable nor a decision variable of any agent. It is an aggregate outcome of households' decisions. The aggregation happens to be trivial here because there is only one household. But the distinction between l_t and L_t must be maintained because the household must behave as if it takes prices (W_t and R_t) as given, and these would be functions of L_t, not l_t, if we had more than one consumer.

So how should L_t be handled? (Though it does not appear in the model, we also need to worry about I_t for reasons that will become clear momentarily.) The model assumes that households have rational expectations about L_t and I_t, so they recognize that equilibrium values of these variables will satisfy the first-order conditions. In maximizing the right-hand side of 5″ at each iteration, the first-order conditions define a linear relationship among choice variables l_t and i_t, aggregates L_t and I_t, and state variables:

$$0 = u_{0l} + u_{1l}l_t + u_{2l}i_t + u_{3l}L_t + u_{4l}I_t + u_{5l}k_t + u_{6l}K_t + u_{7l}\lambda_t$$

$$0 = u_{0i} + u_{1i}l_t + u_{2i}i_t + u_{3i}L_t + u_{4i}I_t + u_{5i}k_t + u_{6i}K_t + u_{7i}\lambda_t.$$

The first-order conditions can be solved for l_t and i_t to get household decision rules specified in terms of state variables, as well as L_t and I_t. However, if L_t is substituted for l_t and I_t for i_t in the first-order conditions (thus imposing 7), the equations can be solved for L_t and I_t as functions of state variables. These solutions can be interpreted as households' conditional expectations of *aggregate* labor supply and investment, given the current values of state variables. Hansen and Prescott call these "aggregate decision rules." The solutions for aggregate labor supply and investment replace L_t and I_t in the household decision rules which then become functions of state variables alone.[9] This procedure ensures that condition 7 for a recursive competitive equilibrium is satisfied at every iteration.

When the value function approximations converge, we have found a value function, decision rules for l_t and i_t, and aggregate labor supply and investment functions that satisfy equations 6 and 7 by construction. The Contraction Mapping Theorem does not apply to this particular dynamic programming problem, but the algorithm does find the value function

[9] Though it appears here formally, I_t drops out of household decision rules for this model, that is, $u_{4l} = u_{4i} = 0$.

Table 1

Percentage Standard Deviations and Correlations with Output

	United States[1]		Model[2]	
	S.D.	Corr.	S.D.	Corr.
Output	1.76	1.00	1.76	1.00
Consumption	1.29	0.85	0.51	0.86
Investment	8.60	0.92	5.75	0.99
Capital	0.63	0.04	0.48	0.06
Hours	1.66	0.76	1.34	0.98
Productivity	1.18	0.42	0.51	0.87

[1] As reported by Hansen, Table 1.

[2] Averages across 500 simulations.

if given an appropriate V^0. The results are, of course, subject to the caveat that if shocks take the economy too far from the steady state, the quadratic approximation may not be accurate.

CALIBRATION

There are six unknown parameters in the description of Hansen's model, θ, δ, β, B, γ and the variance of ε. Hansen chose values as follows. Given Cobb-Douglas technology, θ is capital's share of output. He used an estimate of $\theta = 0.36$ based on time series for the U.S. economy. A choice of $\delta = 0.025$ (corresponding to an annual depreciation rate of 10 percent) was chosen as "a good compromise given that different types of capital depreciate at different rates." A steady-state annual riskless real interest rate of 4 percent would be implied by $\beta = 0.99$. Hansen chose $B = 2.85$, which corresponds to an apparently arbitrary value of $A = 2$ in 10, combined with $l_0 = 0.53$. The 0.53 value equated steady-state hours in Hansen's divisible and indivisible labor models.

The standard deviation of ε was chosen so that, for the artificial economy with indivisible labor, the standard deviation of detrended output would be about the same as that of detrended GNP for the U.S. economy. A value $\sigma_\varepsilon = 0.00717$ meets this criterion.[10] A value of $\gamma = 0.95$ was the first-order autocorrelation coefficient of the Solow residuals for the U.S. economy.

[10] This differs slightly from Hansen's value (0.00712) because technology shocks are specified in a different way.

[11] See Kydland and Prescott (1982, p. 1362).

Calibration strategies are often much more complex than this, and the justifications more elaborate, but they always have the same simple purpose, to select a plausible parameter point at which to study the behavior of the model. Kydland and Prescott (1994) detail calibration strategies and their own philosophy of calibration. Researchers often conduct informal sensitivity analyses, varying the parameters whose values are most uncertain. The most common such exercise seems to be to vary the risk aversion parameter in models in which utility is of the constant relative risk aversion form.

RESULTS

Once the value function is found and agents' decision rules are known, it is relatively simple to simulate the model. The equations of motion for λ_t and K_t along with the aggregate decision rule for I_t are a system of three linear difference equations in three unknowns that can easily be simulated. (Recall that $K_t = k_t$ in equilibrium.) Starting values are chosen for the state variables and innovations ε_t are drawn randomly.

The real and artificial data are filtered by taking logarithms and detrending with the Hodrick-Prescott filter.[11] There are two reasons for filtering. First, the model is intended to explain phenomena at business cycle frequencies, and the Hodrick-Prescott filter highlights those frequencies. The models are not intended to match long-run growth facts, so it would be unfair to compare low-frequency movements in the data with those from the model. A filter that removes low-frequency movements in the data and model output allows the model to be compared to phenomena in the data it was designed to explain.

Second, many macroeconomic time series may not be stationary. If this is true, their second moments do not exist. Though it would still be possible to generate sample second moments, there would be no reason to think that another set of observations on the same economy would produce sample second moments similar to the first set. Thus, there would be no point in trying to produce models that matched a particular set of sample second moments. Filtering that induces stationarity removes this problem in the sense that samples drawn from the same data-generating process would be expected to produce similar sample second moments.

There are other ways to filter the data, by taking first differences, for example. While the Hodrick-Prescott filter is somewhat controversial (Cogley and Nason, 1995; King and Rebelo, 1993), proponents argue that it does a good job of emphasizing the movements in the data that most macroeconomists would call business cycle movements. For example, Kydland and Prescott (1990) say "...the implied trend path for the logarithm of real GNP is close to the one that students of business cycles and growth would draw through a time plot of this series." Cogley and Nason argue, on the other hand, that if the data are an integrated process, "the filter can generate business cycle periodicity and co-movement even if none are present in the original data. In this respect, applying the HP filter to an integrated process is similar to detrending a random walk."

The results in Table 1 summarize 500 simulations of 115 periods each. The statistics are calculated from natural logarithms of each series detrended using the Hodrick-Prescott filter with a parameter of 1600. Each simulation chooses λ_0 from the unconditional distribution of λ_t. This is more difficult for K_0, so I simulate the model for 100 periods, starting K at its steady-state value. The value after 100 periods is used as K_0 for the simulations reported in Table 1.[12] In other words, I simulate the model for 215 periods and throw away the first 100 in order to get a representative distribution of starting capital stocks. This procedure allows the statistics reported in the table to be interpreted as averages across 500 identical artificial economies with independent realizations of the technology shocks.

Evaluation of RBC models' output has usually been informal. Hansen, for example, was interested in how well this indivisible labor model performed relative to a more standard divisible labor model (with utility given by $\log c_t - A \log l_t$). He noted that the standard deviation of hours relative to that of productivity in the divisible labor model was only about 1 compared to 1.34/0.51 = 2.6 for the indivisible labor model and 1.4 for the U.S. economy. He argued that the indivisible labor model showed promise because standard models chronically produced ratios that were too small. Since the real world is not characterized by fully indivisible labor, he argued, it was good that the ratio for the U.S. economy lay between the two models' predictions.

A few additional tools have been used to evaluate model output. A fairly common approach is to compare impulse response functions from the model with those from a vector-autoregression on the data. Watson (1993) has proposed a procedure for evaluating the fit of a calibrated model. A variety of new approaches is discussed in Pagan (1994), which is a thought-provoking overview of calibration exercises.

EXTENDING THE BASIC MODEL

The solution technique described above is more powerful than needed to solve Hansen's model, but makes it possible to outline how more sophisticated models can be handled. I've chosen two examples from areas in which extensive contributions have been made. These particular papers fit easily into the framework developed above.

Fiscal Policy

One obvious road to follow in generalizing the basic RBC model is to add fiscal policy to the model. Though obvious, this was not initially an easy road because a minimally realistic model requires distorting taxes. The first generation of solution methods that relied on solving the social planner's problem are not appropriate for models in which the Second Welfare Theorem is not true.

A recent contribution in this area is McGrattan (1994a, 1994b), which developed a model in which agents face stochastic tax rates on both labor and capital income. McGrattan (1994b) modified the indivisible labor model as follows. The government uses tax revenue to fund government purchases and lump-sum transfers. Thus, the consumer's budget constraint (2) is replaced by

[12] The values reported in columns three and four of Table 1 differ very slightly from those reported by Hansen. Sampling variation and a slightly different process generating λ probably account for the differences.

$$c_t + i_t \leq (1-\tau_t) R_t k_t + \delta \tau_t k_t + (1-\phi_t) W_t l_t + \xi_t,$$

where the capital tax allows a depreciation deduction and ξ_t is the lump-sum transfer. The tax rates, τ_t and ϕ_t, and government purchases, g_t, are exogenous state variables (like the technology shock λ_t). The size of the transfer is determined by the government budget constraint which imposes period-by-period budget balance:

$$\xi_t = \tau_t (R_t - \delta) K_t + \phi_t W_t L_t - G_t.$$

The representative agent must form expectations about ξ_t assuming that her decisions have no influence over government revenue. Thus, K_t and L_t rather than k_t and l_t appear in the government budget constraint. In this model, there are four exogenous state variables, λ_t, τ_t, ϕ_t and G_t. McGrattan calibrated the stochastic processes for these variables by estimating a first-order autoregression for each. She argues that her results indicate the addition of these fiscal shocks to the basic indivisible labor model brings it into "much better agreement with the data."

To solve the model using the procedure outlined above, substitute the new budget constraint into the utility function, as before.[13] Then substitute the right-hand side of the government budget constraint for ξ_t. Add the assumed stochastic processes for tax rates and government purchases to the list of equations of motion (the matrix A in the language of the appendix).

Money

Cooley and Hansen (1989) studied an RBC model with a cash-in-advance constraint. In the simpler version of their model, the money supply M_t grows at a constant rate, g:

$$M_t = (1+g) M_{t-1}.$$

Households' consumption decisions must satisfy the cash-in-advance constraint,

$$P_t c_t \leq m_{t-1} + g M_{t-1},$$

which says that the nominal value of consumption purchases, $P_t c_t$, must not exceed money balances carried over from last period, m_{t-1}, plus the lump-sum transfer of seigniorage revenue, gM_{t-1}.

The household budget constraint is

$$P_t c_t + P_t i_t + m_t = P_t W_t l_t + P_t R_t k_t + m_{t-1} + g M_{t-1}.$$

The last term on the left represents money balances carried into $t+1$.

Because positive money growth results in inflation, it is necessary in this model to make a change of variables for the zero-shock path to be stationary. (Recall that we need a steady state around which to form a quadratic approximation.) There is a steady state when the model is written in terms of $\hat{m}_t = m_t/M_t$ and $\hat{P}_t = P_t/M_t$. The two constraints (transformed by the change of variables) are used to eliminate c_t and l_t from the consumer's utility function, leaving an optimization over m_t (money holdings carried into t+1) and i_t.

The money supply M_t is an exogenous state variable, and is added to the list of equations of motion. The endogenous state variables are k_t, K_t and m_{t-1}. An equation of motion that says that this period's purchases of money become next period's money state variable is added to the list for endogenous state variables (the B matrix in the notation of the appendix).

The aggregates that must be determined are an investment function $I(\lambda_t, M_t, K_t)$ and an aggregate price function $P(\lambda_t, M_t, K_t)$. Since M_t is exogenous, there is no aggregate that corresponds directly with the decision variable m_t. The aggregate price level P_t serves this role instead: At each iteration, $I(\lambda_t, M_t, K_t)$ and $P(\lambda_t, M_t, K_t)$ are chosen by setting $i_t = I_t$ and $\hat{m}_t = 1$ (that is, $m_t = M_t$) in the first-order conditions and solving for I_t and P_t as functions of state variables. (For Hansen's model, by contrast, we set $i_t = I_t$ and $l_t = L_t$ in the first-order conditions, then solved for I_t and L_t.) Details on how to handle this slight variation can be found in Cooley and Hansen (1989).

CONCLUSION

RBC methods have found application in a wide spectrum of questions in business cycles, monetary economics, open economy macroeconomics and finance. The linear-

[13] McGrattan actually used a method described in McGrattan (1994c).

quadratic approach described in this paper is a popular tool that can be applied to a broad cross-section of the questions posed in this literature. More generally, careful study of a specific method illustrates how equilibrium conditions must be tied to optimization to find an equilibrium numerically.

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Appendix

FINDING THE VALUE FUNCTION

Notation

Let $\rho(x)$ be the number of rows in the vector x. Let z be the vector of exogenous state variables, s and S the vectors of individual and aggregate endogenous state variables, d the vector of decision variables, and D the vector of "aggregate decision variables." For reasons of convenience, the first element of z is always 1. Let

$$X = \begin{bmatrix} z \\ s \\ S \end{bmatrix}$$

and $$Z = \begin{bmatrix} X \\ d \\ D \end{bmatrix}$$

Using ~ to denote next-period values, the constraints are

$$\tilde{z} = Az + \varepsilon = [A \quad 0 \quad 0 \quad 0 \quad 0] \begin{bmatrix} z \\ s \\ S \\ d \\ D \end{bmatrix} + \varepsilon$$

$$\tilde{s} = BZ = [B_1 \quad B_2 \quad B_3 \quad B_4 \quad B_5] \begin{bmatrix} z \\ s \\ S \\ d \\ D \end{bmatrix}$$

$$\tilde{S} = [B_1 \quad B_2 \quad B_3 \quad B_4 \quad B_5] \begin{bmatrix} z \\ S \\ S \\ D \\ D \end{bmatrix}$$

$$= [B_1 \quad 0 \quad B_2 + B_3 \quad 0 \quad B_4 + B_5] \begin{bmatrix} z \\ s \\ S \\ d \\ D \end{bmatrix}$$

or, combining all three,

$$\tilde{X} = CZ = \begin{bmatrix} A & 0 & 0 & 0 & 0 \\ B_1 & B_2 & B_3 & B_4 & B_5 \\ B_1 & 0 & B_2 + B_3 & 0 & B_4 + B_5 \end{bmatrix} \begin{bmatrix} z \\ s \\ S \\ d \\ D \end{bmatrix} + \begin{bmatrix} \varepsilon \\ 0 \\ 0 \end{bmatrix}$$

The matrix C is $\rho(X) \times \rho(Z)$.

For Hansen's model,

$$Z_t = [1 \;\; \lambda_t \;\; k_t \;\; K_t \;\; i_t \;\; l_t \;\; I_t \;\; L_t]',$$

$$A = \begin{bmatrix} 1 & 0 \\ 0 & \gamma \end{bmatrix},$$

$$B = [0 \;\; 0 \;\; (1-\delta) \;\; 0 \;\; 1 \;\; 0 \;\; 0 \;\; 0].$$

The General Form of the Problem

Using the notation in Hansen and Prescott (1995), the problem we wish to solve in order to find an equilibrium is

$$\text{(A1)} \quad V(X) = \max_d \; r(Z) + \beta \mathrm{E}\{V(\tilde{X}) | z\}$$

$$\text{subject to} \quad \tilde{X} = CZ + \begin{bmatrix} \varepsilon \\ 0 \\ 0 \end{bmatrix}$$

$$\text{with} \qquad D = D(z, S).$$

All nonlinear constraints have been substituted into the return function r. As mentioned above, the $D = D(z, S)$ equation summarizes agents' rational expectations about aggregate values of their own decision variables, for example, labor supply. Since it does not involve the choice variables d, it is not really a constraint, but will be used to derive decision rules that depend only on X rather than both X and D. This is why the problem specifies "with" rather than "subject to."

Steady-State Solution

The return function will be approximated around a steady-state solution to the model when $\varepsilon = 0$. The steady-state solution solves the following set of $\rho(Z)$ equations in elements of Z:

$$X = CZ \text{ (excluding the } s \text{ rows)}$$
$$0 = r_d(Z) + \beta r_s(Z)[I - \beta B_s]^{-1} B_d$$
$$d = D$$
$$s = S.$$

The first vector equation contains $\rho(z) + \rho(S)$ scalar equations.[1] The second vector equation contains $\rho(d)$ scalar equations that are the first-order conditions for d. They take into account the recursive nature of A1, that is, the fact that d affects every future period by changing $\tilde{s}$. B_s is the derivative of BZ with respect to s, that is, the $\rho(s)$ columns of B that correspond to the s elements of Z (the $\rho(z)+1$ through $\rho(z)+\rho(s)$ elements). Similarly, B_d consists of the $\rho(d)$ columns of B that correspond to the d positions in Z (the $\rho(X)+1$ through $\rho(X)+\rho(d)$ elements).

The Quadratic Approximation as a Quadratic Form

Let x be a k row vector and let Ψ be a $(k+1)\times(k+1)$ matrix. Partition Ψ so that Ψ_{11} is a scalar. Then

$$\begin{bmatrix}1\\x\end{bmatrix}'\begin{bmatrix}\Psi_{11} & \Psi_{12}\\ \Psi_{21} & \Psi_{22}\end{bmatrix}\begin{bmatrix}1\\x\end{bmatrix} = \Psi_{11} + (\Psi_{21}' + \Psi_{12})x$$
$$+ x'\Psi_{22}x.$$

Thus, any quadratic function from $\mathbf{R}^k$ into $\mathbf{R}$ of a vector x can be written as a single quadratic form in $[1\, x']$ by collecting the constant terms in Ψ_{11}, the linear terms in $(\Psi_{21}' + \Psi_{12})\,x$, and the squared terms in $x'\Psi_{22}x$.

The quadratic approximation to the return function is subsequently written in this way. Denote the quadratic approximation to $r(Z)$ by $Z'QZ$. The matrix Q involves derivatives that can be calculated either analytically or numerically.

Substituting Out Constraints and Equilibrium Conditions

The remainder of this appendix describes the process of finding a sequence of approximations to the value function that converges to the actual value function for the linear-quadratic problem. The value function for this kind of problem is known to be quadratic. The first function in the sequence can be any quadratic function, but convergence is sometimes sensitive to the choice. Hansen and Prescott recommend $V^{(0)} = \eta I$, where η is a small negative number.

If $V^{(n)}$ is the $\rho(X)\times\rho(X)$ matrix of the n^{th} quadratic value function approximation, the $(n+1)^{\text{st}}$ approximation is given by

$$\max_d Z'QZ + \beta\tilde{X}'V^{(n)}\tilde{X}$$
$$\text{subject to } \tilde{X} = CZ$$
$$\text{with } D = GX.$$

The equation $D = GX$ summarizes the "aggregate decision rules" implied by $V^{(n)}$ (the derivation of these is described below). As explained above, this equation is not a constraint.

First eliminate the equations of motion for state variables to get an equivalent problem

$$\max_d Z'QZ + \beta Z'C'V^{(n)}CZ \text{ with } D = GX$$

or

$$\max_d Z'RZ \text{ with } D = GX.$$

Decision Rules

The first-order conditions for this problem are the second-to-last $\rho(d)$ rows (the $\rho(X)+1$ through $\rho(X)+\rho(d)$ rows) of

$$0 = (R + R')Z.$$

Write these $\rho(d)$ equations as

$$0 = UZ$$

where U is $\rho(d)\times\rho(Z)$.

Partition U to conform with the components of Z:

$$0 = [U_1 \;\; U_2 \;\; U_3 \;\; U_4 \;\; U_5]\begin{bmatrix}z\\s\\S\\d\\D\end{bmatrix}.$$

Solving for d yields[2]

$$d = -U_4^{-1}(U_1 z + U_2 s + U_3 S + U_5 D).$$

The aggregate decision rules are obtained

[1] Numerical methods for solving these equations usually require dropping the equation that describes the evolution of the state variable 1. Most economists have little trouble solving this equation analytically, however.

[2] In some circumstances U_4 is close to singular, which leads to convergence problems. An alternative is to impose the equilibrium condition $D = d$ before solving for d, which instead requires $(U_4 + U_5)^{-1}$. One caveat is needed, however. This variation leads to individual decision rules which have the wrong weights on d and D, though the sum of the weights is correct (so that aggregate decision rules are correct). If, for some reason, individual decision rules are needed, the correct weights can be found by choosing them so that the first-order conditions used in finding the steady state are satisfied with D at its equilibrium values but with $d \neq D$.

by setting $d = D$ and $s = S$ in the first-order conditions. This leads to

$$D = -(U_4 + U_5)^{-1}\begin{bmatrix} U_1 & 0 & (U_2 + U_3) \end{bmatrix}\begin{bmatrix} z \\ s \\ S \end{bmatrix}$$

$$= GX.$$

Substituting this into the previous equation gives individual decision rules that are functions of state variables only:

$$\begin{aligned} d &= -U_4^{-1}(U_1 z + U_2 s + U_3 S + U_5 GX) \\ &= -U_4^{-1}\left(\begin{bmatrix} U_1 & U_2 & U_3 \end{bmatrix} + U_5 G\right)X \\ &= HX. \end{aligned}$$

Substitute

$$\begin{bmatrix} d \\ D \end{bmatrix} = \begin{bmatrix} H \\ G \end{bmatrix} X$$
$$= JX$$

into the objective function as follows to obtain the new value function:

$$\begin{aligned} Z'RZ &= \begin{bmatrix} X \\ JX \end{bmatrix}' R \begin{bmatrix} X \\ JX \end{bmatrix} \\ &= \begin{bmatrix} X' & X'J' \end{bmatrix} R \begin{bmatrix} X \\ JX \end{bmatrix} \\ &= \begin{bmatrix} X' & X'J' \end{bmatrix} \begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \begin{bmatrix} X \\ JX \end{bmatrix} \\ &= \begin{bmatrix} X'R_{11} + X'J'R_{21} & X'R_{12} + X'J'R_{22} \end{bmatrix} \begin{bmatrix} X \\ JX \end{bmatrix} \\ &= X'R_{11}X + X'J'R_{21}X + X'R_{12}JX + X'J'R_{22}JX \\ &= X'[R_{11} + J'R_{21} + R_{12}J + J'R_{22}J]X \\ &= X'V^{(n+1)}X. \end{aligned}$$

The value function is updated until $V^{(n+1)}$ and $V^{(n)}$ are sufficiently close. The (1,1) element of V tends to converge slowly, but, because it does not enter the first-order conditions ($UZ = 0$), that element can be ignored when testing for convergence, unless the value function itself is needed.

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